# Transforming and Embracing Innovation in Ohio's 9th Congressional District:

# Moving towards Sustainable, Efficient and Reliable Energy

**December, 2011**

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# Executive Summary

The overall objective of this project was to lay the conceptual and analytical foundation for a healthy, efficient and sustainable energy economy in Northern Ohio. Under this award, researchers analyzed the feasibility of implementing solar, wind and biogas energy projects in the 9th Congressional District. Others evaluated options for improving the energy efficiency of residential and commercial buildings, as well as the transportation sector. The key findings resulting from this research and analysis are:

## *The 9th Congressional District has sufficient wind, solar and biogas potential to meet all of its electricity demands*

### Energy generated from wind, solar and biomass currently comprises only a tiny fraction of the District's total annual energy production.

Only 1.4% of the District's (non-transportation) energy derives from renewable sources. The preponderance of the District's renewable energy derives from biomass, with solar and wind combined comprising only 16.8% of total renewable energy production. Tremendous opportunity exists for growth in the District's renewable energy production, particularly energy derived from wind, solar and biogas from farm and food processing waste.

### An estimated 13,347 gigawatt hours (GWh) of wind energy could be generated annually in the 9th Congressional District, almost twice the amount of electricity that the entire District consumes in a year.

The District's greatest wind speeds are near Lake Erie, though much of this land is excluded from wind development because it is a protected wildlife area or has other restricted uses. If wind development were to be restricted further—for example, requiring 1 km or 3 km buffers between excluded areas and wind turbines—estimates of potential wind energy drop considerably to 4,076 GWh and 1,279 GWh annually, respectively. Because the strongest winds tend to be in or near restricted areas, and because wind is not a baseload power source, it is unlikely that the District could ultimately generate all of its electricity from wind. However, wind energy could certainly become a much larger component in our District's energy mix.

### The District's total residential rooftop space could accommodate enough photovoltaic panels to generate 12,598 to 14,173 GWh—enough to power between 1.2 million and 1.4 million homes.

Though not a sunny climate relative to other parts of the country and world, the 9th Congressional District's solar resources are comparable to other states (Massachusetts, New Jersey) and greater than countries (Germany) with the highest deployment of photovoltaics. In addition to rooftop solar arrays, ground-mounted "solar farms," such as the 2.8 MW array in Perrysburg, Ohio, could also generate large quantities of clean, safe and sustainable energy.

### Our District's biomass "waste" (animal manure, crop residue and food processing waste) could generate sufficient electrical energy to meet the needs of 1134 households in the District.

Although the embodied energy in this farm and food processing waste is insufficient to be a major energy source for the District, converting this waste to biogas has many ancillary benefits beyond energy production. In the case of food processing waste that currently incurs fees, biogas conversion would enable food processing businesses to turn a net loss into a net gain in money, energy, or both. Likewise, farm-scale manure digesters could enable farmers to simultaneously eliminate odors, reduce animal bedding costs, provide heat or electricity to the farm, and possibly even sell surplus electricity to the utility.

### In spite of its vast untapped renewable resources, energy production from wind, solar and biogas in the 9th Congressional District is not economically viable without supportive state and federal policies and incentives.

Under this award, case studies of energy generation from wind, rooftop-mounted solar, ground-mounted solar, farm-based biogas and regional biogas projects all highlight the necessity of sustained, supportive government policies and incentives to enable a transition to these cleaner, safer, renewable energy sources. The wind, roof-mounted solar, and ground-mounted solar projects all propose financing the projects in part through the American Recovery and Reinvestment Act Section 1603 grant program. Both biogas projects rely upon USDA's Rural Energy for America grants for a significant portion of their financing. All of these projects are supported by Ohio's Renewable Portfolio Standard, which mandates the state's investor-owned utilities to acquire a certain percentage of their total electricity portfolio from renewable sources. These and other government programs are absolutely vital for enabling the region's transition from traditional fuel sources to still emerging renewable sources.

### *To be effective, any large-scale effort to improve the energy efficiency of the District's homes and businesses must be carefully designed to overcome barriers unique to particular consumers or communities.*

Although energy efficiency—energy acquired through the elimination of waste—is by far the cheapest, cleanest energy source, energy and cost savings can be maximized through careful analysis of energy consumption data and feedback from other energy efficiency retrofit programs.

### Energy consumption within the District is very unevenly distributed, with 208 industrial customers consuming 39% of the District's total electricity while 238,466 residential customers collectively use 29%.

Moreover, energy companies serving the 9$^{th}$ Congressional District forecast residential energy use decreasing over the next ten years while consumption by industrial and commercial sectors increases. It is apparent from this data that any attempt to significantly reduce energy usage in the District must target industrial customers. However, commercial and residential customers also account for a sizeable portion of consumption and thus must be part of any community-wide energy efficiency program.

### Energy efficiency program models that are effective for industrial and commercial customers are generally not well-suited for residential customers.

Energy use of industrial and commercial entities tends to be fairly centralized and higher than residential customers. Therefore, a program model in which a third party is engaged to either guarantee energy savings or to finance the retrofit through eventual energy savings, is generally much more effective for industrial and large commercial customers than residential ones.

### A successful community-wide residential energy efficiency retrofit program will structure the financing and repayment of energy efficiency work so as to appeal to the broadest residential constituency.

Experts identified seven common barriers to energy efficiency programs: upfront costs, opportunity costs, risk, lack of knowledge or understanding, transaction costs, split incentives, and structural barriers. Many of these barriers can be overcome by incorporating creative methods for residents to repay loans for energy efficiency retrofits. Property Assessed Clean Energy (PACE), repayment linked to the property and Pay As You Save (PAYS), repayment linked to the utility meter, are examples of repayment methods that can broaden the reach of energy retrofit programs.

## *The 9th Congressional District is home to a growing number of businesses and jobs in the solar and wind industry supply chains, yet far more workers in the District could be employed by the clean energy economy.*

### Researchers estimate that 177 businesses involved in the wind and solar supply chains exist within the 9th Congressional District, employing approximately 6,535 full-time positions.

The wind and solar supply chains represent large and growing industries in the 9th Congressional District, with solar-related industries clustering in northwest Ohio and wind-related industries predominating in northeast Ohio. Although some of these are large, well-established companies, the majority employ less than ten people. As these industries have grown while the State and District's overall manufacturing sector has shrunk, they represent an enormous economic development opportunity for the District.

**A large-scale energy retrofit program would provide many additional jobs**.

Unemployed workers from the building industry could easily be retrained to weatherize and insulate homes and businesses.

### *A transition away from our region's current inefficient, fossil-fuel based transportation system will require major changes in individual and business behavior, land use planning, allocation of public funds, and interregional coordination.*

A case study of the transportation system in the City of Oberlin conducted under this award demonstrates that, achieving climate neutrality in the transportation sector by 2050, while possible, will require enormous shifts from current practice. Although the City of Oberlin has certain characteristics that make its transportation profile unique, many of the strategies proposed in this case study are applicable to other municipalities seeking to reduce petroleum consumption and greenhouse gas emissions.

### *As with previous energy transitions in our nation's history, a large-scale transition towards clean, sustainable renewable energy sources requires supportive state and federal policies as well as significant and sustained incentives.*

The employment opportunities, energy production, and energy savings through energy efficiency retrofits analyzed in this report are all achievable. The technology and expertise already exists. A workforce with both manufacturing and building skills exists. Wind, solar and biomass resources exist. The missing element is confidence in consistent government policies and incentives comparable to those that promoted our nation's shift to oil and gas, nuclear, and hydroelectric energy in the past.

# Introduction

In September of 2010, Marcy Kaptur, Congresswoman for the U.S. 9th Congressional District, secured funding from the U. S. Department of Energy's (DOE) National Energy Technology Laboratory to increase the reliability of the District's energy infrastructure, the sustainability of its energy sources, and the efficiency by which energy is transmitted and used. This award advances one of the DOE's main goals moving forward:

> "To catalyze the timely, material, and efficient transformation of the nation's energy system and secure U.S. leadership in clean energy technologies."[1]

Ultimately, the work resulting from this award prepares the 9th Congressional District to lead the region in its transition away from a fossil fuel-based energy system towards a cleaner, more sustainable future.

## *Project Objectives*

The overall objective of this project was to lay the conceptual and analytical foundation for an energy economy in Northern Ohio that would:

- Improve the efficiency with which energy is used in the residential, commercial, industrial, agricultural and transportation sectors for Oberlin, Ohio;
- Identify the potential to deploy wind and solar technologies and the most effective configuration for the regional energy system;
- Analyze the potential within the District to utilize farm wastes to produce biofuels;
- Enhance long-term energy security by identifying ways to deploy local resources and building Ohio-based enterprises;
- Identify the policy, regulatory, and financial barriers impeding development of a new energy system; and
- Improve energy infrastructure within Northern Ohio.

Some of these objectives have been met through immediate, concrete improvements to the District's energy systems, thereby increasing reliability and efficiency. American Municipal Power (AMP), a non-profit wholesale energy supplier and services provider for member municipal electric systems, partnered with the member municipalities of Oak Harbor, Elmore and Wellington on a variety of energy improvement initiatives. These included: upgrading energy transmission lines, converting street lighting to energy-efficient LEDs, and installing a solar array that creates sufficient energy to power an electric vehicle that reads and services the community's metering system.

However, most of the Project's objectives have involved long-term planning and analysis, rather than "bricks and mortar" enhancements. By assessing the feasibility of various renewable energy and energy efficiency initiatives that would reduce the District's reliance on fossil fuels, this work paves the way for the District's transition to a clean energy economy. To this end, researchers have analyzed the feasibility of implementing solar, wind and biogas energy projects in the District. Others have evaluated options for improving the energy efficiency of residential and commercial buildings, as well as the transportation sector.

## *Potential Benefits for the 9th Congressional District*

If enacted, the proposed plans resulting from these analyses would enable the 9th Congressional District to:

### Become more self-reliant in its energy sources, keeping more energy dollars locally and increasing energy security.

An estimated $40 billion is spent *annually* within the State of Ohio on imported fossil fuels to meet its total energy needs. In addition to importing virtually all of its oil and gasoline, Ohio imports approximately 75% of its coal (which accounts for 85% of the state's electricity production) from other states, making Ohio the 5th highest coal-importing state in the nation.[2] Even offsetting a small proportion of these fossil fuel imports with renewable sources would generate great benefits to the local economy. Moreover, creating local sources of energy and reducing energy consumption through efficiency would insulate this region from political instability, natural disasters and terrorist threats that could jeopardize the extraction, transport, and production of energy derived from fossil fuels.

### Reinvent its economy, retooling existing factories and retraining workers to perform clean energy jobs.

Transitioning to a clean energy economy benefits our region, not only because it allows us to keep our energy dollars locally, but because it provides a tremendous opportunity to retool Ohio's dwindling manufacturing base to produce components for the growing wind and solar industries. Between 1998 and 2007, clean energy jobs grew by 7.3% in Ohio while total employment in the state fell by 2.2%.[3] Currently, 665 Ohio companies are part of the wind industry supply chain[4] and 93 are part of the solar industry supply chain[5]—making the renewable energy industry one of the fastest growing job creation sectors in Ohio.[6] Because of Ohio's manufacturing base, trained workforce, central location and transportation networks, it is well-poised to create more wind industry jobs than any other state besides California.[7] Jobs are also growing in Ohio's energy efficiency sector. At least 1,130 Ohio businesses are directly involved in improving energy efficiency, including conducting energy audits, weatherizing homes and manufacturing energy-efficient products such as windows, light bulbs and appliances.[8] Not only is the clean energy industry growing, but, because many of these jobs require a person to be on site (i.e., insulating a building, installing a solar array) they cannot be outsourced. As the state and region continue to battle high unemployment, the clean energy industry presents a tremendous economic development opportunity for the region.

### Assist the agricultural and food processing industry to convert its waste products into energy.

Biomass—including agricultural crops and trees, wood and wood residues, grasses, aquatic plants, animal manure, municipal residues, and other residue materials—is becoming an increasingly significant source of energy in the U.S. In 2009, 4.1% of total energy consumed in the U.S. derived from biomass, representing half of all renewable energy consumption. Twelve percent of the biomass energy consumed nationally derived from waste, such as municipal solid waste, landfill gas, sludge waste, tires, agricultural by-products, and other secondary and tertiary sources of biomass.[9] Biomass has the advantage of being not only a renewable, carbon-neutral energy source, but—unlike solar or wind energy—available on demand, rather than subject to the vagaries of weather. Much of the 9th Congressional District is rural, with significant numbers of corn and wheat producers, food processing plants, and livestock operations. All of these businesses create biomass waste which, depending on the particular type of waste, may incur disposal costs or have negative environmental impacts, such as greenhouse gas emissions through the release of methane. Yet, this "waste" could potentially be converted into biogas that could be used as a source of heat and/or electricity, using off-the shelf technology.

### Save money on fuel costs through energy-efficiency measures.

Energy efficiency programs, which cost on average 2.5 cents per kilowatt-hour (kWh) of energy saved, are far more cost-effective than creating the same amount of energy through supply-side measures; current conventional supply-side options cost approximately *three times more* to create a kWh than the equivalent in energy efficiency program savings.[10] Merely by adopting updated building energy code standards recommended by the Department of Energy, the State of Ohio could save $98 million in energy costs by 2020.[11] Energy-efficiency programs have an added advantage over energy production because the costs of implementing such programs are far less volatile over time than energy generation costs. As the State of Ohio and municipalities struggle with enormous budget shortfalls, potential cost-savings through energy-efficiency endeavors ought to be particularly appealing.

### Waste less electrical energy via a more distributed transmission system.

A significant percentage of the energy generated by Ohio's electric power plants is lost during generation and transmission of electricity through its outdated electrical system. Electrical and transmission system upgrades would help to reduce this loss. In addition, in transitioning from large, centralized forms of electrical production—coal-fired power plants—to smaller, more distributed forms such as wind, solar, and biogas, the distance electricity would need to travel between generation and end-use would diminish, thereby reducing transmission loss.

### Improve the health of its citizens and the environment by reducing the toxic byproducts derived from burning fossil fuels.

Reducing our reliance on fossil fuels also improves human and environmental health by reducing the emission of pollutants that are byproducts of fossil fuel combustion. Ohio's power plants are the 4th highest emitters of nitrous oxide, which, when combined with volatile organic compounds and sunlight, creates toxic ground-level ozone. Constant exposure to ground-level ozone over time has been found to permanently damage lung tissues, decrease the ability to breathe normally, exacerbate or even causes chronic diseases like asthma, and possibly harm pre-natal growth. [12] Ground-level ozone exposure has also been found to reduce yields of economically important crops such as soybeans, kidney beans, wheat and cotton as well as commercial forest production. In addition to ozone pollution, these power plants emit noxious chemicals such as cadmium, lead, arsenic and mercury, a highly toxic pollutant that can cause long-term developmental delays in children that have been exposed in utero.[13] Coal-fired power plants contribute 41% of total national mercury emissions, far and away the greatest source of mercury pollution in this country; Ohio's power plants are the third highest emitters of mercury in the nation.[14] In contrast, energy produced from renewable sources emits none of these pollutants.

### Reduce greenhouse gases that lead to global climate change

Carbon dioxide ($CO_2$), a byproduct in the combustion of fossil fuels, is the most prevalent of the greenhouse gases that cause global climate change. Ohio's power plants are the third greatest emitter of $CO_2$ in the nation (after Texas and Florida), releasing 124,966,156 tons of $CO_2$ into the atmosphere in 2010, a 4.3% *increase* from the previous year.[15] The impact of climate change is already apparent in this region of Ohio: over the past century, average annual temperatures in the Southern Great Lakes region have increased 1.3º F and precipitation has increased by 10%. Yet, despite increased precipitation, Lake Erie's water level has dropped 3.5 feet since 1997, due to greater surface water evaporation caused by temperature increases. All of these negative trends are expected to continue in the absence of significant reductions in our state and nation's greenhouse gas emissions. Among the dire consequences of climate change projected for our region are the economic losses that would be sustained by the shipping industry; if Lake Erie's water levels continue to drop at its current rate, the shipping industry could lose an estimated $5.54 billion over ten years,[16] just one of many anticipated negative outcomes in the absence of greenhouse gas reductions.

## *Renewable Energy and Energy Efficiency Commitments*

The renewable energy and energy efficiency initiatives discussed in this report should be viewed in the context of a growing acknowledgement on the federal, state and local levels of the need to transition away from fossil fuel-based energy and commitments to do so.

**Federal:** The U.S. DOE plays a key role in guiding the nation's energy generation and use through its policies, funding mechanisms and energy-efficiency standards. Its most recent strategic plan sets forth ambitious targets towards meeting its goal of transforming the nation's energy system and becoming a world leader in clean energy technology:

- Reduce energy-related greenhouse gas emissions by 17% by 2020 and 83% by 2050, from a 2005 baseline.
- Put 1 million electric vehicles (EVs) on the road by 2015.
- Generate 80% of America's electricity from clean energy sources by 2035 (with a benchmark target of doubling renewable electricity generation—excluding conventional hydropower and biopower—by 2012)

**State:** The State of Ohio, for its part, has primed the pump for this transition to clean energy through its 2008 Clean Energy Law that mandates the four investor-owned utilities operating in Ohio (FirstEnergy, Duke Energy, Dayton Power and Light, and American Electric Power-Ohio) to:

- Purchase or generate more renewable electricity each year until 2025, when each utility is expected to obtain 12.5 percent of its electricity from renewable sources—including 0.5 percent that must come from solar energy—and at least half of all renewable energy must be generated in-state. This mandate is known as Ohio's Renewable Portfolio Standard (RPS).
- Implement efficiency programs that achieve annual energy saving targets, ultimately saving 22 percent of their total sales volume through efficiency by 2025.

**Local:** The City of Oberlin is more ambitious. Along with sixteen other cities throughout the world that are part of the Clinton Climate Initiative, Oberlin has committed to work towards reducing its net $CO_2$ emissions to below zero.[17] This commitment is part of larger plan known as The Oberlin Project, a collaboration between community members, the City of Oberlin and Oberlin College. Because the City of Oberlin has been leading the region in its transition to a clean energy economy, many of the feasibility studies outlined below and detailed later in the report are focused on the City of Oberlin. However, proposed plans, including creative solutions suggested to meet barriers, are intended to be replicable by other communities within the 9th Congressional District and beyond, albeit with some fine-tuning to address the unique challenges surrounding each community.

## *This Report*

This report is divided into three chapters, each of which focuses on a different aspect of our region's transition away from fossil fuels: renewable energy, energy efficiency, and cleaner, more efficient transportation.

### Chapter 1: Renewable Energy

This chapter explores the feasibility of producing renewable energy from wind, solar and biogas in the 9th Congressional District, including case studies focusing on each type of renewable source. The chapter also discusses and quantifies industry and job growth of the wind and solar supply chains in the District. It concludes with policy recommendations for fostering renewable energy development in the District.

### Chapter 2: Energy Efficiency

This chapter first quantifies total consumption of (non-transportation) energy in the 9th Congressional District and then considers various mechanisms for reducing energy use, including case studies for these different methods. It concludes with a discussion of community cost savings and job creation resulting form energy efficiency deployment.

## Chapter 3: Transportation

Chapter 3 is essentially a case study for reducing fossil fuel consumption in the City of Oberlin's transportation sector. It begins by summarizing the City's current "transportation profile," a quantitative and qualitative analysis of the City of Oberlin's (and, by extension, Northern Ohio's) existing transportation programs, policies, and impacts of this transportation system on energy use, emissions, and household costs. This profile is followed by an energy-efficient transportation and land-use plan for Oberlin that would allow it to become carbon neutral by 2050.

## Conclusion:

The report concludes with policy considerations for moving beyond fossil fuels.

# Chapter 1: Renewable Energy

Ohio has excellent renewable energy potential. It is estimated that it has sufficient technical potential to generate nearly 1.3 times the amount of electrical energy it used in 2008 through renewable energy sources—primarily wind and biofuels—but also solar[18]. Until recently, virtually all of Ohio's electricity was generated either from coal or nuclear power. In fact, Ohio ranks 45th out of 50 states in electricity generation by renewable sources.[19] However, in 2008, Ohio took a positive step towards weaning itself off of fossil fuels by passing the Clean Energy Law, which includes a Renewable Portfolio Standard (RPS), a mandate that the state's four investor-owned utilities (AEP-Ohio, Dayton Power & Light, Duke Energy, and First Energy) produce at least 12.5% of the state's electricity from renewable sources by 2025, with at least half of this renewable requirement generated *in Ohio.* Since this law's enactment, renewable energy generation has grown considerably, though it is still dwarfed by conventional energy production.

This Renewable Energy chapter investigates renewable energy's potential as an engine for job growth and for energy production in the 9th Congressional District. It is useful to consider these two facets of renewable energy together. First, the same federal and state policies that drive renewable energy production can stimulate associated industries. For example, more than 9% of the major components, technology and labor used to produce the solar field on the National Guard Base at Toledo Express Airport, expected to generate 1.2 MW of electricity, was developed, produced and constructed by the citizens of Northwest Ohio.[20] In addition, as we transition away from fossil fuels, we need to ensure not only that we generate our electricity from renewable sources, but that we establish a strong industry for manufacturing the components of wind, solar and biogas generation; otherwise we will have supplanted one type of energy import (oil) with another, albeit cleaner import (PV arrays and wind turbines from China).

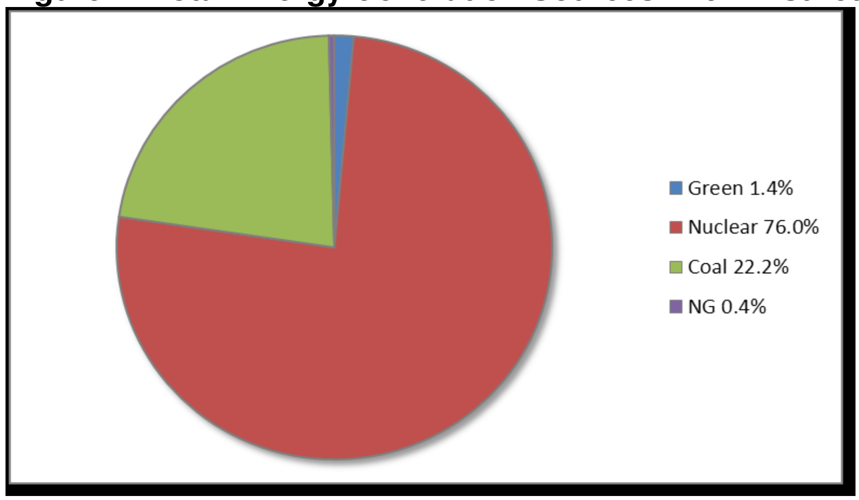
Part I will provide data concerning the particular energy mix in the 9th District. It will also offer guidance for the development of new wind, solar, and biogas projects, detailing possible financing mechanisms, funding models, ownership structures, and pertinent utility regulations that are applicable to all types of renewables. Individual case studies for roof-mounted solar, ground-mounted solar farm, wind and biogas projects will follow. Part II of this chapter will discuss employment and industry growth in the District's renewable energy supply chain. The chapter will conclude with policy recommendations to promote renewable energy on a local, state and federal level.

## *Part I: Energy Development*

### Renewable Energy Production in the 9th Congressional District

According to Palmer Energy's analysis undertaken for this award, approximately 76% of the energy produced within the 9th Congressional District comes from nuclear power (all of which is generated at the Davis-Besse nuclear plant), 22.2% derives from coal, 0.4% from natural gas and the remaining 1.4% is generated by renewable sources (See Fig. 1).[21]

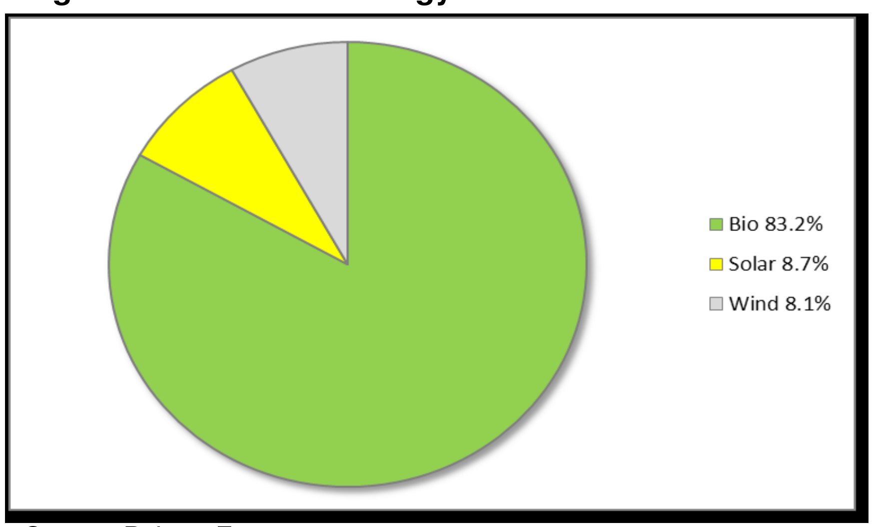
**Figure 1: Total Energy Generation Sources in 9th District**




Source: Palmer Energy

This 1.4% of renewable energy translates into approximately 100 million kilowatt-hour (kWh) derived from 107 renewable sources in the District. Of this 100 million kWh of renewable energy, total wind and solar output in the District is approximately 16.8 million kWh annually (See Appendix A for a full listing of renewable energy generation projects in the 9th Congressional District). Although passage of the Renewable Portfolio Standard (RPS) was crucial to accelerating the growth of this industry, renewable energy still accounts for a tiny fraction of the District's total energy generation—there is clearly plenty of opportunity for further expansion.

**Figure 2: Renewable Energy Generation in 9th District**




Source: Palmer Energy

## Considerations for Planning All Types of Renewable Energy Projects

## Financing Options

The main barrier to implementing renewable energy projects is financing them. As was the case during our nation's previous energy transitions (i.e., to timber and coal in the 1800's, and more recently, to oil, gas, nuclear and hydroelectric),[22] many state and federal programs exist to promote the development of renewable energy. Unfortunately, most of these financing mechanisms lack long-term stability, creating a difficult business environment and likely hampering growth in these industries. The following are the main financing mechanisms currently available to Ohio-based renewable energy projects:

**Table 1: State of Ohio Financing Options for Renewable Energy Projects**

| Program Name | Brief Explanation | Limitations |
|---|---|---|
| **Ohio Air Quality Development Authority (OAQDA)** | Can support renewable energy programs by issuing bonds, making loans and grants to local governments, and providing low-interest loans to businesses. Administers federal Qualified Energy Conservation Bonds. | |
| **Ohio Advanced Energy Job Stimulus Fund** | Administered by the OAQDA, consists of $84 million in forgivable and non-forgivable loans for non-coal-related energy projects; awards are based on the project's potential for creating jobs and attracting investment. | Funding will end at the end of 2011. |
| **Qualified Energy Property Tax Exemption** | Allows for 100% exemption of tangible personal property tax and real estate taxes for all projects less than 5 MW. However, projects between 250kW and 5 MW must make a "payment in lieu of taxes" (PILOT). Property tax exemptions for projects over 5MW must be approved by local county commissioners. | Must apply to the Ohio Department of Development by December 31, 2011 to be eligible for exemption. |
| **Renewable Energy Credits (RECs)** | RPS legislation established a REC tracking system, enabling utilities to buy, sell and trade credits to comply with the standard, thereby allowing some renewable energy projects to be financed by selling its RECs. | Dependent on the continuation of Ohio's RPS legislation. |
| **Advanced Energy Fund grants** | This Fund was created in 1999 and administered by the Ohio Department of Development. Before it expired, it was funded through a 9¢ annual rider on electric utility bills of investor-owned utilities. It has provided over $44 million in grants and loans for energy projects[23]. | Rider was allowed to expire at the end of 2010 so less funding exists than in the past; new programs under this grant will be released in fall 2011. Incentives are not available to municipal utility customers. |
| **Net Metering** | Customers of the 4 investor-owned utilities who produce renewable energy can enter into a net metering arrangement with the utility in which the customer is credited for the energy "sold" to the grid | Municipal electric systems and rural electric cooperatives are not required to offer net metering. |
| **Residential Solar Thermal Rebate Program** | Sponsored by Green Energy Ohio, provides rebates for solar water heating systems in owner-occupied residential properties. | System must have been purchased after April 1, 2009; capped at $2,400/applicant. |

### Table 2: Federal Financing Options for Renewable Energy Projects

| Program Name | Brief Explanation | Limitations |
|---|---|---|
| **Federal Business Energy Investment Tax Credit (ITC)** | Provides tax credit to businesses for 30% of eligible costs of the renewable energy project; generated at the time the project is placed in service. No cap on credit. | Cannot be combined with PTC; wind turbines must be 100kW or less<br>Projects must begin construction by Dec. 31, 2011 and placed in service by Dec. 31, 2016. |
| **Federal Renewable Electricity Production Tax Credit (PTC)** | A per-kilowatt-hour tax credit (2.2¢/kWh for wind; 1.1¢/kWh for open loop biomass) electricity generated by a qualified energy source and sold to an unrelated person ; can be claimed for 10 years | Cannot be combined with ITC<br>Solar electric and solar thermal projects are ineligible<br>Projects must be under construction by Dec. 31, 2011 |
| **Section 1603 of the American Recovery and Reinvestment Act** | Allows ITC or PTC-eligible projects to receive a cash grant of 30% of the eligible costs of the project rather than taking tax credits; also provides $3.2 billion in bonding authority to each state and its local governments to finance renewable energy projects through Qualified Energy Conservation Bonds. | Projects must begin construction by Dec. 31, 2011 |
| **Federal New Market Tax Credit (NMTC)** | Though not geared specifically toward renewable energy projects, NMTCs can be used if a renewable energy project is sited in qualifying low-income communities. | Cannot be combined with USDA REAP or B&I loan guarantee programs |
| **US DOE Loan Guarantee Program** | Full repayment required over a period not to exceed the lesser of 30 years or 90% of the projected useful life of the asset to be financed. | Focused on projects that exceed $25 million |
| **USDA Rural Energy for America Program (REAP) grants and loan guarantees** | Provides grants and loan guarantees for agricultural producers (at least 50% of gross income must come from agriculture) and rural small businesses for renewable energy systems and energy efficiency improvements. | Grants are limited to 25% of proposed project cost<br>Loan guarantees cannot exceed 75% of total eligible project cost; limited to $25 million<br>Cannot be combined with NMTC |
| **USDA Business & Industry (B & I) Loan Guarantees** | Provides loan guarantees for businesses that expand jobs and preserve the environment in rural areas, including the development of renewable energy projects. | Cannot be combined with NMTC |
| **Renewable Energy Production Incentive (REPI)** | Performance-based incentive available to local, state, and tribal governments, municipal utilities, rural electric cooperatives, and native corporations. | Systems must be placed in service by Oct. 1, 2016 |
| **Modified Accelerated Cost-Recovery System (MACRS)** | Businesses can recover certain renewable energy investments through depreciation deductions. | Must be placed in service by Dec. 31, 2011 |
| **Environmental Quality Incentives Program (EQIP)** | Authorized by the Farm Bill, provides cost-share assistance for constructing manure management and storage equipment (part of a biogas system). | Only pertains to biogas |

## Local Financing: Property Assessed Clean Energy

In addition to these financing options, Property Assessed Clean Energy (PACE) financing could be an attractive option to property owners who would like to install renewable energy equipment, such as solar panels or a small wind turbine, on their property. PACE allows the financing of renewable energy improvements using special assessments that secure local government bonds or other obligations that do not require borrowers or local governments to pledge credit. Ohio law allows municipalities and townships to establish Energy Special Improvement Districts (ESIDs), which can include different areas of a municipality, not necessarily contiguous, but requires consent of participating property owners within the SID. The SID typically allows property owners within the district to borrow money at relatively low interest rates, with the source of capital often deriving from public bonds. Property owners can then use this loan to invest in renewable energy installations on their property, which is then repaid as an assessment on their property tax bill over a period up to 30 years. Although PACE could provide a much-needed mechanism for homeowners to finance expensive renewable energy installations, most local PACE programs in Ohio are temporarily on hold because the Federal Housing Finance Authority released a statement indicating that they would not allow a mortgage to be placed on homes in an Energy SID. However, some commercial PACE programs are moving forward, including the Northeast Ohio Advanced Energy District.

## Ownership: Power Purchase Agreements (PPAs)

A variety of ownership structures exist for non-residential renewable energy projects. However, in cases in which an entity that is not in the energy business (e.g., Oberlin College) wishes to host a renewable energy project, a Power Purchase Agreement (PPA) is generally recommended (utility companies may even use a PPA in order to meet its renewable energy requirements). A PPA is a contractual arrangement between a host site and a developer whereby the host purchases power at a predetermined price per kilowatt hour and the developer, in turn, is responsible for all aspects of implementing and maintaining the project. The PPA is advantageous to the host because the third-party developer assumes all financial risk while simultaneously providing price stability. Also it can be more economical to engage in a PPA because the third-party developer, which develops and maintains many renewable energy projects, gains economies of scale not realized by an individual project developer.

## Local Utility Regulations

There are a total of 14 electric utility companies serving the 9$^{th}$ District. Toledo Edison and Ohio Edison, subsidiaries of First Energy, serve the largest area. The remainder is served by three rural electric cooperatives and nine municipal electric systems. Prior to planning any renewable energy project, it is crucial that one investigate pertinent local utility regulations. Four mechanisms for interfacing with the utility are uniquely applicable to renewable energy projects:

***Third Party Ownership:*** If a PPA structure is to be employed, the local utility must allow the third-party developer, which is not a utility customer, to install and operate power generation equipment that is connected to the utility grid.

***Net Metering:*** Because solar, wind, and even biogas energy production fluctuates throughout the year, it is highly desirable for a customer to have the ability to "bank" energy from times of greater energy production to be used later when production does not meet needs. Net metering, an arrangement between the customer and the utility, allows such banking and also stipulates an energy price for "selling back to the grid" in the event that total production by the renewable energy source exceeds the building's needs. Ohio law allows customers of the four investor-owned utilities to enter net metering arrangements; customers of other utilities need to seek permission; Table 3 displays the current status of interconnection agreements among electric utilities serving 9th Congressional District.

**Table 3: Interconnection Agreements in 9th District Electric Utilities**

| Utility | Counties of Service | Interconnection Agreement? |
|---|---|---|
| Amherst Municipal | Lorain | None |
| Elmore Municipal | Ottawa | Currently Drafting |
| Firelands Rural Electric | Lorain | Yes |
| Genoa Municipal | Ottawa | Did not respond to inquiries |
| Grafton Municipal | Lorain | Did not respond to inquiries |
| Hancock-Wood Rural Electric | Erie | Yes |
| Huron Municipal | Erie | None |
| Lorain-Medina Rural Electric | Erie, Lorain | Yes |
| Milan Municipal | Erie | None |
| Oak Harbor Municipal | Ottawa | Currently Drafting |
| Oberlin Municipal | Lorain | Currently Drafting |
| Ohio Edison | Erie, Lorain, Ottawa | Yes |
| Toledo Edison | Lucas, Ottawa | Yes |
| Wellington Municipal | Lorain | Moratorium on construction to draft new zoning and interconnection legislation |

Source: Green Energy Ohio

***Remote Net Metering:*** Occurs when a meter at a renewable power generation site records power exported to the grid and credits it to a particular customer, necessary for certain renewable systems such as solar farms and wind turbines that are not immediately adjacent to, and therefore connected to, a building that it is powering. *There is currently no remote net metering legislation in Ohio.*

***Feed-in Tariff (or CLEAN contracts):*** A rate published by a local utility indicating what the utility will pay to developers of renewable energy projects for the renewable energy they produce. The rate is typically determined by the average cost of the technology plus a reasonable rate of return for the developer of the project. The utility then engages in a long-term PPA with one or more renewable energy project developers for the energy that project produces; the number and size of projects accepted by the utility depends on the utility's predetermined goals for renewable energy capacity. Unlike net metering or remote net metering, projects under feed-in rate contracts are developed solely for selling power onto the grid. *There is currently no feed-in tariff legislation in Ohio.*

## Renewable Energy Credits (RECs)

Ohio's Renewable Standard allow utilities to meet their renewable energy benchmarks through the purchase of RECs, defined as the environmental attributes associated with one megawatt hour of electricity generated by a renewable energy resource. A REC can be sold separately from the underlying physical electricity associated with a renewable-based generation source. The sale of RECs, as noted in Table 1, can help secure financing for renewable energy projects.

## Ohio Power Siting Board (OPSB)

Prior to construction, a "major utility facility"—defined as 50 MW or more for solar facilities and 5 MW or more for wind facilities—must receive approval from the OPSB. The OPSB, which accepts community input into its decision-making process, provides regulations that ensure that the facility is located and built in a manner that addresses environmental, aesthetic, recreational and any other concerns. For example, siting of wind turbines must minimize disruption to bird and bat habitats; the OPSB requires developers to implement a post-construction avian and bat mortality monitoring plan.

## Local Zoning Requirements

Each local government has its own zoning ordinances, some of which have specific regulations pertaining to wind and/or solar installations. As part of this grant, GEO reviewed these ordinances and compiled relevant specifications for the 77 governments within the 9th Congressional District (for a full listing see Appendix B). Although all of these regulations differ, there were a few similarities: most limited noise of wind turbines to 60dBA and mandated that turbine setbacks be 0.5 to 1.5 times the turbine height. Only five governments had rules regarding solar installations.

### 1. Wind

## Wind Energy Resources

Ohio has good wind resources. The National Renewable Energy Lab found that Ohio's *onshore* wind resources alone could provide 95.3% of the state's current electricity needs.[24] If offshore wind were tapped, Ohio could easily generate more electrical energy through wind than its current demand. Yet, despite being ranked 19$^{th}$ among states for wind energy potential, it ranks 27$^{th}$ for wind power production.[25] Total state wind resources, excluding areas that cannot or unlikely to be developed, are estimated at 54,920 megawatts (MW) of potential installed capacity, yet as of May of 2011, only 11 MW of wind projects had been installed (though 406 MW are under construction and another 3,683 MW are in queue).[26]

### *9$^{th}$ Congressional District*

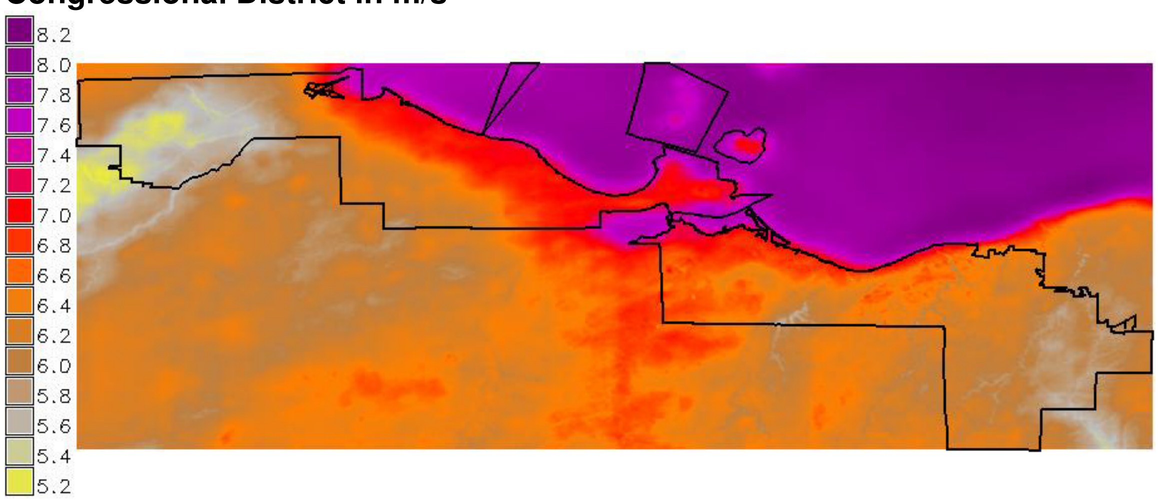
#### Wind Speed Maps

Based on NREL wind speed maps, the 9$^{th}$ Congressional District's wind speeds at 80 meters, a measure used to ascertain economic viability for utility-scale wind turbines, range from 5.2 m/s to 8.2 m/s (See Figure 3); average annual wind speeds of 6.5 m/s or higher are considered to be economically viable for development of utility-scale turbines. District wind speeds at 30 meters, used to evaluate viability of residential-scale turbines, were found to be in the 3.8 m/s to 7.2 m/s range. The highest wind speeds in the District, and therefore the areas that are the most desirable sites for wind development, particularly at a utility scale, are found on the southern edge of Marblehead, northern Catawba Island, the southern half of Kelley's Island, and all of South, Middle and North Bass Islands. Although this region in or near Lake Erie is the windiest section of 9th Congressional District, the offshore wind speeds in the part of Lake Erie that borders the District are weaker than any other part of the Lake. The District's lowest wind speeds are in mid-central and south-central Lorain County, south-central Erie County, and in, and southwest of, the City of Toledo.

**Wind Monitoring Station Data**

Complementing, and providing better detail to NREL's wind maps, is site-specific data derived from wind monitoring stations. Three of these stations, the Toledo Zoo, Port Clinton and NASA Plum Brook Station are in the 9th Congressional District and three additional stations, Bowling Green, Sullivan and Lorain are nearby. The wind resources at these six sites have been evaluated and classified according to NREL's "wind classes." Class 1 winds, those that are less than 5.6 m/s are not considered economically viable for wind power generation; Class 2, those between 5.6 and 6.4 m/s are considered only marginally viable. Of these six sites, only one—Bowling Green—was considered to be a definite Class 2 site. Two others, Port Clinton and Sullivan, were borderline Class 1/Class 2. The three other sites were Class 1. In order to reach their full-rated capacity, these turbines need wind speeds of 12 to 15 m/s.[27]

**Figure 3: Annual Average Wind Speed at 80 meters for Ohio's 9th Congressional District in m/s**




Source: Wind resource data developed by AWS Truepower, LLC

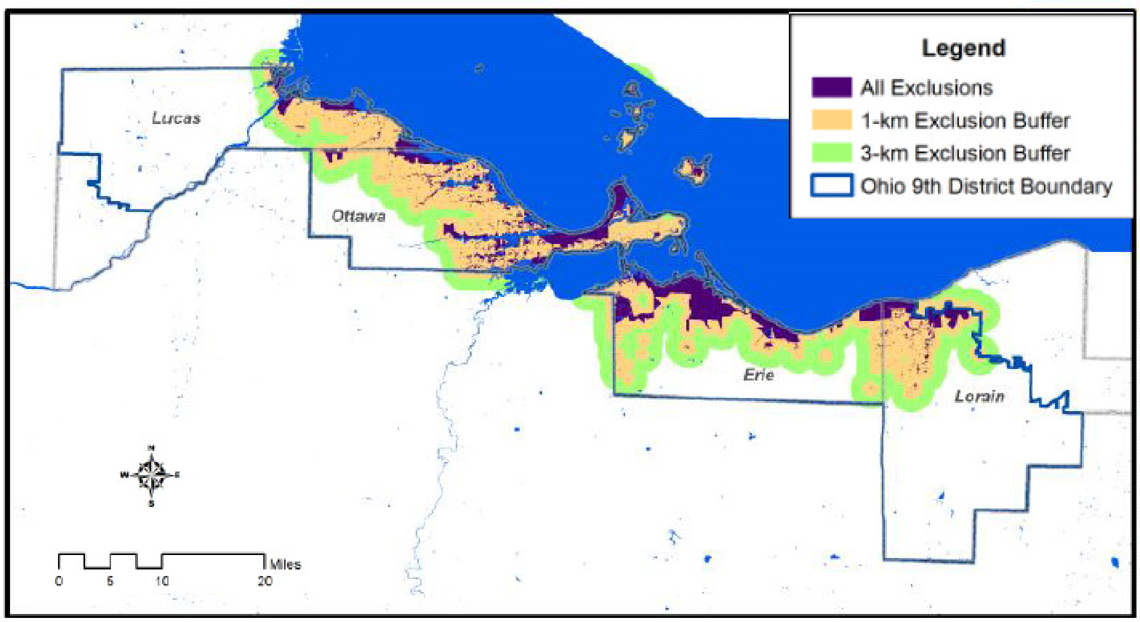
**Wind Capacity Factor**

Although a location's average wind speed is a key data point for determining an optimal wind turbine site, "capacity factor" is an even better determinant. Capacity factor is the ratio of the power *actually* produced by a turbine to the amount of power that the turbine could *theoretically* produce if operating at maximum capacity. Capacity factor is more representative of the power output from a utility scale wind turbine than wind density; NREL considers locations that have a gross capacity factor of greater than 30% at 80m suitable for wind development.

**Exclusions and Buffers**

In order to arrive at an accurate estimate of total wind capacity that could be installed in the 9th Congressional District, Green Energy Ohio not only assessed wind speeds and capacity factors throughout the District, but then excluded land unlikely to be developed because they are protected wilderness areas, airfields, urban areas, or other reasons. The District has a high percentage of protected wildlife areas (two national wildlife refuges and numerous state wildlife areas) relative to other districts in Ohio and most of the Midwest. GEO made three calculations of available wind capacity in the District, based on there being no buffer between wind turbines and sensitive areas, a 1 km buffer and a 3 km buffer. They determined that, with just the land exclusions, the District has potential installed wind capacity of 4,524 MW; this capacity decreases to 1,454 MW with a 1 km buffer, and 471 MW with a 3 km buffer. Because of these substantial exclusions, GEO concluded that the District contains just 1% of the potential wind energy production in Ohio. Figure 4 illustrates land available for wind installations based on these different exclusions and buffers, which unfortunately has considerable overlap with the District's highest wind speeds shown in Figure 3:

**Figure 4: Windy Lands (Capacity Factors greater than 30% with Exclusions and 1km and 3 km Buffers**




Source: Green Energy Ohio

## Factors to Consider in Siting Wind Projects

After establishing that sufficient wind resources exist to generate power in a general area, several additional factors will determine the specific wind turbine installation site:

***Ownership of the land:*** If the site is not owned by the entity wishing to install the turbines, it must investigate leasing options from the landowners.

***Proximity to existing infrastructure:*** The site should be accessible both to roads and the power transmission infrastructure. Any additional infrastructure that needs to be built will add to project costs.

***Wind-disrupting obstacles:*** Even though the wind turbines may be taller than any nearby obstacles, such as buildings or trees, no tall obstacles should exist up-wind of the turbine site.

***Extent and orientation of land:*** Ideally the site should allow for turbines to be spaced at least five rotor diameters apart in the direction perpendicular to prevailing winds and ten rotor diameters apart in the direction parallel to prevailing winds.

***Proximity to sensitive lands:*** Wind turbines are excluded from protected wildlife areas and Important Bird Areas and may be required to be located some distance from these areas in order to create an adequate buffer.

## Wind Case Study: City of Oberlin

As part of this NETL award, Sunwheel Energy Partners and Sustainable Community Associates compiled a feasibility study for developing a wind demonstration project in Oberlin, Ohio (specifically, the possibility of entering into a power purchase agreement with a large entity that would consume all of the energy associated with the project) [28]

### *Wind Resources*

According to NREL wind maps, wind speeds in Oberlin hover between Class 1 and Class 2 and come primarily from the west/southwest. Additional data gathered from a monitoring tower located in Oberlin indicates that average annual wind speed is approximately 4.6 m/s, corroborating NREL's data.

Sunwheel's report recommended the following for an Oberlin-based wind project:

### *Location*

The report recommended that wind turbines be located at the George Jones Memorial Farm on State Route 511 west of Oberlin because it resides within a qualifying New Market Tax Credit (NMTC) census tract. However, this site has several disadvantages: significant woods and wetlands occupy the site; the remaining area is being used as an organic farm, the use of which would likely be disrupted by moderate-sized wind turbines; and no highly reliable wind speed data exists, as it is more than a mile from the wind monitoring tower from which local wind speed data has been derived. Ultimately, however, the financial benefits of the NMTC caused this location to be selected for the case study.

### *Size of Wind System*

The cost effectiveness and productivity of a wind system is directly related to the size of its turbines: larger turbines are able to access more available wind and have a lower installed price per watt. Over the past decade, the size of installed turbines has rapidly increased. Thus, Sunwheel's report recommends a system of three 1.5MW turbines for a total of 4.5MW installed "nameplate capacity"—the normal maximum output of the wind project—which, though not utility-scale, would be large enough to realize sufficient economies of scale. Such a system would also be large enough to offset a meaningful amount of energy use, but small enough to finance and construct on a reasonable timeline, without overwhelming the local utility and grid.

### *Regulatory Involvement: Oberlin Municipal Light and Power System (OMLPS)*

Assuming that the wind project would be connected to the grid—it would be highly impractical to try to store the power—the entire project could not proceed without the approval of Oberlin's local utility, OMLPS. As discussed in "Considerations for Planning All Renewable Energy Projects" (page 13), this project would present a couple of unprecedented regulatory variances. One would be permission for a third-party (in this case, through a Power Purchase Agreement, discussed in greater detail below) to build and operate a power generation project that is connected to OMLPS's grid. The second would be allowing remote net metering, the ability to track and receive credit for power generation (and its "green" attributes) without directly using that power.

### *Financial Model*

#### Ownership Structure: Power Purchase Agreement (PPA)

In determining an ownership structure for a wind project, one must weigh the long-term value of the asset versus the long-term cost of owning the asset. In its analysis, Sunwheel recommended that Oberlin College enter into a PPA with a developer rather than own the turbines themselves so that risk is transferred away from the College onto the developer. Under a PPA, the College would not be responsible for installation, operation or maintenance costs; these are all borne by the developer. Table 4 explains and quantifies the specific provisions of the PPA assumed for this financial model:

**Table 4: Assumed Provisions of Power Purchase Agreement (PPA) between Oberlin College and Wind Developer**

| Provision | Explanation of Provision | Model Assumption |
|---|---|---|
| Renewable Energy Credits (RECs) | The PPA must establish which partner would own the RECs associated with the project; the College may want to own the RECs so that it could claim them in its carbon emission calculations, but the developer may need to keep them in order to finance the project. | Oberlin College will retain the RECs. |
| Price | Under a PPA the college purchases the power output at a pre-determined price per kilowatt hour. Includes "commercial generation charge" and a premium for "green" attributes; price for "greenness" is hard to project as it varies by location, future policies and project specific factors | Standard credit given by OMLPS ($0.073/kWh) + premium for "green" attributes ($0.0175/kWh) = $0.0905/kWh |
| Duration | The length of the contract should extend for the expected life of the wind turbines; allows the developer to recoup its initial investment while simultaneously providing Oberlin College with long-term price stability. | 20 years |
| Escalation | A PPA allows the host to lock in the escalation rate of the electricity prices—a great benefit, as they are highly variable and unpredictable | 3 percent annually |
| Assets at End of Project | Contract must establish what is done with the equipment after its useful life expires. | After 20 year developer will be responsible for disassembling the equipment and restoring the land to its prior condition; assumes remaining value of the equipment at project end will cover these costs, resulting in a zero net value for these assets. |

**Financial Obligations of the Wind Project Developer in a PPA**

Under a PPA the developer is responsible for securing financing for the project. It also assumes all pre-development, installation, operation, maintenance and soft costs.

- Pre-development Costs: The developer is responsible for ensuring the legality and feasibility of installing the wind project in the particular site chosen. The various prerequisite obligations vary by location, but for this Oberlin wind project, the developer's responsibilities would include securing an environmental review of the location, zoning approval, and net metering approval from OMLPS. Although it is the developer's responsibility to address these issues, the more that can be done in advance by the host site to lay the necessary regulatory groundwork, the easier to attract a willing PPA developer and the smoother the development process will be.
- Installation Costs: The wind equipment generally accounts for 80-85% of installation costs. However, turbine prices fluctuate considerably due to such factors as global supply/demand and metal prices, making accurate cost estimates

difficult to assess. Historically, smaller (under 5MW) wind turbine orders have been 30-50% more expensive than larger orders on a per kilowatt basis. In addition to equipment costs, the developer must cover other installation costs such as road construction, grid interconnection and electrical installation.

- Taxes: Under Ohio Law, wind projects are exempt from personal property taxes. However, they are subject to a Payment In Lieu of Taxes (PILOT) which can range from $6,000 to $8,000 per MW of installed nameplate capacity per year, depending on percentage of local workers employed on the project. In addition, the County is allowed to tax up to $9,000 per MW per year. This model assumes $9,000 per MW per year.
- Operation/Maintenance Costs: This model assumes an annual cost of $0.014 per kWh, with an annual inflation factor of three percent. Actual operation costs are far more variable, with higher costs expected in later years and zero during the turbine's warranty period. Routine maintenance costs are typically stable throughout the life of the contract.

**Financing Sources**

Due to the relatively small scale of the project and marginal local wind resources, the various loans, incentives and cost share programs discussed earlier in this chapter are insufficient to cover projected project costs (See Table 5). Thus, this financing will need to be supplemented by private investors, albeit those whose motivation is environmental or philanthropic rather than wealth-building. Although the investor would receive some tax benefits and a modest rate of return (5-6% annually over 20 years), these financial benefits would not compensate for the initial investment.

**Table 5: Proposed Financing of Oberlin Wind Project**

| **Fund Source** | **Explanation of Funding** | **Projected Amount Secured** |
|---|---|---|
| Leverage Loan | 20-year loan with 20-year amortization | $4,700,000 |
| 1603 Cash Grant | This model assumes that the project would be eligible for the 1603 grant program detailed in Table 2, although that program currently only extends to projects that begin construction in 2011 | $4,175,760 |
| NMTC | In order to obtain a NMTC, the developer would need to locate a Community Development Entity (CDE) with an existing NMTC allocation and then request that they designate a portion of their NMTC allocation to the wind project. | $4,372,251 |
| Private Equity | An initial $2.5 million investment would leverage $16 million in renewable energy for the Oberlin community | $2,536,589 |
| **Total Project Cost** | | **$15,784,600** |

## 2. Solar

## Solar Energy Resources

Ohio has vast untapped solar resources. A 2008 study conducted for the National Renewable Energy Laboratory concluded that by 2015, given favorable policies, Ohio would have the potential to install cumulative 26 GW of solar generating capacity just on residential and commercial rooftops. Dedicated solar fields, such as the Wyandot power station currently operating in Upper Sandusky, could generate even more.[29] During a "standard weather year," solar resources in Ohio range from 1200 to 1400 kilowatt hours per kilowatt year (kWh/kW), comparable to states such as New Jersey and Massachusetts that are rapidly expanding their solar industries. In fact, Ohio has greater solar resources than Germany and Italy (in the 1000 to 1200 kWh/kW range) which are leading the world in solar deployment.

This data demonstrates that the increased proliferation of solar industries and installations in these other states and countries relative to Ohio is not a reflection of greater inherent solar resources in those areas, but, rather, the particular policies and incentives motivating (or hindering) this growth. Despite Ohio's relative lag in solar development, it is now poised to rapidly expand both its solar manufacturing and deployment due in part to its adoption of Renewable Portfolio Standards (RPS) in 2008. In addition to the requirement that 12.5% of electricity used in state be generated by renewable sources, the Ohio RPS mandates that 0.5% of total electricity is obtained from solar sources.

### *9th Congressional District*

Solar resources are uniform across the 9th Congressional District, according to NREL's solar maps, at 4.0-4.5 $kWh/m^2/day$.[30] The following table shows annual production estimates for eight existing example solar energy systems installed in the District, based on data gathered from REC applications filed with the Public Utilities Commission of Ohio:

**Table 6: Annual Production Estimates of Eight Example Solar Energy Systems**

| City | County | Generating Capacity (kW) | Manufacturer | Estimated Annual Production (kWh) | Estimated Capacity Factor (%) |
|---|---|---|---|---|---|
| Milan | Erie | 4.7 | Sharp | 6,500 | 15.78 |
| Milan | Erie | 11.232 | Sharp | 13,000 | 13.20 |
| Holland | Lucas | 4.3 | First Solar | 6,000 | 17.0 |
| Maumee | Lucas | 1.988 | Sharp | 2,186.8 | 13.13 |
| Perrysburg | Lucas | 2440 | First Solar | 2,861,110 | 13.4 |
| Toledo | Lucas | 101 | First Solar | 120,000 | 15.7 |
| Toledo | Lucas | 248.6 | SolarWorld | 316,593 | 14.5 |
| Elmore | Ottawa | 6.0 | Sharp | 3,700 | 7.0 |

Source: Green Energy Ohio

As part of this award, Green Energy Ohio estimated total rooftop space available for solar installations in the 9th Congressional District.[31] Because floor space data was only available on the county level, their analysis encompasses rooftop space in Erie, Lucas, Lorain and Ottawa counties—a slightly greater area than what is included in the 9th Congressional District. This analysis revealed that these four counties had sufficient rooftop space for potential solar installed capacity of 928.8 MW on residential buildings and an additional 660.5 MW on commercial buildings. This could generate 12,598 to 14,173 GWh of electricity annually—enough to power between 1.2 million and 1.4 million homes.

## Factors to Consider in Siting Solar Projects

There are two general types of solar installations: solar farms and roof-mounted solar. Some criteria for determining an optimal site for solar installations apply to both types of installations, while others are specific to installation type.

### *Site Criteria for Both Solar Farm and Roof-Mounted Solar Projects:*

- **Existing Electrical System:** The potential PV system must be compatible with existing electrical equipment and loads.
- **Orientation and Tilt of PV Modules:** The optimal siting of a PV array is True South or 180º (solar productivity decreases by up to 20% as it moves from 180º). While roof-mounted solar may deviate from True South, as they are constrained by existing roof orientations, solar farms rarely deviate more than a few degrees. The optimal tilt of a PV module is generally equivalent to the latitude of the site (i.e. an array installed at 45º latitude would ideally be at a 45º tilt).
- **Shading:** PV arrays must be located away from shading objects, including trees, other buildings, other racks in the system, or other roof-mounted equipment.

### *Site Criteria Specific to Solar Farms:*

- **Land and Available Space:** Optimal land for a solar farm is flat, unobstructed, and rectangular. Surface (wetlands, creeks) and subsurface (soils) topography also influence solar farm siting. Finally, as solar farms are generally considered commercial, rural land may require a zoning variance.
- **Remote Net Metering:** Because solar farms generally do not feed its energy directly into a building but rather transfer energy onto the grid, the utility needs to accept a remote net metering arrangement in order for the customer to be credited for the solar-generated energy.
- **Tracking vs. Fixed Tilt:** Solar farms that employ panels that tilt to track the sun add significant productivity at latitudes below 41.5º N. However, tracking panels are more expensive than fixed-tilt so a full analysis of the project needs to be conducted to determine the relative benefit of tracking panels.
- **Property Line Setbacks:** Solar farms need to account for local codes distance requirements for property line setbacks.

### *Site Criteria Specific to Roof-Mounted Solar*

- **Structural Engineering of Roof/Building:** A structural analysis of the entire building, and especially the roof, must be conducted to determine its ability to withstand the weight of the PV array.
- **Flat vs. Sloped Roofs:** The slope of the roof affects how PV systems are mounted: they can often be mounted to flat roofs with little or no penetration into the roof to secure it, which is not the case for sloped roofs.
- **Fire Code Setbacks:** Fire codes will mandate certain setback distances and that access routes exist.

## Solar Field Case Study: City of Oberlin

Sunwheel Energy Partners and Sustainable Community Associates conducted a feasibility study for developing a solar farm demonstration project in Oberlin, Ohio[32]. This study recommended the following parameters:

### *Location*

The site selected for the model is a field on the southwest corner of Parsons Road and Hallauer Road/Route 20. The advantages of this site are that it is:

- Located in an NMTC-eligible census tract
- Adjacent to an OMLPS distribution line
- Large enough to be able to contain the proposed solar field without being so large as to generate additional costs that are unrelated to the project
- Seemingly undesirable for commercial or residential development
- Close to Oberlin College's George Jones Memorial Farm; a solar farm could be a good programmatic tie-in to this organic farm

### *Size of Solar Field/System Output*

The model assumes a total size of 5MW with a fixed tilt installation of 41.6°. The estimated power generation is 6,036,650 kWh annually, with an expected ongoing 20% power loss due to transformers. The 5MW size was chosen as a balance between the benefits in economies of scale that can be achieved in larger projects and the ease with which OMLPS could accommodate a smaller project into its current infrastructure.

### *Regulatory Involvement: Oberlin Municipal Light and Power System(OMLPS)*

As with the wind case study, this case study assumes OMLPS approval for the solar field, as it will be connected to the grid. It also assumes that it will allow for remote net metering.

### *Financial Model*

#### Ownership Structure: Power Purchase Agreement (PPA)

As with the previous wind case study, Sunwheel suggests that Oberlin College should enter into a PPA with a developer rather than own the solar panels themselves, thereby transferring the financial risk away from the College onto the developer (see page 21 for a more detailed description of a PPA, as it relates to the wind case study).

**Table 7: Assumed Provisions of Power Purchase Agreement (PPA) between Oberlin College and Solar Field Developer**

| Provision | Explanation of Provision | Model Assumption |
|---|---|---|
| Renewable Energy Credits (RECs) | The PPA establishes which partner would own the RECs associated with the project. Although Oberlin College would desire to keep the RECs as a method for offsetting a portion of its overall carbon footprint, the College would need to sell the RECs for the project to be economically viable. | Solar RECs are priced according to the Alternative Compliance Payment—the price that utilities have to pay if they do not buy sufficient solar RECs to meet the state requirement—discounted 25% annually. |
| Price | The College purchases the power output at a pre-determined price per kilowatt hour that Includes "commercial generation charge" and a premium for "green" attributes. | Standard credit given by OMLPS ($0.073/kWh) + premium for "green" attributes = $0.09/kWh |
| Duration | The length of the contract should extend for the expected life of solar panels, which is 20-30 years; allows the developer to recoup its initial investment while simultaneously providing Oberlin College with long-term price stability. | 20 years |
| Escalation | A PPA allows the host to lock in the escalation rate of the electricity prices—a great benefit, as they are highly variable and unpredictable | 3 percent annually |
| Assets at End of Project | Contract must establish what is done with the equipment after its useful life expires. | After 20 years, developer will be responsible for disassembling the equipment and restoring the land to its prior condition; assumes remaining value of the equipment at project's end will cover these costs, resulting in a zero net value for these assets |

**Installation Costs**

The preponderance of installation costs are for the equipment itself, but also include racking systems and electrical installations. The model assumes $4/watt in installation costs. In a PPA, these costs are all borne by the developer.

**Operation Costs**

Under the PPA arrangement, the developer would be responsible for all of the operation costs described in Table 8. The model assumes these costs would be incurred for 20 years at a 3% rate of inflation:

**Table 8: Operation Costs of Proposed Solar Field Project**

| Type of Cost | Description | Model Assumption |
|---|---|---|
| Taxes | Solar field projects must pay a Payment In Lieu of Taxes (PILOT) to the State of Ohio | $9,000 per MW per year |
| Insurance | Includes coverage for property damage, income interruption and general liability | 0.625% of installed costs annually |
| Operation Costs | Includes inspections, semi-annual cleanings and any other costs associated with operating the solar field. | $7.50 per kW per year |

**Financing Sources**

The project would be financed using the mechanisms explained in Table 9. Unlike the wind and roof-mounted solar case studies presented in this section, the proposed field-mounted solar array could offer a reasonable return to an investor.

**Table 9: Proposed Financing of Oberlin Solar Field Project**

| Fund Source | Explanation of Funding | Projected Amount Secured |
|---|---|---|
| 1603 Cash Grant | This model assumes that the project would be eligible for the 1603 grant program detailed in Table 2, although that program currently only extends to projects that begin construction in 2011 | $7,112,900 |
| NMTC | In order to obtain a NMTC, the developer would need to locate a Community Development Entity (CDE) with an existing NMTC allocation and then request that they designate a portion of their NMTC allocation to the solar field project. | $7,274,419 |
| Leverage Loan | 6.0%, 7-year interest rate, fully amortized | $6,000,000 |
| Private Equity | An investment of approximately $6 million would leverage about $26 million in renewable energy, while providing reasonable returns to the investor | $5,883,604 |
| **Total Project Cost** | | **$26,270,924** |

## Roof-Mounted Solar Case Study: City of Oberlin

### *Location:*

After considering the various solar rooftop siting factors listed on page 25, Sunwheel recommended the Oberlin rooftops described in Table 10 for solar installations:

**Table 10: Proposed Sites for Solar Rooftop Installations in Oberlin**

| Location | Location Description | Potential Energy System Could Support |
|---|---|---|
| Firelands Dormitory | Highest building in Oberlin, has flat roof, and is in a NMTC census tract. Main disadvantage is large cooling tower in the middle of the roof that would shade the middle and northern parts of the roof. | 10kW |
| Apollo Theatre | Has a new roof, is not shaded by surrounding buildings and in a NMTC census tract. Disadvantages: historic building; has curved roof. | 37kW |
| Hall Auditorium and Annex | Annex has flat roof; main auditorium has sloped roof. Roof is spacious and in NMTC census tract. | 100kW |
| Art Library and Allen Art Museum | Roof on main part of museum could not be used because it is tile and an historic building; roof of art library and other art museum buildings could be used. | 152kW |
| Lorain Street Art Studios | Buildings are in NMTC census tract but roofs would probably need to be replaced prior to installing solar panels. | 20kW |
| Robert Kahn Dormitory | Was built to support a future solar array; not in NMTC census tract. | 30kW |
| OC Science Center | Has a new, spacious roof. | 170kW |
| **Total Rooftop Energy** | | **519kW** |

## *Regulatory Involvement: Oberlin Municipal Light and Power System (OMLPS)*

Although OMLPS would have to approve these grid-connected arrays, the arrays would not require approval from OMLPS for remote net metering. The arrays could use net metering, an arrangement that has been approved by OMLPS in the past. However, by engaging in a PPA (see below), Oberlin College would have to seek approval for ownership of a grid-connected solar array by a *third party*, an unprecedented arrangement for OMLPS.

## *Financial Model*

### Ownership Structure: Power Purchase Agreement (PPA)

Sunwheel also recommends that Oberlin College enter into a PPA for the rooftop solar arrays.

**Table 11: Assumed Provisions of Power Purchase Agreement (PPA) between Oberlin College and Rooftop Solar Developer**

| Provision | Explanation of Provision | Model Assumption |
|---|---|---|
| Renewable Energy Credits (RECs) | The PPA establishes which partner would own the RECs associated with the project. Although Oberlin College would desire to keep the RECs as a method for offsetting a portion of its overall carbon footprint, the College would need to sell the RECs for the project to be economically viable. | Solar RECs are priced according to the Alternative Compliance Payment—the price that utilities have to pay if they do not buy sufficient solar RECs to meet the state requirement—discounted 10 percent annually. |
| Price | The College purchases the power output at a pre-determined price per kilowatt hour that Includes "commercial generation charge" and a premium for "green" attributes. | Standard credit given by OMLPS ($0.073/kWh) + premium for "green" attributes = $0.13/kWh |
| Duration | The length of the contract should extend for the expected life of solar panels, which is 20-30 years; allows the developer to recoup its initial investment while simultaneously providing the Oberlin College with long-term price stability. | 20 years |
| Escalation | A PPA allows the host to lock in the escalation rate of the electricity prices—a great benefit, as they are highly variable and unpredictable | 3 percent annually |
| Assets at End of Project | Contract must establish what is done with the equipment after its useful life expires. | After 20 years, developer will be responsible for disassembling the equipment and restoring the land to its prior condition; assumes remaining value of the equipment at the end of the project will cover these costs, resulting in a zero net value for these assets |

**Installation Costs**

The preponderance of installation costs are for the equipment itself, but also include racking systems and electrical installations. The model assumes $5.80/watt in installation costs plus 10 percent for rooftop installation.

**Operation Costs**

Under the PPA arrangement, the developer would be responsible for all of the operation costs described in Table 12. The model assumes these costs would be incurred for 20 years at a 3% rate of inflation:

**Table 12: Annual Operation Costs of Proposed Roof-Mounted Project**

| Type of Cost | Description | Model Assumption |
|---|---|---|
| Taxes | Solar field projects must pay a Payment In Lieu of Taxes (PILOT) to the State of Ohio | $9,000 per MW per year |
| Insurance | Includes coverage for property damage, income interruption and general liability | 0.625% of installed costs annually |
| Maintenance/ Other Operation Costs | Includes inspections, semi-annual cleanings and any other costs associated with operating the solar field. | $10 per kW per year |

**Financing Sources**

As with the wind case study, other financing sources will need to be supplemented by private investors, albeit those whose motivation is environmental or philanthropic rather than wealth-building; returns on investment would be below market rates.

**Table 13: Proposed Financing of Oberlin Roof-Mounted Solar Project**

| Fund Source | Explanation of Funding | Projected Amount Secured |
|---|---|---|
| 1603 Cash Grant | This model assumes that the project would be eligible for the 1603 grant program detailed in Table 2, although that program currently only extends to projects that begin construction in 2011 | $1,124,920 |
| NMTC | In order to obtain a NMTC, the developer would need to locate a Community Development Entity (CDE) with an existing NMTC allocation and then request that they designate a portion of their NMTC allocation to the solar project. | $ 1,229,436 |
| Leverage Loan | 2.0% (1st loan: 7year, 10-year amortization; refinanced, remaining $314,263 paid in years 8-15) | $1,000,000 |
| Private Equity | An investment of approximately $1.1 million would leverage approximately $4.4 million in renewable energy. | $1,087,188 |
| **Total Project Cost** | | **$4,441,545** |

## 3. Biomass

Biomass, defined as any organic matter that is available on a renewable or recurring basis, includes agricultural crops and trees, wood and wood residues, grasses, aquatic plants, animal manure, municipal residues, and other residue materials. Unlike other renewable energy sources, such as wind and solar, which fluctuate with the weather, biomass is available upon demand, and thus can be used as a baseload power source.

## Biomass Resources

Biomass currently is the single largest renewable energy source in Ohio—66% of all non-hydroelectric renewable energy in the state derives from wood and wood waste alone[33]—

and is growing rapidly. Biomass could generate 7.5 percent of Ohio's electricity needs by 2020[34]. While approximately 30% of biomass energy in the state currently derives from landfill gas/municipal solid waste—an enormous increase from past years—only a little over 1% of total state biomass energy derives from agriculture byproducts/crops, sludge waste, and other biomass solids, liquids and gases, representing largely untapped fuel sources.[35]

As part of this NETL award, a research team from Solutions in Sustainability, Ohio State University's Ohio Agricultural Research and Development Center (OARDC), and the Ohio BioProducts Innovation Center sought to measure total animal waste, crop residue and food processing waste produced in the 9th District.[36] The research team also evaluated total "biogas," a renewable fuel composed of approximately 65% methane, that could be generated via anaerobic digestion from this waste. Biogas is naturally produced when biomass waste is fed into a container in the absence of oxygen. It can be burned to generate electricity and/or heat, it can be conditioned for pipeline injection, or it can be compressed into a liquid fuel. If not captured, the methane embodied in this waste is emitted into the atmosphere. These emissions, though small in scale compared with other greenhouse gas emissions, are potent: on a molecule-for-molecule basis, methane is about 72 times stronger a greenhouse gas than carbon dioxide over a 20 year time frame.[37]

### *9th Congressional District*

Agriculture is a leading industry within the 9th Congressional District. The majority of agricultural land in the District is devoted to raising crops (predominantly wheat, corn and soybeans) rather than animals, though with 1,134 animal operations in the District, substantial sources of animal waste exist. The District is also home to 112 food processing companies, some of which are very large: 17 businesses, including Kraft Foods Global, JM Smucker and General Mills, generate over $1 million in annual sales. Researchers on this project initially attempted to obtain data on food processing waste directly from the food processing companies but were unsuccessful due to company privacy policies; the food waste data in Table 14 was extrapolated using other methodologies.

**Table 14: Estimates of Potential Biogas and Associated Energy in the 9th Congressional District.[38]**

| | Biogas ($m^3$/yr)* | Pipeline Methane ($m^3$/yr)* | Electrical Energy (MWh) | Thermal Energy (MWh) |
|---|---|---|---|---|
| Animal Manure | 1.17 | 0.7 | 234 | 351 |
| Corn Stover | 33.08 | 19.9 | 6616 | 9924 |
| Wheat Straw | 7.2 | 4.32 | 1440 | 2160 |
| Food Processing Waste | 0.61 | 0.37 | 1219.5 | 1861.8 |
| **Total** | **42.06** | **25.29** | **9509.5** | **14296.8** |

* x100,000
Source: Solutions in Sustainability

**Crop Residue**

Data in Table 14 would seem to indicate that crop residue, specifically corn stover and wheat straw (soybean residue decomposes too rapidly to be useful for biogas conversion), embodies the most potential energy of any biomass waste in the 9th Congressional District, and therefore is the most desirable type for biogas conversion. However, crop residues in the District are distributed over many small farms that are not currently collecting them, resulting in significant logistical hurdles and transportation costs inherent to converting this farm waste to biogas. Furthermore, the chemical composition of corn stover and wheat straw make them poor feedstock candidates for anaerobic digestion.

**Food Processing Waste**

Food processing waste is far less plentiful than crop residue in the District, but embodies much more energy potential. One option for this waste is that it could be combined with another feedstock, such as manure, to significantly boost biogas production above what could be generated by just one feedstock, in a process called "co-digestion." Because companies currently pay a "tipping fee" to landfill food processing waste, they may be willing to pay a fee to have it instead processed in a digester. Food processing waste is a potential feedstock for a "regional digester" (See discussion below).

**Animal Waste**

Animal manure, as shown in Table 14, appears at first glance to be the least promising source of biomass waste in the 9th Congressional District. No Concentrated Animal Feeding Operations (CAFOs) exist in the District and few large operations—only 5% of the animal operations have greater than $50,000 in annual sales. Smaller operations not only produce less waste, but they cannot realize the same economies of scale as larger operations in implementing an anaerobic digester. However, by collaborating with other counties in the region, sufficient quantities of manure could be collected to create an economically viable "regional digester." When sized appropriately, anaerobic digestion of animal waste can produce many financial and environmental benefits for individual animal operations, making a farm-scale digester an economically viable option when various revenue streams are considered (see Case Study).

Although off-the-shelf anaerobic digester technology currently exists, biogas recovery systems operating at commercial livestock farms are still relatively rare. As of July 2011, there were an estimated 171 digesters operating in livestock farms across the United States of which 153 were generating electrical or thermal energy from the captured biogas (equivalent to approximately 455,000 MWh annually).[39] The failure to adopt this technology on a large scale indicates that farmers, on balance, perceive the digester's costs to outweigh its benefits based on current policies, particularly those valuing carbon. The following financial models explore these costs and benefits in more detail.

## Proposed Regional Digester for 9th Congressional District

Researchers conducted a cost/benefit analysis of a 0.5MW digester that would operate as an independent business. The model is based on 3,700 animal equivalents (ae) of manure—what is produced by approximately 2,750 cows. The model assumes that 1,145ae is generated on-site at a farm and the digester accepts or purchases manure and other wastes as feedstock of an additional 2,245ae.

Other assumptions of this financial model:

- The manure that is not onsite is hauled an average of 10 miles to the digester;
- Manure cost is $1/wet ton for additional manure from other farms;
- Electricity price, estimated at $0.12/kWh, is the average Toledo and Ohio Edison retail price;
- Project is financed by 25% REAP grant, 20% equity, 55% loan @ 8% for 10 years.

Given these assumptions, this model indicates that the digester has a 10-year payback period, under current policies.

**Table 15: 0.5MW Regional Digester, Electricity Sold at Retail**

| | |
|---|---|
| **Capital Costs** | $3,000,000 |
| **Operating Costs** | $400,000 |
| **Total Electricity Production (kWh)** | 4,500,000 |
| **Annual Electricity Revenue ($0.12)** | $540,000 |
| **Bedding/Fertilizer Sales** | $165,000 |
| **Net Revenue/Savings** | $306,000 |
| **Simple Payback Period (yrs.)** | 10 |

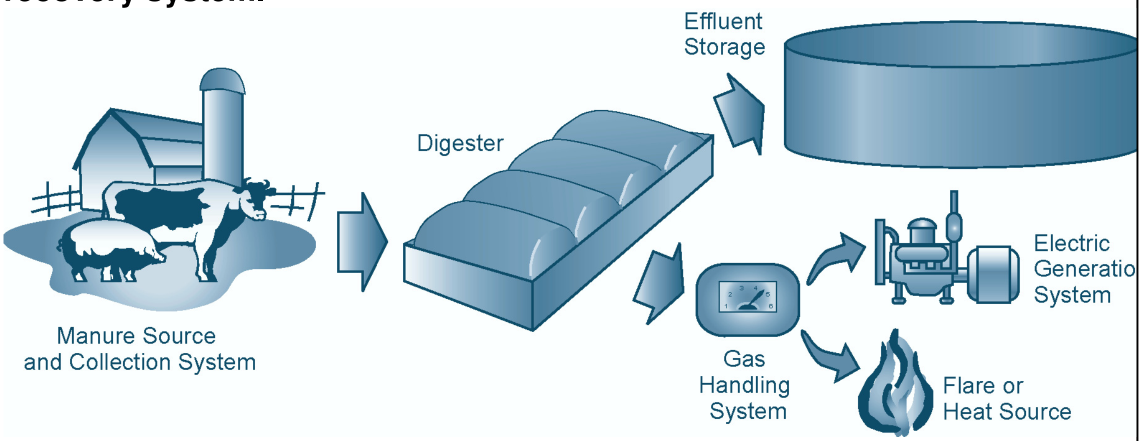
When researchers modeled the digester with these same assumptions but doubled the average distance the manure is hauled to 20 miles, this payback period increased *to 21 years*, illustrating the economic importance of locating a regional digester near other operations that plan to contribute feedstock to the digester.

Researchers also modeled the regional digester incorporating the sale of RECs and carbon credits (assuming $20/REC and carbon credits for methane avoidance at $8/ton), *the payback time decreased to 6.5 years* for a digester in which manure is hauled 10 miles, a significant reduction in payback time. It is important to note that the carbon credits are currently traded through private exchanges, and RECs are traded within a fledgling state-wide exchange, both of which fluctuate greatly; federal legislation capping or taxing carbon, by standardizing the monetary value of carbon, would stabilize revenue streams and could substantially increase the adoption of this technology (See Policy Recommendations at the end of the chapter).

## Biogas Case Study: Dovin Dairy Farms, LLC in Oberlin, Ohio

The Dovin Dairy farm is a family-owned farm with 700 lactating dairy cows and 400 calves. It is too small to fall under EPA regulations concerning nutrient levels or soil and water quality. However, it manages its manure responsibly through a scrape and lagoon manure collection system and dragline application in which liquid manure is injected directly into the soil. It currently uses sand and straw to bed its cows. This case study explored the financial feasibility and other ancillary benefits of implementing a farm scale "plug flow digester," a methane digester commonly used in dairy farms.

**Figure 5. Schematic showing the components and products of a biogas recovery system.**




Source: Managing Manure With Biogas Recovery Systems, US EPA AgStar Program

### *Benefits of Farm-scale Plug Flow Digester*

Anaerobic digestion of manure has many potential benefits, even for smaller-scale animal operations:

**Odor reduction:** Although in Ohio only CAFOs are subject to strict odor control regulations, many smaller-scale farms voluntarily choose to take odor-control measures to improve their own and their community's quality of life.

**Reduction in Greenhouse Gases:** Methane that would otherwise go into the atmosphere as a greenhouse gas is instead captured and converted to energy, likely offsetting other carbon-intensive forms of energy production.

**Savings in Electrical Costs:** Biogas can be converted to electricity to meet the farm's own needs and potentially to sell by exporting to the grid.

**Savings in Heating Costs:** the combustion of biogas to produce electricity creates heat that can be captured to be used on-site.

**Savings in Purchased Bedding Materials For Animals:** Digested biosolids, a by-product of anaerobic digestion, can be dried and used for bedding in lieu of sand or other purchased materials.

**Other Potential Economic Benefits:** Farmers may be eligible for tax breaks or could generate revenue through sale of excess electricity, RECs and/or carbon credits.

Researchers from Marquette University analyzed Dovin Dairy Farm's manure. Table 15 displays the energy potential of this waste.

**Table 15: Energy Potential of Dovin Dairy Farm, Oberlin, OH**

| | |
|---|---|
| Animal Equivalents (ae) | 1,145 |
| Estimated Manure Production | 17,800wet tons/year |
| Volatile Solids (VS) | 11,800lbVS/day |
| Estimated Methane | 41,300ft$^3$ methane/day; 15074500ft$^3$ biogas/yr |
| Estimated Electricity Production Potential | 3,700kWh/day; 1,350,500kWh/year |
| Estimated Waste Heat | 8,954,253,00BTU waste heat/year |
| AE/kW | 7.6 |

Based on these calculations, researchers then evaluated the economic feasibility of implementing a plug flow digester. As with the regional methane digester, researchers ran calculations under different scenarios but all scenarios were based on the following economic assumptions:

- 20 year project life
- 20 percent down payment
- 25% implementation grant (e.g., REAP)
- 8 percent loan interest rate
- 10 year loan term
- 10 percent project discount rate
- 15 percent marginal tax rate
- Modified Accelerated Cost Recovery System 7 year depreciation method
- 3 percent annual inflation

Table 16 models the payback for this technology based on: savings from replacing the cow's sand bedding with dried digester solids ($56,000/year), savings of the farm's own electricity costs, and revenue from selling its excess electrical production back to the utility through net-metering (at $0.08/kWh). Under this scenario, the technology has a payback period of 5 years with a net present value of $43,600[40]

**Table 16: Economic Feasibility of Plug Flow Digester in "Conventional" Scenario**

| Financial Estimates | Estimated Value |
|---|---|
| Capital Investment | $936,000 |
| Annual revenue from the recovery and use of biogas | $125,700 / year |
| Revenue received from the sale of biogas | $54,200 / year |
| Revenue derived from on-site use of biogas | $71,500 / year |
| Total Annual Cost | $74,800 / year |
| Simple payback | 5 years |
| Estimated average annual net income before taxes (loss) | $106,800 / year |
| **Net present value** | **$43,600** |

When other possible revenue streams were added, the economic picture improved. By selling RECs and carbon credits, the payback period can be reduced to four years with a net present value of $417,500. Again, it should be noted, the carbon price used in this model is based on what is currently *voluntarily* traded in private markets. Federal policy that monetized carbon (such as a carbon tax or cap-and-trade) would likely further reduce the payback period of this technology, thereby providing livestock operators with greater opportunities to earn revenue while simultaneously reducing greenhouse emissions. A USDA report estimated that carbon priced at $13 per metric ton of carbon dioxide equivalent would:

- Induce dairy and hog operations to supply offsets equivalent to about 22 million tons of carbon dioxide annually, *amounting to about 62 percent of the current greenhouse gas emissions from manure management in these industries*, or about 5 percent of total greenhouse gas emissions from the U.S. agricultural sector
- Allow dairy and hog operators as a group to earn up to *$1.8 billion in additional profits over 15 years from installing methane digesters.* [41]

## Part II: Economic Development

The 9th Congressional District is home to many companies that are part of the solar and wind industry supply chains. A former manufacturing center for the automotive industry, this region of Ohio has both factories and a workforce that are being retooled and retrained for this new growth industry. In Northwest Ohio, solar industries predominate. First Solar, a world leader in PV "thin film" manufacturing, currently employs 1200 people in its Perrysburg plant, doubling the number it employed five years ago.[42] CalyxoWillard and Kelsey in Perrysburg, and Xunlight in Toledo, are among many other sizeable employers in the District's solar supply chain. Wind-related industries are concentrated in Northeast Ohio. In addition to its wind and solar manufacturing facilities, the District has a unique opportunity to create the nation's first off-shore wind assembly facility bordering the Great Lakes. The District's deep water ports with their logistical capabilities offer a huge advantage as a potential wind component staging and assembly area for fresh water installations throughout the five Great Lakes. Finally, the District's location within the nation—just one day's drive of approximately 60% of U.S. manufacturing facilities and 600 miles from 50% of the U.S. population[43]—provides an advantage for supplying the nation's wind and solar generation facilities.

### Job Growth

As part of this NETL grant, companies in the 9th District that are involved in the wind and photovoltaic supply chains were identified and surveyed. Extrapolating from these survey responses, researchers estimate that 177 businesses involved in the wind and solar supply chains exist within the District, employing approximately 6,535 full-time positions (See Table 17). This represents significant industry growth; a 2005 report found only 67 solar- and wind-related industries.[44] However, as a relatively new industry, most of the businesses are still quite small, the majority of which employ less than 10 people.

**Table 17: Employment in Wind and Solar Supply Chains in 9th Congressional District**

| Employee Count Range | # of companies | Total # of Employees | Avg. employee Count Per Range |
|---|---|---|---|
| 0-10 | 90 | 467 | 5.2 |
| 11-20 | 26 | 413 | 15.9 |
| 21-30 | 10 | 207 | 20.7 |
| 31-40 | 10 | 377 | 37.7 |
| 41-50 | 16 | 793 | 49.6 |
| 51-60 | 13 | 748 | 57.5 |
| 60-70 | 02 | 130 | 65.0 |
| 70+ | 10 | 3380 | 338.0 |
| **TOTAL** | **177** | **6535** | **36.9** |

Interviews with representatives of these companies found they were optimistic about their future business growth, albeit with concerns regarding the unpredictability of future relevant federal and state regulations and incentives. Eighty-two percent of respondents reported that their business was either "stable," "very good," or "excellent," despite the current economic downturn. Perhaps not surprisingly, companies that were exclusively in the renewable energy industry ("tier I") were far more likely to desire government involvement than those companies with wider business interests that played more of supporting role in the industry ("tier II"). Given the fact that most of the companies in the wind and solar supply chains are relatively new and tend to be associated with a building industry that has been severely negatively impacted by recent economic events, these responses are very encouraging. Nevertheless, as any new industry is volatile, this positive trend should be viewed with cautious optimism. The future of these industries will be significantly affected by future federal and state policies.

## *Policy Recommendations for Fostering Renewable Energy Development in the 9th Congressional District*

The feasibility of a particular renewable energy project, financial and otherwise, fundamentally relies upon a labyrinth of favorable local, state, and federal policies. However, it is not sufficient that policies benefit renewable energy, they must also be *stable.* In Green Energy Ohio's survey of companies in the solar and wind supply chains, representatives continually cited the negative impact that regulatory instability had on their businesses, as well as the hardship in navigating the constantly fluctuating financing mechanisms for renewable energy, such as grant programs and tax credits. Without long-term regulatory stability and predictable financial incentives, this very promising industry, along with the renewable power generation industries, could flounder, causing these same industries and jobs to relocate to other states or countries with policies more friendly to the renewable energy industries.

In addition to policy stability, the renewable energy industry would benefit from policies that would cause energy prices to reflect their true cost. Currently, energy generated by fossil fuels is generally "cheaper" than their renewable energy counterparts in part because their cost to society, in terms of air and water pollution, global climate change, and geopolitical unrest, are not taken into account. Moreover, renewable energy technology, like any emerging technology, becomes cheaper and more effective with increased research and development, as well as with the greater economies of scale that come with increased deployment. Thus, government investment in this technology can be viewed as a way to push it "over the hump" into widespread adoption so that prices decrease.

Many policies can begin the transition into a renewable energy-powered future. The following recommendations apply to all of the types of renewable energy projects discussed in this chapter, unless noted otherwise. This is by no means a comprehensive list, as there are countless policies that do or could affect renewable energy development, but is an attempt to highlight some of the most important policy recommendations.

### Federal

## Ensure Sufficient Financing.

Access to affordable financing is vital to the growth of renewable energy. The technology is still relatively new and has heavy upfront capital requirements.

***Renew 1603 Grant Program:*** The 1603 grant provides upfront capital for renewable energy projects; although the ITC and PTC are helpful programs for financing renewable energy projects, they do not help with obtaining upfront capital and therefore require the developer to secure upfront financing prior to receiving the tax credit. One report found that the 1603 grant program helped directly motivate as much as 2,400 MW of wind power capacity to be built across the country that would not otherwise have come online in 2009.[45]

***Renew the ITC and PTC:*** Though less helpful than the 1603 grant for financing renewable energy projects, the ITC and PTC should also be renewed.

***Continue and Expand the New Markets Tax Credit:*** The NMTC provides a source of equity vital to renewable energy projects, enabling the development of many projects that otherwise would be unable to go forth.

## Create Demand for Renewable Energy.

Although state Renewable Portfolio Standards have been invaluable in stimulating a market for renewable energy in Ohio, a national Clean Energy Standard (that would be a floor, not a ceiling for state standards) would stimulate the market further, create more stable REC pricing, promote research and development activities to make the technology more efficient and cheaper, and allow for the achievement of mass economies of scale to further reduce the cost of renewable energy.

## State

### Maintain Advanced Renewable Portfolio Standards (RPS).

Ohio's RPS is an enormous driver of the state's renewable energy generation and of the businesses involved in the requisite supply chain. Any changes the state legislature makes to the RPS, either by decreasing the percentage of electricity that must be derived from renewable sources or by removing the mandate that this energy be produced in Ohio, would be detrimental to the renewable energy industry in the state. Regulatory uncertainty would lead to reductions in REC prices, private investment in renewable energy projects and business investment in renewable energy supply chains. Similarly, it is vital that the Public Utilities Commission of Ohio (PUCO) penalize utilities that do not meet their RPS benchmarks; failure to do so will depress renewable energy production and the associated REC market. As such, the fact that First Energy has been granted a waiver by PUCO twice for failing to secure its solar production obligations is a troubling sign.[46]

### Expand Ohio's Net Metering Legislation to Include Remote Net Metering.

Many states currently have legislation allowing for remote net metering. Such legislation promotes renewable energy development by enabling entities other than developers, such as educational institutions and other non-profit organizations, to directly benefit from renewable energy projects. Remote net metering also expands the areas where renewable energy projects would be considered economically viable.

### Renew and Expand Ohio's Advanced Energy Fund.

Ohio's Advanced Energy Fund has provided grants, low-interest loans, and incentive payments for clean energy projects. Unfortunately, the collection mechanism for the fund, a small surcharge on electric utility bills, was allowed to expire in January of 2011, jeopardizing the future of the state's incentive program. The program should be renewed and expanded.

### (Wind) Revise Legislation to Streamline Process for Mid-Scale Wind Projects.

Ohio House Bill 562 mandated that any wind project with an anticipated aggregate capacity of 5 MW or more seek approval from the Ohio Power Siting Board (OPSB). Legislation should be revised upward to allow projects of up to 10 MW be exempt from OPSB's approval. Such an exemption would promote development of mid-scale wind projects.

## Local

### Educate Community Stakeholders.

Local governments (and non-profits) should play a proactive role in educating landowners, including farmers, about leasing their land to wind or solar developers or developing their own farm-based biogas recovery system. Individual landowners, who can play vital roles in renewable energy development, are not in the "energy business" per se, and therefore generally do not have the expertise nor the time to initiate such an undertaking. Thus they need guidance from a trusted third party. Landowners that could potentially lease their land to wind or solar developers should be educated about the typical profit structures associated with such leases. By providing such education in advance, landowners would likely be more willing and quicker to lease their land, expediting the entire project. Likewise, farmers do not generally know about available cost share and incentive programs, do not have experience with electricity or gas generation, and do not want to be distracted from core business activities. A trusted third-party could assist a farmer in adopting this new technology without requiring too much of the farmer's time and effort.

## Streamline Developer Permitting Process.

Communities can help promote renewable energy development by streamlining the permitting process, including establishing a flat permit fee for renewable energy projects.

## Develop Renewable Energy Zoning Classification.

Several communities in the District have already developed a renewable energy zoning classification with associated guidelines (Richfield, Waterville and Jerusalem Townships). Such regulations provide a certain degree of clarity and predictability in a community's acceptance of future renewable energy projects that are attractive to potential developers. Other communities should refer to these townships' guidelines when drafting their own.

## Create an Energy Special Improvement District.

By creating an Energy SID, the locality, whether it be a region, county or city, would be able to provide PACE financing for developing renewable energy or energy efficiency projects. Because PACE allows repayments for energy improvement projects to go on property tax bills and transfers that obligation to new owners in the event that the property is sold, PACE can help property owners secure funds to invest in large energy improvement projects with relatively long payback periods.

## Create Regional Planning Authority.

The Toledo-Lucas County Plan Commission provides guidance in drafting wind legislation and ensuring code uniformity between the City of Toledo and the rest of Lucas County. Similar regional authorities should be established throughout the 9th Congressional District (and the State of Ohio) to coordinate renewable energy legislation and help expedite projects.

## Promote Cluster Development.

A strong effort should be made to coordinate and promote business connections within solar and wind-related industries in the 9th Congressional District, developing "clusters," concentrations of interconnected companies who work closely with each other, local suppliers, infrastructure providers, educational institutions, and other relevant agencies. Clusters increase levels of local expertise, allow firms with complementary skills to bid collaboratively on larger contracts, and can enable economies of scale to be realized by joint purchasing of common raw materials or joint marketing. Perhaps most importantly, clusters create positive feedback, attracting other companies in the same industry to the region. Economic development entities should identify and address the particular barriers that are impeding the growth of the specific clusters. It is especially important that educational and training organizations coordinate closely with regional employers to ensure that employers have a pool of workers with necessary skills and, likewise, that workers can have reasonable assurance that additional training in the clean energy economy will lead to future employment.

## Create a Feed-In Tariff.

With a feed-in tariff, a local utility would spur the development of renewable energy projects by guaranteeing the purchase of energy produced at a reasonable rate.

## (Wind) Conduct Preliminary Wind Capacity Testing.

Local governments could help attract wind developers by performing some of the necessary wind capacity tests indicative of the viability of a wind project, thereby reducing the pre-development costs, time and risks associated with such a project.

# Chapter 2: Energy Efficiency

The cheapest, cleanest energy source is from energy that can be *saved* by eliminating waste. Nationally, the average cost of energy saved through efficiency improvements is 2.5 cents per kWh, far less expensive for both utilities and consumers than buying that power. As part of its Clean Energy Law, Ohio's investor-owned utilities are required to implement energy saving programs in order to reduce energy by 22% of 2009 levels by 2025. To comply with this standard, utilities can implement programs that reduce energy demand, discussed in this chapter, or improve energy transmission infrastructure for more efficient distribution and reduced line loss.

Ohio has great opportunity for reducing its energy consumption: it is currently the 4th largest consumer of electricity in the nation, though it is the 7th most populous state.[47] Between 1980 and 2005, electricity consumption in the state grew at 1.4% per year, which was slightly more than half the national average, though the population grew at just 0.2% per year during that same time period, well below the national average.[48] The American Council for an Energy-Efficient Economy (ACEEE) determined that Ohio could reduce its projected electricity consumption by 33%—a reduction of 64,000 GWh—by the 2025 benchmark cited in the Clean Energy Law through cost-effective energy efficiency measures.[49] However, prior to developing any energy efficiency program within a region, it is vital to understand its particular energy consumption patterns and trends.

This Energy Efficiency chapter will first quantify the energy consumption of the 9th Congressional District and then will explore different energy efficiency program models. Particular focus will be paid to a residential energy efficiency program for the entire City of Oberlin. Finally, the chapter will discuss how energy efficiency work can spur economic development.

## *Part I: Energy Consumption in 9th Congressional District*

### Unevenly Distributed Energy Consumption

As part of this award, Palmer Energy analyzed current energy consumption and future consumption trends within the 9th Congressional District.[50] Their analysis reveals that energy consumption is very unevenly distributed among different types of customers: all 238,466 residential customers in the district consumed just 29% of the District's total electricity, while just 208 industrial customers consumed 39% (Table 18). Natural gas consumption is also concentrated among industrial customers (Table 19).

**Table 18: Electricity Use in 9th Congressional District by Customer Type**

| | Residential Customers | Residential Use(MWh) | Commercial Customers | Commercial Use(MWh) | Industrial Customers | Industrial Use(MWh) | Total Use(MWh) |
|---|---|---|---|---|---|---|---|
| **Erie** | 31,755 | 266,202 | 4,230 | 265,197 | 34 | 283,452 | 814,851 |
| **Lorain** | 32,047 | 268,650 | 4,270 | 267,705 | 34 | 283,452 | 819,807 |
| **Lucas** | 156,803 | 1,314,480 | 20,945 | 1,539,591 | 120 | 2,017,246 | 4,871,317 |
| **Ottawa** | 17,861 | 149,729 | 2,380 | 149,212 | 20 | 166,737 | 465,678 |
| **Total** | 238,466 | 1,999,061 | 31,825 | 2,221,705 | 208 | 2,750,887 | 6,971,653 |

Source: Palmer Energy Company

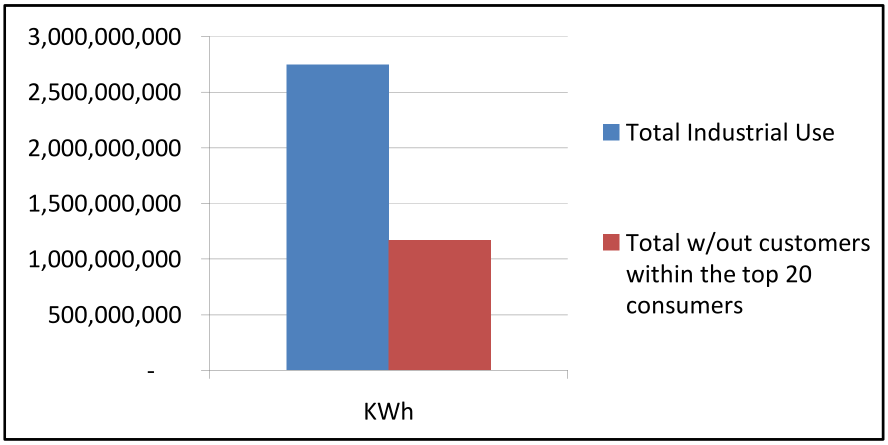
**Table 19: Natural Gas Use in 9th Congressional District by Customer Type**

| | Residential Customers | Use MMBtu | Commercial Customers | Use MMBtu | Industrial Customers | Use MMBtu |
|---|---|---|---|---|---|---|
| **Erie** | 28,043 | 2,860,000 | 2,335 | 1,567,000 | 33 | 3,908,000 |
| **Lorain** | 28,301 | 2,887,000 | 2,357 | 1,582,000 | 33 | 3,908,000 |
| **Lucas** | 138,476 | 14,125,000 | 11,559 | 7,758,000 | 115 | 13,618,000 |
| **Ottawa** | 15,773 | 1,609,000 | 1,314 | 882,000 | 19 | 2,250,000 |
| **Total** | 210,593 | 21,481,000 | 17,565 | 11,789,000 | 200 | 23,684,000 |

Source: Palmer Energy Company

Furthermore, within industrial and commercial sectors, just a few entities consumed a disproportionate share of total electricity (Fig 6,7). For example, BP-Husky, the Chrysler Toledo North Assembly Plant, and Materion account for a substantial proportion of overall energy consumption of the entire District. Because these and other major industrial entities are such large energy consumers, energy efficiency measures adopted by these companies could save the District millions or even tens of millions of kWh of energy. Even so, it can be extremely challenging to prompt large industries to adopt energy efficiency measures; because they tend to be large investments and are considered to be "non-core," they are difficult expenses to justify to investors. Moreover, industries are concerned that energy efficiency measures that affect the manufacturing process could degrade the quality of the end product.

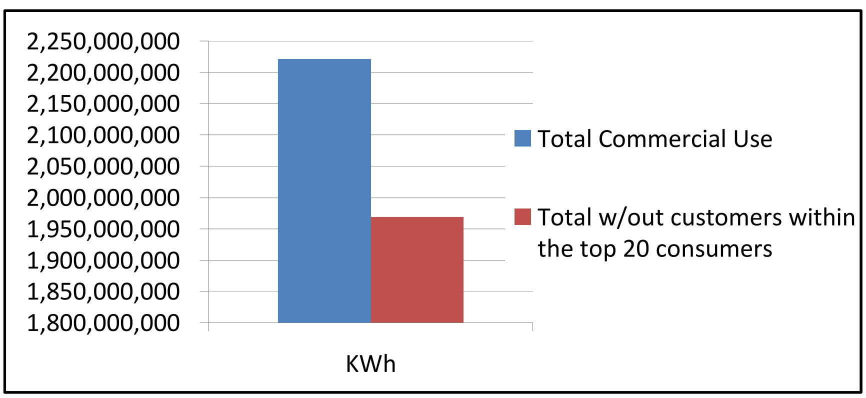
**Figure 6: Industrial Electricity Use in the 9th District**




Source: Palmer Energy Company

Likewise, certain government and healthcare entities (categorized as "commercial" in this report), such as the City of Toledo, University of Toledo, Toledo Hospital and St. Vincent-Mercy Medical Center, consume a disproportionate amount of the District's energy. While these facilities do not consume nearly as much energy as their industrial counterparts, they represent very significant targets for conservation since they have no industrial process requirements.

**Figure 7: Commercial Electricity Use in the 9th District**

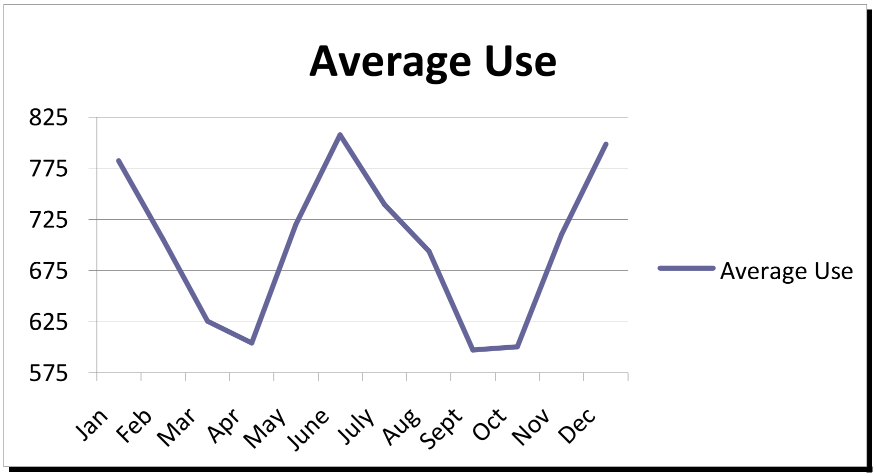



Source: Palmer Energy Company

## Seasonal Variation

Another important electricity consumption pattern in the 9th Congressional District is the peaks and valleys that occur in residential consumption throughout the year (Figure 8), with peak consumption during winter months being almost identical to peak consumption during summer months. Peak summer consumption clearly reflects the use of air conditioning. The spike in electrical use during the coldest winter days is caused by two different factors. In homes heated by natural gas (the great majority of homes in the district), furnace fans are running more (in the case of forced air heating) or their pumps are running more (in the case of hot water heating). The second factor is that approximately 20,000 to 30,000 homes in the District (in the range of 8-10% of all residences) are heated by electricity, likely contributing to a significant portion of the winter peak.

**Figure 8: Seasonal Variation in Residential Electrical Use in 9th District**




Source: Palmer Energy Company

### Future Trends

A final point regarding energy consumption in 9th Congressional District is that the two major electric companies and the natural gas company serving the District all forecast that residential energy consumption will gradually decrease over the next ten years, even in the absence of additional efficiency measures. The main reasons for this expected decline are recently legislated improvements to federal efficiency standards in lighting and household appliances. In contrast, energy use, both electric and natural gas, is expected to grow among commercial and industrial sectors in the next ten years. Forecasts regarding the magnitude of commercial and industrial growth vary by power provider. One of the electric companies serving the District, Toledo Edison, predicts that the increased consumption of their industrial and commercial customers will exceed the reductions in the residential sector, leading to an overall growth of 0.4% in electricity consumption. In contrast, Ohio Edison forecasts that the increased electrical demand by the industrial and commercial sectors will not be enough to outweigh the decreased demand of the residential sector, resulting in an estimated overall 0.10% *decrease* in electrical use in ten years. Columbia Gas predicts an overall increase in natural gas consumption of 0.57% in the next ten years.

## *Part II. Promoting Energy Efficiency*

There are many different energy efficiency program models, some of which are better suited toward different market segments (i.e., industrial, commercial, and residential) than others. An exploration of some of these models follows.

### 1. Efficiency Purchase Option

An Efficiency Purchase Option allows a utility to spend dollars that would have been allocated to power purchases or power plant construction to buy efficiency instead. The end result is the same—demand is met—but the method is changed. Efficiency is "purchased" by contracting with a third party that guarantees a certain quantity of energy savings.

## Case Study: Oberlin Municipal Light and Power System (OMLPS)

In June of 2010, AMP Ohio entered into an efficiency purchase option with Vermont Energy Investment Corporation (VEIC), creating the "Efficiency Smart" program for its member municipal electric systems. The communities that join Efficiency Smart are funding the program, through a rate-payer surcharge, in order to achieve a target amount of electrical energy savings over the three years of the contract. Each community has a specific target for savings that are based on the characteristics of the community.

Through this efficiency purchase option, VEIC guarantees that OMLPS will save its customers a minimum of 985 annual MWh and has a goal to save 1,407 annual MWh in electricity sales by December 31, 2013; the City of Oberlin currently provides 101,936 MWh of electricity annually.[51] Through these guaranteed energy savings, VEIC estimates that it will save OMLPS customers a total of $149,100 annually, for a lifetime savings of $1,884,104. As with energy efficiency implementation in general, the cost of enacting these electricity-savings measures is far cheaper than generating that power through other means; Efficiency Smart estimates that it can implement these savings for $1.82 per MWh of annual retail sales.

Because energy usage is heavily concentrated in the industrial and commercial sectors—in Oberlin, 81% of electricity is consumed by the commercial sector—the Efficiency Smart program is focused on this sector, though it does provide small rebates to residential customers for efficient lighting and appliances. For large commercial and industrial customers (defined by VEIC as using more than 500,000 kWh annually), the Efficiency Smart Program provides efficiency experts who can conduct onsite assessments, helping businesses ascertain the most appropriate efficiency opportunities along with the existing cash incentives for implementing these efficiency measures.

### 2. Energy Service Company (ESCO)

An Energy Service Company (ESCO) is a commercial business providing a broad range of comprehensive energy solutions that include energy saving projects. In an ESCO model, energy cost savings from energy efficiency projects are used to pay back the capital investment of the project; if the project does not provide returns on the investment, the ESCO is generally responsible to pay the difference. In this model, the ESCO is responsible for all aspects of the energy efficiency retrofit: it performs an in-depth analysis of the property, designs an energy-efficient solution, installs the required elements, and maintains the system to ensure energy savings during the payback period. In general, ESCOs work with very large businesses or industries In order to gain sufficient economic margins to be profitable.

## Case Study: Four Oberlin Downtown Buildings

As part of this award, Professional Supply, Inc. (PSI), an ESCO, conducted assessments of four different buildings that house small businesses in Oberlin. Following these assessments, PSI made recommendations regarding possible energy efficiency retrofits and their associated costs, payback times and greenhouse gas emission reductions. PSI's assessment consisted of the following:

***Existing Building Analysis:*** Determined square footage of the building, building setpoints (i.e. what thermostat is set for to trigger either heating or cooling), characteristics of HVAC and boiler equipment, and lighting inventory.

***Existing Energy Analysis:*** Reviewed building's historic cost and usage of gas, electricity and water.

***Weather Analysis:*** Ascertained the building site's longitude and latitude; data regarding heating degree days and cooling degree days (measurements designed to reflect the demand for energy needed to heat and cool the building, respectively); and historical baseline weather data.

***Energy Conservation Measures:*** Detailed specific equipment recommended for reducing the building's energy consumption.

***Energy Model and Savings:*** Estimated annual energy and cost savings from implementing different efficiency measures.

***Emissions Analysis:*** Estimated the "carbon footprint" reduction (reduction in $C0_2$ emissions) from implementing the different recommended conservation measures.

***Investment Analysis:*** Projected the return on investment—the number of years it will take for the initial investment to pay off through energy savings—from each recommended conservation measure.

The overarching result of PSI's analyses of the four buildings was that lighting retrofits were *by far* the most cost-effective conservation measure that they analyzed and provided the greatest percent reductions in carbon emissions. Payback times for lighting retrofits ranged from a low of 4.6 to a high of 6.3 years; average $C0_2$ emission reductions for all of the buildings was 30.2%.[52]

## 3. Residential Retrofit Program Models

In general, ESCOs and Efficiency Purchase Option measures tend to target non-residential sectors, where they can achieve savings more efficiently. (As previously noted, total residential energy consumption in the 9th Congressional District is less than total consumption by other sectors and is dispersed among far more customers than these other sectors). Because of the distributed nature of residential energy use, multiple customers, and other unique challenges associated with implementing a broad-based residential retrofit program, residential programs are generally designed quite differently than their commercial and industrial counterparts.

## Barriers and Programmatic Solutions

Residential retrofit programs face several barriers, most of which also exist in other sectors, but may be exacerbated in the residential sector. Below are explanations of these barriers along with some programmatic elements that could either eliminate or reduce the impact of these barriers.

***Upfront Costs:*** Many programs provide rebates or tax credits *after* work is completed which does not help people who have difficulty accessing an upfront source of capital; although low-interest loans may be available, the consumer may be unwilling to assume additional debt, or unable to, due to bad credit.

> Solution: Innovative repayment mechanisms such as Property Assessed Clean Energy (PACE) and on-bill financing (See page 53) provide a way to capture the value of efficiency and use these savings to pay the upfront costs over time; eligibility for these repayment methods is not based on credit score, but rather bill and tax payment history.

***Opportunity Costs:*** Implementation of energy efficiency measures competes with households' other expenses and may not be prioritized because it is not considered to be as urgent as other needs. Moreover, energy-efficient technologies (e.g., Energy Star appliances, well-insulated homes, and high-efficiency furnaces) are generally more expensive than their less-efficient counterparts.

> Solution: Financing mechanisms that provide upfront funding dedicated to energy efficiency improvements can overcome this barrier. Such funding mechanisms could be associated with repayments coming out of projected energy savings or with energy efficiency measures funded through the utility as a capital investment instead of as an expense

***Risk:*** Homeowners are uncertain whether their investment will pay for itself within a reasonable timeframe, particularly if they do not anticipate living in the house long-term.

> Solution: The best way to ensure that the current occupant benefits from the improvements they make to their home is by structuring the payment obligation to run with the meter or the property (e.g., PACE). Another way the program can reduce risk is by employing or contracting with, a trusted, knowledgeable entity to conduct a home audit and estimate the payback period for various measures. The program could also be designed to finance only those selected improvements that will cover their costs through energy savings, as predicted by audits or deemed savings calculations. Finally, if the building occupant (rather than the program), is paying for a mechanical device, such as a furnace, it can be covered by a warranty.

***Lack of Knowledge or Understanding:*** Many households are simply unaware of the benefits of energy efficiency measures or associated programs, rebates and other incentives. For those that are aware, they are often misguided with respect to which measures are most effective in increasing the efficiency of their home and the relative payback time of various measures. Others may be unfamiliar or uncomfortable with selecting and managing an auditor or contractor.

Solution: Outreach efforts should be community-based through trusted leaders and peers. Once homeowners have decided to participate in the program, a "one-stop shop" model can assist them in navigating the entire energy efficiency retrofit. An "Energy Advocate" could be assigned to each participant, walking them through every step of the retrofit process, including educating the participant about energy efficiency, choosing auditors, interpreting audit results, choosing efficiency measures, choosing contractors, facilitating installation, and facilitating post-test.

***Transaction Costs:*** Making a home more energy efficient can entail several additional "costs" to the homeowner in time and effort. In addition to educating themselves about different energy efficiency measures and payback times, homeowners may need to spend considerable time finding trustworthy auditors and contractors. Furthermore, homeowners may be unwilling or unable to rearrange their schedules to be at home during the hours that auditors and contractors wish to complete their work.

Solution: The program could employ an Energy Advocate, who could greatly reduce the participant's transaction costs associated with the retrofit process (e.g., educating the participant about price ranges and estimated energy savings per implemented measure). Transaction costs could also be reduced by structuring the program to connect customers directly with pre-qualified auditors and contractors.

***Split Incentives:*** In rental properties, in which the renter pays the utilities, the landlord does not have a financial incentive to invest in energy efficiency measures. Likewise, the renter would unlikely be willing to pay for improvements to a property that he/she does not own.

Solution: Utility-based programs can place repayment charges on energy bills that go to tenants. The tenants benefit through decreased energy bills and the landlord benefits from an improved property at no cost other than to notify subsequent tenants of the arrangement.

***Structural Barriers:*** Many of the buildings most in need of energy efficiency improvements are not ready to be retrofitted because of basic structural issues such as lead paint, asbestos, dilapidated roofs, and antiquated electrical wiring.

Solution: The program could identify funding sources that could be used to correct these structural issues and "bundling" the loan or grant applications to simplify the customer's experience.

***Multiple Utilities:*** Many households are served by multiple utilities, such as an electric company and a gas or fuel oil company for heating. This is a drawback for "on-bill" programs, as energy-efficiency measures are likely to reduce both heat and electrical use, and savings will thus be seen on both bills, but costs will only be charged on one of the bills. A related problem exists for PACE and signature loan programs – savings will be seen on utility bills, but will be paid as a monthly loan payment or on the property tax.

## Program Design

Ideally, any residential energy-efficiency retrofit program anticipating widespread adoption should address all of the above barriers. In addition, program designers must determine: which energy-efficiency measures will be covered by the program; what type of financing will be used (including the source of capital, financing method, and repayment method); who will be responsible for the various elements of the program; and finally, how costs, savings and payback will be estimated. Each of these aspects of program design is explored below:

### *Scope of Energy-Efficiency Measures*

As there are countless ways to improve the energy efficiency of a home, one key decision in designing a retrofit program is which energy efficiency improvement will be included in the program. This decision will depend on the ultimate goal of the retrofit program. For example, a program that aims to maximize cost savings to the consumer would consider only measures that have a relatively short payback time, whereas a program focused on maximizing greenhouse gas emissions would consider deeper retrofits with longer payback times. In general, a comprehensive community-wide residential retrofit program will encompass:

**Building Shell:** Includes energy efficiency improvements to walls, ceilings, floors, ducts, joists, pipes, windows, and doors. Some specific measures would be:

- Performing whole house diagnostic using blower door testing to determine air leakage;
- Repairing drywall and window glass, as necessary; and
- Insulating attics, sidewalls, floors, and crawl spaces.

**Heating and Cooling Systems, and Other Mechanical Equipment/Appliances:** Includes measures that ensure efficient operation, safety, proper air flow and moisture levels of this equipment, such as:

- Insulating the water heater, pipes and joists;
- Servicing or replacing HVAC equipment;
- Installing water heater wraps if under-insulated;
- Servicing or replacing appliances, installing Energy Star appliances when appropriate;
- Sealing return ducts to ensure proper air flow; and
- Replacing incandescent bulbs with compact fluorescent bulbs.

**Consumer Behavior:** The manner in which a building occupant uses heat, air conditioning, water and various appliances can have an enormous impact on energy use and, consequently, realized cost savings. In order to maximize energy savings from physical improvements to the household, the program should aim to improve energy efficiency behaviors through education, marketing and outreach.

## *Financial Structure*

Because funds for energy efficiency are limited, the ideal financing structure will capture the value of implementing energy efficiency measures (i.e., the money saved on utility bills) and use these savings to pay for the cost of making the improvements. Such a financial structure requires a source of capital, a method of making financing available to pay for the improvements, and a repayment structure to capture the value. Energy efficiency programs can "mix and match" the various sources of capital, repayment methods and financing options described below, although some combinations will work better than others.

### Sources of Capital

Many potential sources of capital for financing energy efficiency improvements exist. Regardless of the capital source chosen, programs should establish a loan loss reserve to guard against repayment defaults. To date, default rates in energy efficiency programs are quite low (less than 1 percent), but a reserve brings security to the program and lowers risk for the source of capital. Some possible capital sources include:

- State bonding
- Municipal bonding
- Utility capital
- Private lending from local banks or credit unions
- Program related investments from foundations
- Grants

## *Financing Methods*

**Revolving Loan Fund:** This fund would finance any improvements made through the program, with all repayments (minus administration costs) returning to the fund. The size of the fund and speed of repayments would limit the number of households that could participate in the program at any given time. A percentage of the fund should be set aside to cover any defaults.

**Private Lenders and Credit Enhancements:** A private financial institution could pay for any program-related improvements either directly through a loan to the household or indirectly through a loan to the program. The program administrator would negotiate with the lender to establish specific aspects of the loan, such as interest rate and methods for determining household financial eligibility. In order to improve both the number and type of eligible households and the terms offered to households, the program should offer credit enhancements, such as a loan loss reserve fund, an interest rate buy down, or an "eligibility buy down" (some form of security that would make more households eligible). The loan could be designed so that households repay it either directly to the financial institution or to the program, which would then pay back the financial institution.

## *Repayment Methods*

None of the repayment methods described below single-handedly address transaction costs; for any of these methods to be effective, they need to be embedded within a comprehensive energy efficiency program that provides education and technical assistance to the customer. Four options for repaying energy efficiency improvements are described below, followed by a chart summarizing the strengths and weaknesses of each method.

**Property Assessed Clean Energy (PACE):** PACE allows a property owner to pay for energy efficiency improvements to their property through a special assessment that is added to the property tax bill. Traditionally, property tax assessments have been used by municipalities to make infrastructure improvements that benefit the homeowner, such as replacing a sidewalk in front of the taxpayer's home. As with these infrastructure assessments, the PACE charge can stay with the property, even if the current owner moves; PACE is a "loan" to the property, not an individual. In a PACE program, a homeowner who chooses to be part of the program interfaces with a third-party intermediary, such as a specially-created development corporation or municipal division. This entity arranges the financing, helps coordinate the efficiency improvements, including the contractor's services, and then is responsible for paying contractor fees and any equipment related to the agreed-upon improvements. Once the improvements are complete, the property owner pays back the costs associated with the improvement over a number of years via his property tax bill. In the case of default, the municipality could take the same actions it would in the event of default on the property tax, including seizing the property.

A PACE program needs a source of capital with competitive interest rates, such as municipal bonds or Qualified Energy Conservation Bonds. It also needs an entity to manage the program that possesses basic legal, financial, and technical expertise, and the ability to negotiate pooled contracts for energy. As previously noted, the main drawback of PACE at this time is that in May of 2010 the Federal Housing Finance Agency, which oversees Fannie Mae and Freddie Mac (which together own or guarantee half of the nation's mortgages), made a statement recommending that lenders not finance properties with PACE loans; this put virtually all residential PACE programs on hold, awaiting resolution to the dispute through the courts.

**On-bill Pay as You Save (PAYS):** On-bill repayment programs are similar to PACE programs, but repayment runs through a utility rather than a municipality, with energy efficiency improvements treated like a utility service. The customer elects to participate in the program and pays for these improvements over time on his utility bill. The utility conducts an audit of the home, helps the customer select a contractor and the improvements desired, pays for the improvements, and then adds a monthly charge to the utility bill, which the customer pays back over a number of years. On-bill repayment programs are generally run by utilities, although their administration may be contracted out. It requires upfront capital, which can derive from the utility or a partner.

A critical element of PAYS is that any improvements must pay for themselves in energy savings over the term of the customer's participation. Similar to PACE, the energy efficiency service is not a personal loan, but is rather an obligation on the utility meter that can transfer from one resident of the property to the next. In the event of default, the utility may employ its normal collections mechanisms, including suspending service. Investor owned utilities regulated by the State of Ohio need approval from the Public Utilities Commission of Ohio to put a charge for energy efficiency services on their customers' bills, but municipal utilities do not.

**Signature Loans:** Signature loans are unsecured personal loans, offered through, or in cooperation with, a bank or credit union, which can only be obtained for energy efficiency work. Customers must have an acceptable credit history to be eligible for the loans and, because they are personal loans, the obligation stays with the person over the term of the loan.

**On-bill "Light":** This repayment method is a hybrid of the on-bill repayment and the signature loan, in which the payment of the loan is placed on the utility bill. The process is identical to that of the signature loan, except that instead of placing the repayment charge on a separate monthly bill, the utility agrees to act as a billing service and add the charge to the utility bill.

Each of these repayment methods has its particular strengths and weaknesses, summarized in Table 20. Where relevant, the table indicates—in red—which barrier is addressed by particular aspects of each repayment method.

**Table 20: Strengths and Weaknesses of Repayment Methods**

| Repayment Method | Strength (Barrier Addressed) | Weakness |
|---|---|---|
| PACE | • Dedicated financing (Upfront cost/ opportunity cost)<br>• Obligation stays with property, not person; enables EE projects with longer payback (risk)<br>• Lowered costs through bulk purchases, pooling resources<br>• Can be funded through federal, state and municipal capital, providing favorable interest rates to homeowner | • Federal Housing Finance Authority currently not accepting mortgages on residential properties with PACE obligations, thus most PACE programs on hold<br>• Portable measures (e.g., appliances) can be removed from property and therefore may not be included or could reduce overall energy savings |
| On-Bill (PAYS) | • Renters can participate (split incentive)<br>• Obligation tied to meter, not person (risk)<br>• Dedicated financing for EE projects (opportunity cost/upfront cost)<br>• Can lower costs through bulk purchasing and contract negotiations<br>• Low delinquency because tied to utility bills which have low default rate<br>• Savings appear on utility bills so customer may be able to view costs and savings on same bill | • Requires utility—which makes profit by selling energy, not saving it— to implement it<br>• Increases chance of utility disconnection<br>• When home served by multiple utilities, costs of EE measures may appear on different bill than savings |
| Signature Loan | • Loans only available for EE work (opportunity cost)<br>• Credit check of customer so less chance of default | • Require assumption of debt and credit history check so doesn't overcome upfront costs<br>• Personal loans so doesn't overcome risk barrier<br>• Tenant unlikely to take out loan to improve landlord's property—does not overcome split incentive |
| On-Bill "Light" | • Loans only available for EE work (opportunity cost)<br>• Credit check of customer so less chance of default<br>• Costs and savings can be on same bill | • Require assumption of debt and credit history check so doesn't overcome upfront costs<br>• Personal loans so doesn't overcome risk barrier<br>• Tenant unlikely to take out loan to improve landlord's property—does not overcome split incentive |

### *Comprehensive Program Functions*

Any comprehensive retrofit program will include administrative, financial, outreach and auditing/construction duties. Program designers need to determine which entities will be responsible for these various program components.

| Work Components | Representative Tasks |
|---|---|
| Administrative | Manage any employees;<br>Hold contracts with other entities;<br>Determine eligibility;<br>Scheduling of contractors;<br>Manage contractor eligibility;<br>Manage projects and measures eligibility;<br>Track data;<br>Possibly hold revolving loan fund or loan loss reserve. |
| Financial | Determine financial eligibility;<br>Process payments;<br>Possibly hold revolving loan fund or loan loss reserve;<br>Collections. |
| Outreach | Marketing;<br>Deployment of Energy Advocates<br>Community outreach.<br>Referrals |
| Auditing/<br>Construction | Audits<br>Installation of Measures |

### *Estimating Costs, Savings, and Payback Periods*

Estimating individual household costs, savings, and payback periods can be difficult because the building occupants' behavior substantially impacts energy savings. On a programmatic level, savings and payback will depend on the source and type of capital, the program design, and the initial size and scale of the program itself. On a household level, savings will be affected by the home's current electricity use, the types of energy efficiency measures taken, the price of future energy compared to the current price, as well as the age, size, and type of construction of the house.

The most accurate way to predict future energy savings from a residential retrofit is by conducting a comprehensive home energy audit. Barring that possibility, estimates can be based on savings realized in similar homes in the same region. As a general rule of thumb, retrofits can be expected to reduce energy use by up to 30 percent with relatively minor work, and substantially more with greater investment.

## Case Study: City of Oberlin Residential Retrofit Program

Through this NETL award, a team of energy efficiency experts, led by the Ohio Environmental Council, was commissioned to design an energy-efficiency program for the City of Oberlin.[53] Because VEIC is already implementing the Efficiency Smart program, focused on industrial and commercial sectors, the research team focused on creating a program for the residential sector.

This residential retrofit program was designed to meet the criteria articulated by the Oberlin Project Energy Policy Committee for a comprehensive residential energy efficiency program.

### *Oberlin Project Energy Policy Committee Goals for Residential Energy Efficiency Program*

1. Demonstrate environmental stewardship
2. Reduce greenhouse gas emissions
3. Save money for all property owners/rate payers, with an emphasis on tenants and low income households
4. Provide financing  to households to overcome upfront cost barrier to energy efficiency retrofits
5. Target, but do not limit, the program to the southeast quadrant of the City
6. Include all energy efficiency measures, but focus on those that are thermal (rather than electric) in nature and those that have a 5-10 year payback
7. Create jobs for local residents
8. Leverage private capital
9. Leverage existing programs
10. Show national leadership
11. Build relationships and have clear communication between stakeholders

### *Community Profile*

**Building Stock**

The City of Oberlin's residential sector is about 44% rental properties and 56% owner-occupied.  Its building stock is older than the average community in the state, with 38% of its residential structures built before 1940.  Because older buildings tend to be less energy efficient, an Oberlin retrofit program is likely to realize greater energy savings than other Ohio communities.

**Energy Poverty**

Many Oberlin residents struggle with energy costs. In 2008, Oberlin Community Services assisted 606 homeowners with utility bills, an increase of 41% from 2007. In the same year, utilities were shut off in an average of 25 homes per month for lack of payment.

**Long-term Energy Contracts**

In 2008, following heated community debate, Oberlin City Council, decided *not* to enter into a long-term contract with other AMP communities to own a share of a new coal-fired power plant.  Instead, it sought to purchase energy derived from renewable sources.  In 2011, it signed a 15-year power purchase agreement with AMP and Waste Management Renewable Energy LLC for the landfill gas from two different Ohio landfills, one in Geneva and one New Springfield.   Together, these landfills are expected to produce

60,000 MWh of electricity, approximately 55% of City's power requirements. In addition, the City has entered into two long-term contracts for hydroelectric energy from the Ohio River, expected to generate 17% of the City's power. Along with other smaller renewable energy sources, the City of Oberlin anticipates generating *90% of its power from renewable sources.* [54]

In addition to the environmental benefits of these energy sources compared with traditional sources of power, these contracts reduce the City's exposure to regulatory actions (e.g., possible future carbon taxes) and fuel price volatility. The downside is that the longer-term nature of the supply and the diminution of reliance on wholesale market purchases reduce the City's flexibility in accommodating changes in consumer demand. If Oberlin residents and businesses were to significantly reduce their energy consumption through energy efficiency measures, the City and OMLPS would face an energy surplus. Such a surplus, if not used for other purposes or for new customers would create a financial loss to the municipal utility and the residents it serves. Thus, any energy efficiency program should be complemented by plans for use of any surplus power, whether through attracting new businesses and residents or seeking alternative uses for the power, such as electric vehicles (See Transportation chapter)

**Existing Energy Efficiency Programs**

*Efficiency Smart:* As discussed earlier, this is essentially a commercial and industrial program. However, it does offer some small rebates for energy-efficient appliances and discounts on compact fluorescent light bulbs.

*Oberlin Municipal Light and Power System:* OMLPS conducts free heat-loss inspection services that include a blower door test and building envelope analysis with a thermal imaging camera and then recommends cost-effective energy-efficiency measures that could be implemented. It also offers customers the use of appliance meters to view the appliance's energy performance. Finally, it distributes some free compact fluorescent light bulbs.

*Columbia Gas:* The local natural gas distribution and supply utility provides various programs addressing energy efficiency and weatherization through a compendium of rebate, no cost, and loan programs covering all incomes and sectors.

- Home Performance Solutions: Available to all Oberlin residents, HPS provides low-cost comprehensive home energy audits as well as many generous rebates on installed energy efficiency measures. This program has a good state-wide reputation but demand for services outstrips supply: last winter there was a three-month waiting list for the program.

- WarmChoice: A weatherization and energy efficiency program, free to customers up to 150% of federal poverty level. Following a comprehensive home energy audit, the program will implement such measures as attic and wall insulation, air sealing, and gas furnace or water heater repair or replacement.

- Simple Energy Solutions: A rebate-based energy efficiency program that offers programmable thermostats and low-flow shower heads.

*Home Weatherization Assistance Program (HWAP):* Operated in Lorain County by the Lorain County Community Action Agency, HWAP is a federally-funded no-cost energy efficiency and home weatherization retrofit program available to homeowners or renters that earn up to 200% of poverty. HWAP includes a home energy audit and any energy efficiency improvements deemed necessary, including repair or replacement of heating, ventilation air conditioning, high energy usage appliances, duct sealing, caulking, and attic and wall insulations. Despite the comprehensive nature of this program, less than 1% of Oberlin residents have taken advantage of it so far, possibly because its application process is perceived to be cumbersome.

*Providing Oberlin With Efficiency Responsibly (POWER):* POWER is an Oberlin-based no-cost weatherization program for homeowners that are at or below area median income. It partners with OMLPS to conduct a home energy audit and uses local contractors to insulate homes. It currently has limited staff and funds and therefore small in scope.

*Community Housing Improvement Program (CHIP):* The federally funded CHIP program was sponsored by the City of Oberlin and provided grants and deferred loans to households for rehabilitation of their properties. The intent of the rehab program was to install weatherization and energy efficiency retrofit measures while addressing necessary structural and health and safety issues. Funding for the CHIP program was not renewed in 2010-11 but may be reapplied for in the next grant cycle.

*U.S. Department of Agriculture (USDA):* Oberlin is defined as a “rural area” by USDA, allowing residents to take advantage of various energy efficiency grants and loans. The Very Low-Income Housing Repair Program provides grants, loans, or a combination of the two to income-qualifying homeowners to repair, improve, or modernize their dwellings or to remove health and safety hazards. The Rural Energy for America Program (REAP) administers grants to rural small businesses for energy efficiency and renewable energy improvements of up to 25% of total project cost.

*Loans and Tax Incentives:* A wide variety of loans and tax incentives are available on a federal- or state-wide basis, and can be taken advantage of by Oberlin residents. While many loans offer favorable rates, assumption of debt can be a major barrier to use. Similarly, since tax credits are not available until after the work is done and paid for, they may not be practical for many households. (See Appendix C for listing of loans and tax credits available regionally).

## *Proposed Program Design*

In their report, Implementing Residential Energy Efficiency, the design team led by the Ohio Environmental Council recommended that Oberlin implement a comprehensive whole home energy efficiency program. Such a program should include personalized customer service in the form of a "one-stop shop" and provide financing that is as accessible as possible to its customers. Interestingly, such a program is not exorbitantly expensive relative to other infrastructure projects; the OEC estimates that *every household* in the City of Oberlin could complete a whole-house retrofit for a total of $12 million. Other aspects of the recommended program are detailed below:

**Program Administration:** A third party (i.e., an entity other than the City or OMLPS) should administer all marketing, contractor and auditor certification, financial, and customer service program functions. Through this "one-stop shop," each participant would have a single point of contact, an "Energy Advocate," who would facilitate all aspects of the energy efficiency program for participants. The Energy Advocate's role would include: answering general questions, choosing auditors, interpreting audit results, choosing measures, choosing contractors, facilitating installation, and facilitating post-test. The Energy Advocate would also leverage other energy efficiency programs, ensuring that participants take advantage of any discounts, rebates or tax credits for which they are eligible. This "one-stop" agency would also be responsible for all outreach, marketing, and community education. The report recommends that POWER collaborate with the City, the utilities, Lorain County Community Action Agency (LCCAA) and Ohio Partners for Affordable Energy (OPAE) to design, establish and administer the program.

**Eligibility:** All residential properties in the City of Oberlin would be eligible to participate, including rental properties, assuming that both landlord and tenant agree to participate and new tenants are informed that the property is participating in the program. The program may wish to screen applicants on the basis of the age of their home (likely pegged to building code implementation dates), the magnitude of their energy expenditure, their income level, or their geographic location. Participants who are eligible to receive fully-subsidized retrofits from the HWAP program should be strongly encouraged to apply to that program and given help in completing the requisite paperwork.

**Sources of Capital:** Qualified Energy Conservation Bonds (QECBs) or other state bonding sources would supply capital for a revolving loan fund, with a 5% loan loss reserve. If PACE is pursued, Oberlin may be able to issue municipal bonds to support the program. In addition, Ohio-based Community Development Financial Institutions (CDFIs) should be approached about providing low-cost capital. Similarly, local banks, credit unions or foundations should be asked to make program-related investment loans at below-market rates.

**Repayment Options:** PACE should be pursued, if the objections to it are resolved at the federal level or if the City is willing to proceed without this resolution, with the efficiency improvement charge placed on a monthly municipal bill. Another option would be on-bill “light,” preferably placing the charge on the gas bill, as most of the savings are likely to be thermal. A third, less attractive, repayment option would be signature loans.

*PACE:* Improvements would be paid for through a special improvement district, and repayment by residents would be via a municipal bill, with the obligation attached to the property, not the person.. The value of the improvements would be secured by the property tax. The City would accept any potential risk that might stem from the FHFA’s disapproval of PACE programs. Financial eligibility would be based on property tax payment history and an appropriate loan-to-value ratio. The program could be open to tenants that have permission from the property owner.

*On-bill “Light”:* Columbia Gas, OMLPS or the City would agree to place a charge on the utility or municipal bills of customers who opt in to the program, but would not treat this as a tariff nor be able to discontinue service for non-payment. Financial eligibility might need to be based on more than bill payment history. Columbia Gas, OMPLS or the City would not be liable for non-payment, so additional security for the loan would be needed, or the program would have to accept the risk. The obligation would stay with the person, not the meter.

*Signature Loan:* The program administrator would assess the financial eligibility of the household and offer the loan, either directly or via a financial partner. Interest rates could be tiered based on credit score and/or credit enhancements could be used. The loan would be to the person, not the property.

**Eligible Efficiency Measures:** The scope of retrofit measures to be implemented in a given building should be determined by the results of the energy efficiency assessment or audit, using modeling software, conducted by a certified professional. Bundles of measures that have a Savings to Investment Ratio (SIR) of greater than 1.1 over a 10 year period would be eligible, assuming that the expected life of the measure is equal to or greater than that time. In addition, the program could choose to add or eliminate individual measures (e.g., “portable” measures may be excluded or limited). The minimum cost for total improvements to a property should be $1000.

**Process:** After applying to the program and being screened for eligibility, a home energy audit would be performed on the participant’s home. The auditor would then generate a list of cost-neutral measures and payback time. The Energy Advocate would work with the participant to identify any available rebates, incentives or financing options for which the participant is eligible, and to select a contractor. After the contractor has completed the work, the auditor or other contractor would complete post-test measurements and verification. Once this work is deemed acceptable by the program and resident, the contractor is paid by the program and the homeowner begins repayment.

**Contractor Involvement:** The program would be responsible for screening potential contractors. At minimum, the contractors should be certified by the Building Performance Institute (or equivalent), have no history of complaints regarding work done through the program, and consistently perform work of a high caliber, as determined by the post-retrofit audits. The program could require that contractors meet other criteria, such as residing locally or willingness to participate in training others. Once the program develops a list of acceptable contractors, there are many ways that a particular contractor could be selected for a particular job, though it is recommended that the program be involved in soliciting bids for the participant.

If the program aims to create local jobs, it needs to be involved in coordinating job programs to ensure that potential workers are being properly prepared to do the work that the retrofitting process requires of them. (See the Economic Development section below for a discussion of job creation and job training in the energy efficiency sector).

**Data Collection, Quality Control and Verification:** Properties that participate in the program should undergo a full post-improvement audit to determine the efficacy of installed measures. Program participants would give the program permission to access their utility bill data, including heating bills, for the entire repayment period. The program will calculate and track greenhouse gas reductions based on the program.

## *Part III: Economic Development*

### Energy Cost Savings

Making buildings more energy efficient creates both community-wide and individual financial benefits. The community benefits because the utility can avoid or delay building additional power plants which, as mentioned earlier, are substantially costlier to build (per kWh generated) than the implementation of an efficiency program (per kWh saved). This reduced cost should be reflected in lower energy costs to the consumer.

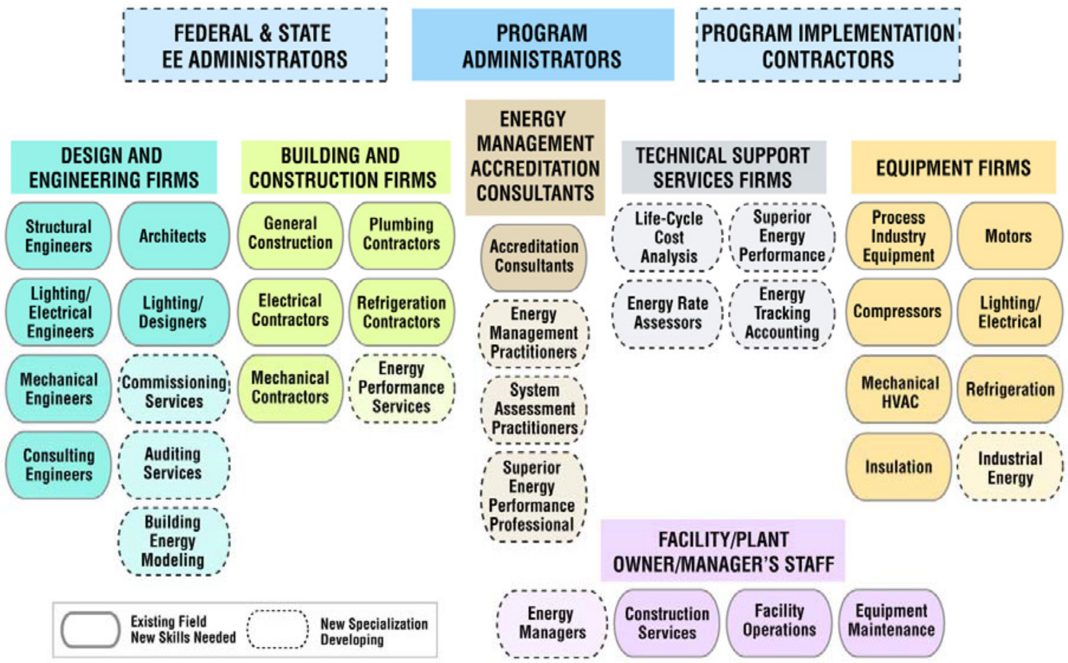
In addition, individual homeowners whose own homes have been retrofitted will realize financial benefits after reaching the payback period. It is important to note that because energy costs are a "regressive good"—the less money a household has, the greater the percentage of disposable income that must be spent on energy bills—lower-income households benefit the most financially from energy efficiency retrofits; a median income family spends approximately 6% of income on home energy but a low- income household might spend more than 40%.

Energy efficiency improvements also benefit commercial and industrial customers by ultimately reducing production and operational costs. These cost savings can be used to reinvest in the business. Energy cost savings to individuals and businesses can indirectly spur economic development in the community because more money is freed to be expended elsewhere.

### Job Creation

Energy efficiency programs also create direct economic development through job creation. Estimates of direct jobs created by energy efficiency investments range from 5.4 to 24.3 jobs per million dollars invested.[55] The market supply chain for the energy efficiency sector includes product development, manufacturing, wholesale and retail distribution, deployment (e.g., project design, construction, and evaluation of savings) and operations and maintenance. Figure 9 depicts some, but by no means all, of the jobs created through energy efficiency investments.

**Figure 9: Energy Efficiency Services Sector**




Source: Ohio Environmental Council

## Job Training

To date, the bulk of residential energy efficiency programs have focused on low-income populations, funded through federal, state and utility sponsored programs. Thus, most contractors with special energy efficiency training work for Ohio's Home Weatherization Assistance Program (HWAP) through Community Action Agencies or with private subcontractors in coordination with utility sponsored programs. All of the employees serving low-income weatherization programs have been trained through the Ohio Weatherization Training Center (OWTC), operated by the Corporation for Appalachian Development. This network has been serving the weatherization program and service delivery network throughout Ohio since 1980. Currently, OWTC provides training for four distinct occupational pathways recognized by the U.S. Department of Energy: retrofit installer technician; crew leader; energy auditor; and quality control inspector.

# Chapter 3: Transportation

## *Overview*

Any attempt to transition towards a post-fossil fuel economy must be accompanied by a concurrent weaning from petroleum-powered vehicles. In addition to the negative environmental impacts of fossil fuel combustion, a society that relies heavily on automobiles for transportation is not only costly to the car owner but to the community. The community foots the bill for building parking spaces and new roads and the constant repair of existing roads.

In this case study, researchers from the Center for Neighborhood Technology (CNT) assessed the current transportation profile of the City of Oberlin and then mapped out strategies that would allow the City's transportation sector to be completely climate neutral by 2050.[56,57] Although the City of Oberlin has certain characteristics that make its transportation profile unique, many of the strategies proposed in this case study are applicable to other municipalities seeking to reduce petroleum consumption and greenhouse gas emissions.

### Consistency with Other Local and Regional Goals

CNT's target of climate neutrality in Oberlin's transportation sector aligns with the objectives of many other entities including:

***Oberlin College:*** In 2009, the College signed the American College and University Presidents Climate Commitment (ACUPCC), which set a target of climate neutrality by 2025 relative to 2007 emissions. Transportation currently accounts for 7% of College's GHG emissions.

***The Oberlin Project:*** The Oberlin Project, a collaboration between the City of Oberlin and Oberlin College, also has a goal of transitioning towards carbon neutrality. Part of the vision for achieving this goal is by creating a more walkable city and creating a "greenbelt" surrounding the City of Oberlin which could produce food and lumber for the City, both of which would reduce vehicular travel.

***Northeast Ohio's "Sustainable Communities":*** In October 2010, the U.S. Department of Housing and Urban Development awarded a $4.25 million Sustainable Communities Grant to a consortium of 21 metropolitan planning organizations, county and municipal governments, housing authorities, and non-profit advocates in Northeast Ohio. Although the region awarded the Sustainable Communities grant is not part of 9th Congressional District—the focus of this report—Oberlin's transportation sector is inherently interconnected with the surrounding region. Because many jobs, cultural attractions and other destination points for Oberlin residents are located in Cuyahoga County, which borders Lorain County, any transportation plan for Oberlin, Lorain County and the District in general, must interface with the broader transportation plan for Cuyahoga County and the Northeast corner "mega-region" (16 counties anchored by

Cleveland, Akron, Youngstown, Canton ). Many parts of the Sustainable Communities Grant align with the goals of reducing transportation emissions:

1. Creating regional transportation, housing, water and air quality plans that are deeply aligned with and tied to local comprehensive land use and capital investment plans;
2. Reducing social and economic disparities for low-income, minority communities, and other disadvantaged populations in the target region.
3. Decreasing per capita vehicle mile traveled (VMT) and per-capita emissions for the region.
4. Decreasing housing and transportation costs per household.
5. Increasing the proportion of low and very low income households within a thirty minute transit commute of employment centers.

### Affordability

In addition to the environmental and health benefits to be gained from reduced carbon emissions, a transportation plan that reduces a community's reliance on automobiles provides economic benefits. The CNT, in concert with the Brookings Institute, developed the "Housing + Transportation Affordability Index®" to highlight how a residence's location, more than just the cost of the mortgage or rent, impacts affordability. A general guideline for lenders, consumers and planners, this tool attempts to better measure the true affordability of housing by calculating the transportation costs associated with a home's location. Planners, lenders, and most consumers traditionally measure housing affordability as 30% or less of income. The H+T Index, in contrast, suggests that 45% of income is a conservative estimate for combined housing and transportation expenditures, and is a reasonable goal to help ensure adequate funds remain for other household necessities.

## *Transportation Profile of Oberlin*

***Overall transportation Use:*** The City of Oberlin's transportation sector accounted for 15% of community-wide emissions in 2007 (23,887 metric tons). Although transportation accounted for a smaller proportion of total carbon emissions in Oberlin than in most communities, this fact can be misleading. Because the City's current electricity derives almost exclusively from coal, it has a very high carbon intensity, causing electricity to account for an outsized proportion of total carbon emissions in the City; as Oberlin's electricity "decarbonizes," transportation (under a "business as usual" scenario) will be responsible for an increasingly large piece of the carbon emission pie.

***Demographics of Residential Population:*** Oberlin is a small city, with a residential population of 8,761 individuals which includes 2,730 households. Population growth is essentially flat (1% growth between 2000 and 2010). Median household income in Oberlin is $50,045, higher than Area Median Income, but 30% of families with children live below the poverty line.

***Vehicle Ownership:*** 51% of Oberlin households own one car, 32% own two cars, and 13% have none, with an average of 1.5 vehicles per house, slightly less than the national average of 1.7 vehicles/household.

***Vehicle Miles Traveled (VMT:*** Total VMT for the City of Oberlin in 2006 was 40.6 million miles, a 2.5% increase from 2000; if this trend were to continue under a "business as usual" scenario, Oberlin VMT would increase 20% by 2050. In comparison, VMT grew 10% nationally during the same 2000-2006 time period. National VMT has been on the rise for decades and is expected to grow until 2035.

***Mode of Travel for Work Commuters:*** Oberlin is a relatively small city and a large number of residents work in Oberlin (53% commuters travel less than 10 minutes to work). Therefore, average commutes of Oberlin residents differ considerably from national averages: 53% of Oberlin residents drive to work (12% of whom carpool) compared with 86% nationally; 32% walk; and 6% bike.

***Cargo:*** Approximately 20 to 30 54-foot trucks deliver to downtown retail stores and restaurants weekly. Oberlin's Industrial Park, which includes a 700-employee Federal Aviation Administration facility, is also a destination for sizeable cargo traffic.

***Transportation Costs:*** Overall, 2.4 million gallons of petroleum were used on Oberlin's roads in 2007 at a cost of $8.5 million, or $1,000 per capita. Downtown and the west side of Oberlin are the most affordable; the remaining parts of the City have an H+T of 50-60% Area Median Income which is well above the 45% H+T guideline for affordability. People on the outskirts of Oberlin might spend $60-$70 more per month on transportation than someone living downtown.

***Available Fuels:*** Virtually all vehicles on Oberlin's roads are powered by fossil fuels, approximately 82% gasoline and 18% diesel, though hybrid-electric vehicles are increasingly common. Both Oberlin College and the City of Oberlin have hybrid-electric cars in their fleets. At the moment, electric vehicles are uncommon, but the College has a charging station and the City has installed capacity for two others. Given the City's current reliance on coal for its electricity, electric vehicles are not a low-carbon option in Oberlin at the moment, but this will change as the City phases into renewable electric generation. Finally, Oberlin has a biofuel station, Full Circle Fuels, which has converted 300 cars, big rigs, and trucks and tractors to run on straight vegetable oil (SVO); currently about half of the restaurants in Oberlin export their vegetable oil to Fuel Circle Fuels.

***Transportation Needs:*** Three separate constituencies that use transportation to and from the City of Oberlin have very different needs:

- Oberlin residents often work outside of Oberlin and need a way to get to work every day, though because these work destinations are quite decentralized, a fixed route transit system would be difficult to implement. Oberlin residents also need to travel outside of the City for items and services not available within Oberlin.

- Oberlin College students are able to access all classroom and College facilities by foot or bike but may want to get out of Oberlin occasionally (e.g., for a cultural event in Cleveland). They also generally need a way to get home during College breaks.

- In addition to all of the people that travel to Oberlin for work daily, there are many more that come occasionally for special events, shopping and dining.

The wide variation in transportation behavior of these three different constituencies makes it difficult to find equitable and cost-effective transportation alternatives to individually-owned and -operated automobiles.

***Available Public Transportation:*** Oberlin's small size means that it cannot gain economies of scale to support transportation alternatives. Its relative remoteness prevents it from benefiting from regional transportation.

**Lorain County Transit (LCT):** In 2010, LCT reduced its routes from 12 to 2 and totally eliminated any routes through Oberlin, due to state and federal budget cuts and a failed sales tax levy. LCT is the only transit agency in Ohio that lacks a dedicated revenue source; Lorain County voters have consistently refused to endorse a dedicated revenue stream. Lorain County is also the only county that borders Cuyahoga County but lacks an express connection to downtown Cleveland.

**Oberlin Connector:** Following the elimination of LCT routes through Oberlin, City and College representatives collaborated in assessing the City's public transportation needs and then creating and funding an alternative. Because they have been unsuccessful in attracting sufficient funding to provide a robust public transportation system that would adequately meet the needs of potential riders, they have established a stop-gap "Oberlin Connector" which runs on Mondays and Thursdays to pre-arranged destinations within Oberlin, with alternating routes to Elyria and Lorain on Thursday afternoons. The fact that a city the size of Oberlin has been able to cobble together any type of public transportation service without the help of state or federal funds, reflects upon the commitment and determination of town and county leaders to provide such a service. Having said that, the Connector is clearly no alternative to a full public transportation system; it cannot be used to transport people to daily jobs or medical and other appointments that are set according practitioners' schedules, not according to the bus schedule.

**Other Long-Distance Options:** Amtrak does have two long-distance train routes that stop in Elyria, which is twelve miles away from Oberlin. However, both trains stop in the middle of the night, making them somewhat inconvenient. Elyria also has a Greyhound Bus station that provides interstate bus transit.

**Limited Oberlin College Student-Specific Transportation:** The College operates a shuttle around campus from 9-2 AM and the Student Union occasionally provides a bus to particular destinations in Cleveland, such as Crocker Park or the West Side Market. In addition, some former students started Wilder Lines, a charter bus service from Oberlin to New York City during College breaks. All of these transportation options are limited to College students and are obviously very limited in scope.

***Other Transportation Options:***

**Hertz Connect:** Starting in October, 2010 Oberlin College partnered with Hertz to provide a ride sharing program in Oberlin. The program currently has 91 members in the Oberlin program for whom three cars are available. Membership for students is free.

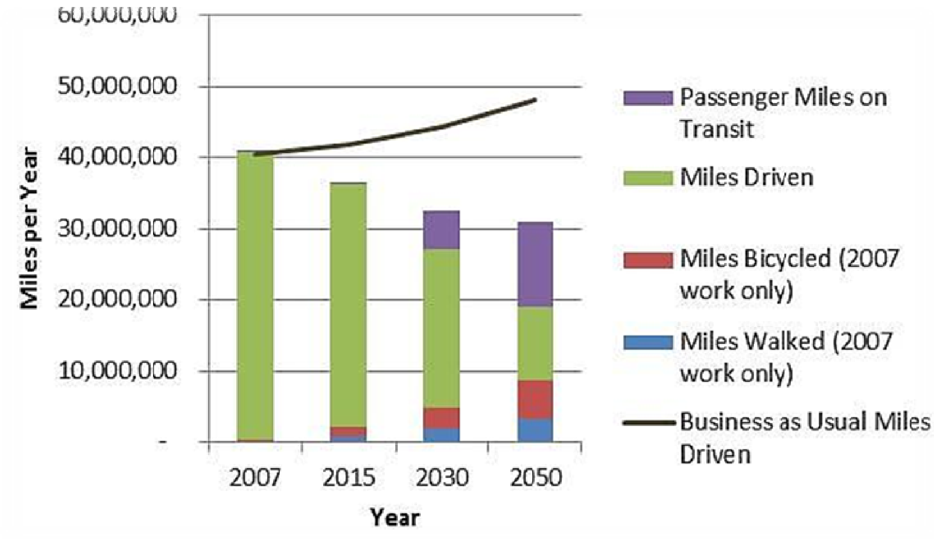
**OhioRideShare:** Northeast Ohio Areawide Coordinating Agency (NOACA) and two other regional planning agencies operate this service which allows users to identify potential carpool partners in their area.

***Land Use:*** At 4.4 square miles, Oberlin is a relatively small, compact City with many amenities in its pedestrian-friendly downtown. However, recent land use trends have made Oberlin residents increasingly car-dependent. In recent years, Oberlin has annexed property on the outskirts of town to accommodate development, creating non-downtown shopping destinations primarily accessed by car. Not only does the average Oberlin resident have to travel further to get to these destinations, but the Ohio Department of Transportation has resisted putting in sidewalks leading to these destinations, making walking to them unsafe. In addition, housing is increasingly being built on the outskirts of town; over the past decade, the number of Oberlin residents within walking distance of downtown has declined.

## *Transportation Strategies*

Using Oberlin's "transportation profile," CNT identified ten strategies for reducing greenhouse gas emissions (GHGs) in the Oberlin transportation sector and then performed a quantitative analysis, determining the amount of GHGs that could be eliminated from the atmosphere through the implementation of each proposed strategy. Recognizing that attaining carbon neutrality would be an enormous leap from Oberlin's current emission levels, CNT provided data illustrating the stages in which Oberlin could reach zero emissions: 25% reduction from 2007 emission levels by 2015, 75% reduction by 2030, and finally 100% reduction by 2050. Figure 10 illustrates the changes in relative use of different transportation modes during those different timeframes,

**Figure 10. Travel in Oberlin 2007 to 2050**




Source: Center for Neighborhood Technology

## Assumptions

In making their GHG calculations, CNT made several assumptions. Most importantly, it assumes that a sustainably-sourced, carbon-neutral biofuel becomes available to Oberlin drivers and that Oberlin's electricity supply is completely carbon neutral by 2050. The model also assumes that national fuel economy standards will improve by 50% by 2050. The calculations are based on direct emissions from transportation and carbon neutrality is achieved without purchasing carbon offsets.

In general, there needs to be a "three-legged stool" approach to reducing GHG and energy from transportation: reducing vehicle travel, improving fuel economy and de-carbonizing fuel supply. The ten strategies detailed below fall within those three approaches. Table 21 illustrates the tradeoffs within each strategy; strategies that are the least expensive and have the shortest implementation timeframes generally provide lowest community-wide GHG reductions.

**Table 21: Transportation Strategies for Achieving GHG Reductions**

| Strategy Type | GHG Reduction Potential per Trip | Community-wide GHG Reduction Potential | Implementation Timeframe | Capital Cost | Operation and Maintenance Cost | Cost Effectiveness | Feasibility |
|---|---|---|---|---|---|---|---|
| Walking | High | Low | Near-term | Intermediate | Intermediate | Intermediate | High |
| Biking | High | Low | Near-term | Low to Intermediate | Low to Intermediate | Intermediate to High | Intermediate to High |
| Shared Transit | Intermediate | Varies | Medium to Long | High | High | Intermediate | Intermediate |
| Alt Fuels | High if Renewable/ Sustainable | High if Renewable/ Sustainable | Medium | Intermediate to High | Intermediate | Intermediate | Intermediate |
| Reduced Car Ownership | High | Intermediate | Medium | Intermediate | Intermediate | High | Intermediate to High |
| Trip Reduction | Intermediate to High | Intermediate | Near-term | Low to Intermediate | Intermediate | High | High |
| Land Use | Intermediate to High | Intermediate to High | Long | Intermediate to High | Low | Intermediate to High | Intermediate |
| Parking | Intermediate | Intermediate | Near-Term | Low | Low | High | High |
| Cargo | High | Low | Near- to Medium-term | Low to Intermediate | Intermediate to High | Low to Intermediate | Intermediate to High |
| Reduce long-distance travel | Intermediate | Low | Medium to Long | High | High | Intermediate to High | Low to Intermediate |

## Strategy Explanations

### *1. Promote walking as a major mode of transportation in Oberlin.*

This strategy requires little investment, other than some infrastructure improvements by the City (such as improved sidewalks). However, if the trend towards decentralized development is not curbed (see Strategy 7) walking will become increasingly less feasible as an alternative to driving in Oberlin.

### *2. Increase bicycling's share of trips in Oberlin.*

This low-cost strategy also requires some improved infrastructure both within the downtown and connecting outlying retail districts to bike-friendly routes.

### *3. Create shared passenger transportation.*

As apparent from the previous review of public transportation options available to Oberlin residents, this strategy will be far more difficult to implement than the first two. CNT envisions a bus transportation network that supports over 5 million passenger miles of travel on Oberlin's roads by 2030 and a fixed guideway transit system by 2050 supported by a network of buses that transport Oberlin residents, visitors, students and workers 12 million passenger miles each year.

They suggest that, as a first step, the Oberlin Connector should be stabilized and expanded. To fund the Connector they state that an annual transit pass for College students plus farebox revenues would cover 25% of operating expenses. Public and private sources could finance the remaining expenses. However, the City of Oberlin's income tax and vehicle registration fee are both the maximum allowable by the State of Ohio. Added to these restrictions, the City is facing a serious budget crunch due to various budget cuts to cities from the state which will amount to an aggregate loss of one million dollars of revenue for the City of Oberlin in 2012. In spite of these constraints, CNT asserts that the City could establish a per-household fee to fund transit, although with transit ridership currently at 1%, convincing residents that such a fee is worthwhile could be challenging. CNT suggest that local businesses could fund the outstanding gap, either through voluntary contributions or through a small increase in property taxes in a special taxing district such as a SID.

A more robust, regional system will require coordinating with other regions and will require additional sources of funds which currently do not appear to be forthcoming from either county or state sources. As previously mentioned, Lorain County is the only county in Ohio lacking a dedicated revenue stream for public transit. Moreover, Ohio's Governor recently refused $400 million to establish a high-speed rail between Cleveland, Columbus and Cincinnati.

### *4. Promote fuels and vehicles that can make motorized transport zero- or low-carbon.*

Even if no action were taken by Oberlin to reduce vehicle emissions, they are expected to decrease due to federal regulations concerning fuel economy standards. The average vehicle on the road today gets 20.4 mpg; 2016 model vehicles must achieve an average of 34.1 mpg, but there is a delay between when mandated fuel economy standards take effect and when the majority of cars on the road reach that level of efficiency. DOE estimates that the average light-duty vehicle will get 27mpg by 2030 and 33mpg by 2050. However, recent national improvements in fuel economy have not compensated for the corresponding increase in VMT during that same time period. Though Oberlin cannot engineer vehicles to improve their fuel economy, it could play a role in promoting low- or no-carbon fuel.

**Biofuel:** In order to meet its GHG reduction goals, a zero- or low-carbon biofuel will need to be developed that can replace current petroleum-based fuels. Biofuels emit GHGs when combusted, just like gasoline does, but the global warming impact of those GHGs can be countered if the crop that created the biofuel is sustainably renewed and allowed to absorb carbon from the atmosphere again. Non-sustainable, fossil fuel driven agriculture, refining, and transportation of biofuels undercut their overall GHG reduction potential from a lifecycle perspective. Conventional biodiesel offers just a 22% lifecycle GHG savings as compared to petroleum diesel.[58] Although the waste vegetable oil and grease that is sold at Fuel Circle Fuels meets this definition of sustainability, it cannot be scaled up to the volume needed for the entire community. Therefore, if biofuels are going to be explored in Oberlin as a transportation solution at scale a sustainable supply system must be established. One potential source of sustainable biofuels is crop waste from area farmers (See Biomass section of Renewable Energy). Creating biofuel from crop waste could simultaneously expand the City's fuel supply and support the regional economy.

**Electricity from Renewable Sources:** The City of Oberlin is expected to acquire 85% of its electricity from renewable sources by 2013. Thus, electric vehicles charged in Oberlin would be very low-carbon in the near future and, as assumed by this model, zero-carbon by 2050. As the City is expected to have surplus electricity, this represents a viable source of fuel for vehicles. However, the City's electric vehicle charging infrastructure would have to be developed; only one electric charging station currently exists (owned by the College), though the City has created capacity for two downtown charging stations. In addition to providing charging stations, the City can promote electric vehicles by using them in its own fleet (municipal operations currently account for 6.5% of total community transportation emissions). A larger barrier to widespread adoption of electric-powered vehicles is that they are not currently well-suited for long trips as they need to be recharged frequently, take a long time to recharge, and require an infrastructure of charging stations that does not currently exist.

### *5. Promote alternate modes of transportation, fewer trips and shorter trips through reduced vehicle ownership.*

The report recommends vastly expanding Oberlin's car share program to ultimately include 4,000 members, including College students, City residents and people who are employed in town. The City could initially scale up with the assistance of peer-to-peer sharing. Peer-to-peer sharing allows vehicle owners to rent their cars to members of the peer-to-peer rental company, which provides the in-vehicle technology to enable car sharing and the insurance on the vehicles during the rental period. Not surprisingly, car sharing leads to far fewer vehicle miles traveled than individual car ownership. However, car sharing would not replace a vehicle needed to commute to a job.

### *6. Reduce the number of trips Oberlin workers and residents need to take.*

This strategy includes telecommuting, videoconferencing and combining multiple trips. Although the implementation of this strategy would not have a huge impact on Oberlin's overall transportation GHG emissions (just 3% of the emission savings needed to get to climate neutral by 2050), it has the advantages of being relatively easy to implement and requiring virtually no additional cost. Combining multiple errands to reduce VMT primarily requires awareness and planning on the part of the driver. Employer policies that allow employees to work longer hours four days per week rather than the ordinary five-day work week and permit telecommuting could immediately reduce GHG emissions. If 18% of employees were to eliminate one trip to work weekly by 2050, nearly 1.5 million vehicle miles would be taken off the road and the savings would be 42,243 gallons of gasoline and 411 metric tons of emitted $CO_2$.

### *7. Land use and urban form that supports lower car ownership, fewer and shorter trips and alternative transportation modes.*

A city's land use plan has enormous impacts on VMT and, consequently GHG emissions: average annual VMT is 6,090 miles less for households that live in downtown Oberlin as compared with those that live in outlying areas. Unfortunately, recent building trends have tended toward less dense, less walkable parts being developed. However, certain land use policies and incentives could help reverse this trend. For example, the City could provide financial incentives and expedite the approval process for buildings in "location-efficient" areas (areas that reduce travel demand). The City could also make some capital improvements that could lead to reduced driving, such as adding pedestrian paths and alleys to carve up large blocks and improve walkability in outlying areas.

The City of Oberlin has already established some policies to encourage downtown living. For example, it is zoned C-1, which permits residential units on the second floor of downtown businesses. It has also demolished some derelict downtown buildings and banked the land for redevelopment. The East College Street Project, which redeveloped an abandoned brownfield in downtown Oberlin into a sustainably designed, mixed-use building containing 33 condominiums for sale and 20,000 square feet of retail and office space for sale and lease, demonstrates that mixed-use development can succeed in a recovering economy and a community the size of Oberlin; one and a half years after opening, it has leased all of its retail space and sold all but three of its condominiums at list price.[59] However, it is difficult to finance and underwrite infill development without some public assistance.

### *8. Change parking infrastructure and policies to incentivize low-carbon transportation.*

Considerable research demonstrates that restructuring parking design and cost can have a big impact on driving pattern. Currently, permit parking for College students is $100 per year (recently raised from $75/year); College employees receive two free permits to park in faculty spaces. Parking in the City of Oberlin is free though times are restricted. One way to incentivize alternative forms of transportation is for employers to allow employees to opt for payment equal to the value of free or subsidized parking. Another is for the College or City to begin charging a parking fee for big events, parking revenue could be used to fund the City's GHG reduction efforts.

### *9. Low-carbon solutions for cargo transport to and from Oberlin.*

This strategy involves encouraging businesses to change their logistics to combine shipments and use lower-carbon shipping methods. For example, green procurement standards can require suppliers to reveal the carbon intensity of their supply chain and allow purchasers to select goods with lower-carbon lifecycles. One of the businesses leading the drive towards green procurement standards is Wal-Mart, which may provide an avenue for collaboration with Oberlin businesses.

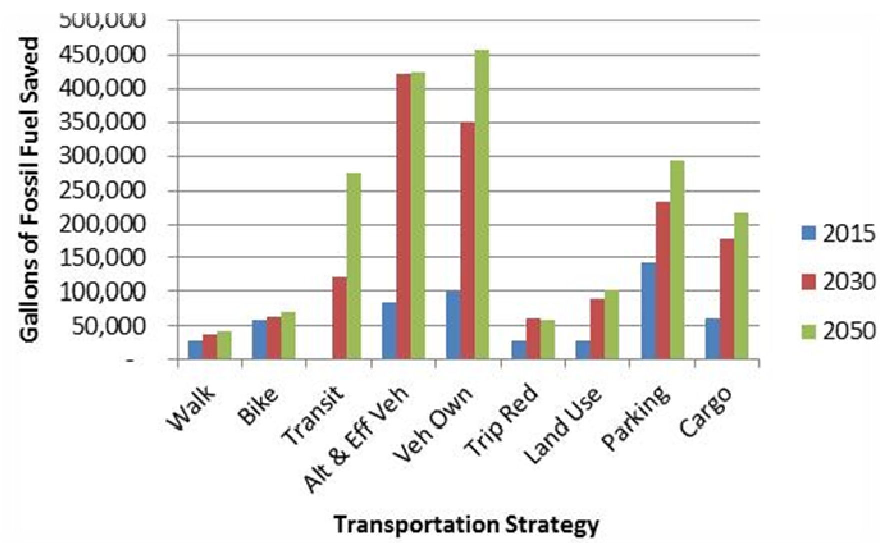
### *10. Create options for low-carbon long distance travel to and from Oberlin.*

Long distance travel is not included in the 2007 GHG inventory for Oberlin because most emissions from long-distance trips occur elsewhere. Because Oberlin's community GHG inventory does not include air travel, efforts to reduce it will not help toward meeting any emissions reduction targets. However, CNT estimates that long distance travel accounts for 31% of Oberlin's total transportation inventory. Providing low-emission long distance travel options, such as high-speed rail and airplanes powered by sustainable biofuels, is obviously not something that Oberlin can undertake alone. However, in addition to collaborating regionally to promote long-distance transportation alternatives, it may be able to initiate some alternatives. For example, Oberlin's Wilder Lines, a charter bus to New York City run during Oberlin College breaks, is considered a "best practice."

## Implementation of All Strategies

Figure 11 illustrates the relative savings in fossil fuels from the implementation of each strategy at the three benchmark years. Strategy 10 is not included as emissions from long-distance travel is not part of this analysis.

**Figure 11. Fossil Fuel Savings from Transportation Strategies**




Source: Center for Neighborhood Technology

# Conclusions

The body of research conducted under this NETL award demonstrates that, while transitioning into a clean, sustainable, low-carbon economy is possible for the 9th Congressional District and elsewhere, it will be an enormous undertaking, as it affects some of the most essential elements of modern life: heat, electricity and transportation. Shifting from our current dependence on fossil fuels will require people and businesses to become far more aware of their energy consumption and to alter their behavior accordingly.

However, this transformation is unlikely to occur in the absence of supportive policies on the federal, state and local levels. Because the price of conventional fuels does not include the social costs associated with these fuels, such as health problems, environmental degradation, political insecurity and global climate change, production of energy from renewable sources is generally more expensive than energy generated from conventional fuel sources. Likewise, it is improbable that widespread deployment of energy efficiency measures or major changes in transportation patterns will occur if the price of conventional energy continues to mask its associated costs to society.

Any mechanism that would assign a cost to carbon, whether through a carbon tax, cap-and-trade policy, or some other measure, would allow the various projects discussed in this report to become more cost-effective and therefore more achievable. Although the comprehensive nature of a national carbon-pricing policy makes it desirable—all of the projects detailed in this report would benefit from such a policy—the continuation, extension or expansion of some current policies would also drive this transition. The numerous federal and state grants, loans and incentives for renewable energy production discussed in the Renewable Energy chapter should be continued or, in the case of the many provisions of the American Recovery and Reinvestment Act that are due to expire at the end of 2011, extended. Although some may disapprove of government subsidies for renewable energy research and development, historically, the government has subsidized every major emerging fuel, including coal, gas, oil, or nuclear power, perhaps all at a greater rate, in terms of inflation-adjusted dollars or percentage of the federal budget, than it has for renewable energy thus far.[60] The health, environmental, and job creation benefits of renewable energy provide additional justification for these subsidies.

At the state level, Ohio must continue, at minimum, to maintain its Renewable Portfolio Standards with their incremental annual benchmarks. However, the law will not have its intended stimulative effects for renewable energy and energy efficiency projects if the law is not adequately enforced. The Public Utility Commission of Ohio needs to hold utilities accountable, sufficiently penalizing them if they do not meet their benchmarks that they are impelled to develop or acquire the RECs from renewable energy projects. Without strong enforcement of the Clean Energy Law the price of RECs and the entire development of renewable energy projects in Ohio will flounder.

While local governments have limited capacity to affect energy pricing, and, therefore, the affordability of renewable energy, energy efficiency, and transportation projects, they can encourage these types of projects in other ways. Among other actions, local governments could establish Energy Special Improvement Districts to enable PACE financing for renewable energy and energy efficiency projects, create zoning that is conducive to renewable energy development, and collaborate with other localities to enhance public transit.

The transition into a cleaner, more sustainable economy will be challenging and will require innovative thinking and practices for all involved. Yet, it will pay rich dividends in employment, fuel security, as well as human and environmental health.

# Appendix A: Biofuels, Solar PV, Solar Thermal, Wind & Wind/Solar Combination Installations in the 9th Congressional District

**Sources:**

NAICS Codes, Harris Index, On Line Sources, GEO Solar Tours, FERC Form 1 Data, PUCO Report, Amp Ohio Data, Columbia Gas Reports, State of Ohio Dept. of Energy Grants and Misc. Public Resources

| Renewable Generating Facility Name 2005-2011 | County | Renewable Resource Technology | Generating Capacity | Capacity Label |
|---|---|---|---|---|
| City of Sandusky | Erie | Solar PV | 18.70 | kW |
| David Miller | Erie | Solar PV | 4.70 | kW |
| Erie County Sanitary Landfill | Erie | Bio Fuels | 1,600.00 | kW |
| P.P.I. Properties LLC | Erie | Solar PV | 11.20 | kW |
| Alto Miller | Erie | Solar PV | 3.00 | kW |
| Bill McCauley | Erie | Wind | 2.40 | kW |
| Corso Flower & Garden Center | Erie | Wind | 50.00 | kW |
| Dean Koch | Erie | Wind | 1.90 | kW |
| Dunlaps Snow Removal | Erie | Wind | 1.80 | kW |
| Encore Industries, Inc. | Erie | Wind | 50.00 | kW |
| Jerry Owens | Erie | Wind | 2.40 | kW |
| Melvin Poeppelman | Erie | Wind | 10.00 | kW |
| Myers Brothers Custom Butchering | Erie | Wind | 33.00 | kW |
| Perkins Board of Education | Erie | Wind | 60.00 | kW |
| Precision Paving, Inc. | Erie | Solar PV | 11.00 | kW |
| Primary Excavation & Fabrication, Inc. | Erie | Wind | 1.80 | kW |
| Robert T. Bair, Jr. | Erie | Solar PV | 5.00 | kW |
| Shepherd Shoreline Construction, Inc. | Erie | Wind | 50.00 | kW |
| Steven P Pullano | Erie | Wind | 10.00 | kW |
| The Chef's Garden | Erie | Wind | 100.00 | kW |
| Toft Dairy, Inc. | Erie | Wind | 50.00 | kW |
| Ventus Delcto HHS Property Mgmt (Encore Plastics) | Erie | Wind | 100.00 | kW |
| Wilkes & Company | Erie | Wind | 10.00 | kW |
| Lorain County Landfill | Lorain | Bio Fuels | 7,800.00 | kW |

| | | | | |
|---|---|---|---|---|
| McDaniel Residence | Lorain | PV & Solar Thermal | 3.10 | kW |
| Morog Residence | Lorain | Wind | 2.40 | kW |
| Oberlin College | Lorain | Solar PV | 100.00 | kW |
| Oberlin College | Lorain | Solar PV | 60.00 | kW |
| Oberlin Municipal Light & Power | Lorain | Solar PV | 3.80 | kW |
| Rybarcyk Residence | Lorain | Solar PV | 7.30 | kW |
| Rybarcyk Residence | Lorain | Wind | 0.20 | kW |
| Thompson Residence | Lorain | Solar PV | 3.90 | kW |
| Frantz Residence | Lorain | Solar PV | 2.00 | kW |
| Gerald Friesenhengst | Lorain | Wind | 10.00 | kW |
| Bintz Residence - Bintz Residence | Lucas | Solar PV | 4.20 | kW |
| City of Toledo Waste Water Plant | Lucas | Bio Fuels | 10,000.00 | kW |
| City of Toledo Water Treatment Plant | Lucas | Solar PV | 1,000.00 | kW |
| City of Toledo - Government Center | Lucas | Solar PV | 20.00 | kW |
| Compaan Residence | Lucas | Solar PV | 4.30 | kW |
| Crane Creek | Lucas | Solar PV | 10.00 | kW |
| Gradkowski Residence | Lucas | Solar PV | 1.80 | kW |
| Collins Residence | Lucas | Solar PV | 5.00 | kW |
| Lundgren Residence | Lucas | Solar PV | 1.50 | kW |
| I-280 | Lucas | Solar PV | 117.00 | kW |
| Lucas County Waste Water Treatment Plant | Lucas | Bio Fuels | 365.00 | kW |
| Madonna Homes, Inc. | Lucas | Solar Thermal | 2.10 | kW |
| Metzgers Arco PV Solar | Lucas | Solar PV | 54.00 | kW |
| Midwest Property Associates Ltd. | Lucas | Solar PV | 52.40 | kW |
| Maumee Bay State Park | Lucas | Wind | 10.00 | kW |
| Ohio PV Solar Six LLC | Lucas | Solar PV | 59.80 | kW |
| Ohio National Guard / Toledo Express Airport | Lucas | Solar PV | 1,570.00 | kW |
| Ohio Air National Guard (OANG) | Lucas | Solar PV | 2.10 | kW |
| Oregon City Schools - Eisenhower Jr. High | Lucas | Wind | 750.00 | kW |
| Oregon City Schools - Clay HS | Lucas | Wind | 750.00 | kW |
| Owens Community College | Lucas | Wind | 50.00 | kW |
| SoCore-HealthCareREIT-Headquarters | Lucas | Solar PV | 248.60 | kW |
| Sylvania Scools | Lucas | Wind | 2.00 | kW |
| Sylvania United Church of Christ | Lucas | Solar PV | 6.40 | kW |

| | | | | |
|---|---|---|---|---|
| Toledo Museum of Art | Lucas | Solar PV | 101.00 | kW |
| Toledo Museum of Art | Lucas | Solar PV | 100.00 | kW |
| Toledo Museum of Art | Lucas | Solar PV | 100.00 | kW |
| Toledo Museum of Art | Lucas | Solar PV | 100.00 | kW |
| Toledo Zoo | Lucas | Wind | 10.00 | kW |
| Toledo Zoo | Lucas | Solar PV | 1.20 | kW |
| Toledo Zoo Solar Walk | Lucas | Solar PV | 98.10 | kW |
| TZ Solar | Lucas | Solar PV | 100.00 | kW |
| University of Toledo at Scott Park | Lucas | Solar PV | 1,100.00 | kW |
| Black Diamond Inc. | Lucas | Solar Thermal | 2.60 | kW |
| Frank Ulrich | Lucas | Wind | 10.00 | kW |
| Greg Baker | Lucas | Wind | 2.40 | kW |
| Homewood Press, Mark Dubuc, VP | Lucas | Wind | 3.70 | kW |
| James E. Moore | Lucas | Wind | 2.40 | kW |
| Jeremy & Robin Scott | Lucas | Solar PV | 4.80 | kW |
| John A Dandar | Lucas | Wind | 10.00 | kW |
| Knitz Greenhouse | Lucas | Wind | 10.00 | kW |
| Lial Elementary School | Lucas | Solar PV | 1.10 | kW |
| Mareda, Inc. | Lucas | Solar PV | 20.00 | kW |
| Mary Witte | Lucas | Solar PV | 2.80 | kW |
| Matrix Technologies Inc. | Lucas | Solar PV | 14.40 | kW |
| Metropolitan Park District of Toledo Area | Lucas | Solar PV | 10.00 | kW |
| Metropolitan Park District of Toledo Area | Lucas | Solar PV | 6.50 | kW |
| Metzgers Frenchmans PV Solar | Lucas | Solar PV | 72.00 | kW |
| Michaelmas Manor | Lucas | Solar PV | 20.00 | kW |
| Ohio Asphalt Roofing Co. Inc | Lucas | Solar PV | 35.90 | kW |
| Ohio PV Solar Development Five, LLC | Lucas | Solar PV | 71.70 | kW |
| Oregon City Schools - Clay HS | Lucas | Wind | 5.20 | kW |
| Rebecca Walters Bardwell | Lucas | Solar PV | 1.00 | kW |
| SoCore Solar 7, LLC | Lucas | Solar PV | 248.40 | kW |
| Solterra | Lucas | Solar PV/Wind | 4.30 | kW |
| The Maumee Bay General Store, Inc. | Lucas | Wind | 100.00 | kW |
| The Olander Park System | Lucas | Solar PV | 14.40 | kW |
| University of Toledo | Lucas | Solar PV | 1.20 | kW |
| University of Toledo | Lucas | Solar PV | 1.20 | kW |
| University of Toledo | Lucas | Solar PV | 12.00 | kW |

| | | | | |
|---|---|---|---|---|
| University of Toledo | Lucas | Solar PV | 12.00 | kW |
| University of Toledo | Lucas | Wind | 100.00 | kW |
| City of Genoa | Ottawa | Diesel | 60.00 | MW |
| Lake Erie Business Park | Ottawa | Wind | 25.00 | kW |
| Marblehead Wind, LLC | Ottawa | Wind | 400.00 | kW |
| Pittman Residence | Ottawa | Solar PV | 6.00 | kW |
| Denny & Sue Ann Krumnow | Ottawa | Wind | 10.00 | kW |
| Gary Durivage | Ottawa | Wind | 10.00 | kW |
| H-D Storage, Inc. | Ottawa | Wind | 50.00 | kW |
| Jerry and Robin Giesler | Ottawa | Wind | 17.50 | kW |
| Keith E. Heilman | Ottawa | Wind | 3.70 | kW |
| Kenneth L. and Kathryn J. Mapes | Ottawa | Wind | 9.00 | kW |
| McKenna's Inn | Ottawa | Wind | 10.00 | kW |
| Murphy Muffler, Inc. | Ottawa | Wind | 5.50 | kW |
| Ohio Air National Guard / Camp Perry | Ottawa | Solar PV | 538.00 | kW |
| Ottawa County Landfill | Ottawa | Bio Fuels | 4,200.00 | kW |
| Rathbun Family Real Estate Group | Ottawa | Wind | 33.00 | kW |
| Robert Williams | Ottawa | Wind | 10.00 | kW |
| Rochelle J. Habel | Ottawa | Wind | 1.80 | kW |
| Rohloff Bros., Inc. | Ottawa | Solar PV | 1.40 | kW |
| Terry Blakenship | Ottawa | Wind | 10.00 | kW |
| Witterhaven Marina & Campground | Ottawa | Wind | 33.00 | kW |
| **SUB TOTAL - BIO FUELS** | | **5 Locations** | **23.64** | **MW** |
| **SUB TOTAL - SOLAR PV** | | **59 Locations** | **6,204.60** | **kW** |
| **SUB TOTAL - SOLAR THERMAL** | | **02 Locations** | **4.70** | **kW** |
| **SUB TOTAL - WIND** | | **49 Locations** | **3,047.70** | **kW** |
| **SUB TOTAL - WIND & SOLAR COMBINATION** | | **02 Locations** | **7.40** | **kW** |

# Appendix B: Zoning Ordinance Specifications in the 9th Congressional District[61]

Note: Turbine height is defined as the height of the system at its maximum vertical extension. For horizontal axis turbines, the height of the turbine includes the height from the ground to the tip of the blade when the tip is at its highest point.

| Color Codes |
|---|
| Townships |
| Cities & Villages |

**Erie County Wind Ordinances for Low Impact or Small Systems**

| Government/Type of Wind Turbine | Conditionally Permitted? | Size Limit (Max.) | Height Limit (Max.) | Height Limit (Min.) | Fall Zone/Setback | Noise Restriction (Max.) |
|---|---|---|---|---|---|---|
| Berlin Township | Yes in all districts, 1 per property unless a lot of ≥ 50 acres than 2 | | 100 ft | | Height plus 10 ft from all neighboring property line, guy wires shall maintain 10 feet from property lines and structures | 60 dBA |
| Florence Township/Low Impact (≤ 100 kW) | Permitted use | 100 kW | 100 ft | | 1.5 x of height to property line, off-site residence, road right-of-way | 60 dBA |
| Huron (city)/ Small Systems | Yes, in any | | | Blade 30 feet above ground or any structure within 50 feet | 1.0 x height from property line, right of way, lines | Not more than 60 dba from 100 feet |
| Huron Township/ Small Systems | Yes in all districts; need a granted variance for roof, ≥ 1 acre | | 60 feet for 1-2 acres, 80 feet for 2-5 acres. 100 feet for > 5 acres | Blade 30 feet above any ground or structure | No front yard, 1.0 x height from property line, right of way, lines, off site inhabited structures | 60 dba at property line or 50 dba at nearest neighboring inhabited building |
| Milan Township/ Low Impact (≤100 kW) | No – Permitted use in Agricultural Districts, Local Commercial (C-1) and General Commercial (C-2) Districts, and Industrial Light (I-1), and Industrial (I-2) Districts | 100 kW | 175 ft | | 1.25 x of height of turbine from property line, off-site residence and right-of-way; Min. of 50 ft from foundation of main structure; No part of the structure (including guy wires) may extend closer than 10 feet from abutting property lines or easement; Not permitted in front yards | 60 dBA |

| | | | | | | |
|---|---|---|---|---|---|---|
| Oxford Township | Permitted uses but each land district provides specific regulations for uses and structures | | | | Height of the tower cannot be greater than the distance to the lot line; height of the turbine is measured to the top of propeller blade extended plus 10 ft. Guy wire shall meet the minimum | 60 dbA |
| Perkins Township/ Small system (1 Turbine) | Need a conditional use permit, not on roof of single family home but OK in C-1,C-2, I-1, I-2, MA zoned, no lot less than one acre | | Btwn 1 & 2 acres: 60 ft.; Btwn 2&5: 80 ft.; > 5: 100 ft | 30 ft from ground to blades lowest point or 30 ft from any structure in 100 ft | No front or side yard; setback not less than 1.0 x property line, off-site residence, right-of-way, electrical wires | 60 dBA measured at property line, or 50 dba |
| Sandusky (city)/ Small System | Yes, in any district | | | Blade 30 feet above ground or structure with 30 feet horizontally | Not less than 1.1 to 1.0 x set back from property line, right-of-way, lines | 60 dBA measured 100 feet away |
| Vermilion (city) | Yes, in any district but historic; commercial only in commercial and industrial | | 100 ft | | 1.0 x height away from property line, right-of-way, lines | 60 dBA |
| Vermilion Township | Permitted use | 100 kW | 100 ft | | 1.0 x height from all neighboring property lines and rights-of-ways | 60 dBA |

## Erie County Wind Ordinances for High Impact or Commercial Systems

| Government/ Type of Wind Turbine | Conditionally Permitted? | Size Limit (Max.) | Height Limit (Max.) | Height Limit (Min.) | Fall Zone/Setback | Noise Restriction (Max.) |
|---|---|---|---|---|---|---|
| Berlin township | Yes in all districts, 1 per property unless a lot of ≥ 50 acres than 2 | | 100 feet | | Height plus 10 feet from all neighboring property line, guy wires shall maintain 10 feet from property lines and structures | 60 dBA |
| Florence Township High Impact (≥100 kW, ≤ 50 MW) | Permitted use | >100 kW | 100 feet | | 1.5 x of height to property line, off-site residence, road right-of-way | 60 dBA |
| Huron (city) Commercial systems | Yes in commercial or industrial districts | | | | 1.0 x height from property line, right of way, and inhabited building or lines; not with 1,000 feet of platted subdivision, park, church, school or playground | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Huron Township Commercial Systems | Yes in any commercial or industrial district ≥ 2 acres | | 200 feet | | 1.5 x height from property line and right-of-way; not within 500 feet of a platted subdivision, park, church, school, or playground; 1.0 x height from inhabited structure | |
| Milan Township; High Impact (>100 kW) | No –Not permitted in any residential district – Location must be pre-approved by U.S. F&WS and ODNR | | | | 1.5 x height of turbine from property line, off-site residence and right-of-way; Min. of 50 feet from foundation of main structure; No part of the structure (including guy wires) may extend closer than 10 feet from abutting property lines or easement; Not permitted in front yards | 60 dBA |
| Oxford Township | Permitted uses but each land district provides specific regulations for uses and structures | | | | Height of the tower cannot be greater than the distance to the lot line; height of the turbine is measured to the top of propeller blade extended plus 10 ft. Guy wire shall meet the minimum | 60 dBA |
| Perkins Township Commercial System (>1 turbine but <5 MW) | Yes in commercial, agric., indus. districts, no lot <2 acres without variance | | 200 ft | | 1.5 x height from property line, right-of-way, inhabited buiding, power or comm. line; not within 500 ft of platted subdivision, park, church, school or playground | |
| Sandusky (city) Commercial (more than 1) | Yes, in non-residential district | | | | 1.0 x height away from property line and right-of-way, inhabited structure, lines; not within 1,000 feet of platted subdivision, park, church, school or playground | |
| Vermilion (city) | Yes, in any district but historic; commercial only in commercial and industrial | | 100 ft | | 1.0 x height from property line, right-of-way, lines | 60 dBA |
| Vermilion Township | Permitted use | 100 kW | 100 ft | | 1.0 x height from all neighboring property lines and rights-of-ways | 60 dBA |

## Lorain County Wind Ordinances

| Government; Type of Wind Turbine | Conditionally Permitted? | Size Limit (Max.) | Height Limit (Max.) | Height Limit (Min.) | Fall Zone/Setback | Noise Restriction (Max.) |
|---|---|---|---|---|---|---|
| Amherst Township | Yes, in (R-AG), (GB-1), (LI) | <5 MW | 140 f t | Blade 30 feet from ground | 1.1 x height from right-of-way, overhead utility lines, property lines | 60 dba at 60 feet |
| Carlisle Township; Vertical Axis | No - provided that the system meets zoning requirements | 15 kW | 35 feet | 12 feet from the ground to first moving part | 1.1 x Height of Turbine | 60 dBA |
| Carlisle Township; Horizontal Axis | Yes - in districts GB-1 and LI-1 (on parcels of one acre or more); in districts RI-1 and RI-2 (on parcels of two acres or more) | | 90 feet | 12 feet from the ground to climbing apparatus; 25 feet from the ground to lowest part of swept area | 1.5 x Height of Turbine; Not permitted in front yard | 65 dBA |
| Lagrange (village) | Yes- in all districts where structures of any sort are allowed | | ≤ ¾ of property width at tower build line or 150 ft, whichever is more restricted | | 1.5 x height ; 1.0 x height for vertical axis systems; no part of turbine or guide wire anchors may be closer than 5 feet to property boundaries | 60 dba |
| Penfield Township For ≤ 5 mw | Yes, in all districts where structures are allowed in a lot of at least one acre | | ≤ ¾ of property width at tower build line or 100 feet, whichever is more restricted | | No part including guy wires closer than 20 feet to boundaries; min set back of height of tower plus length of blade from any structure or property line; none in front yard | 60 dba |
| Pittsfield Township | Yes, lots more than 2 acres | | ≤ ¾ of property width at tower build line or 100 feet, whichever is more restricted | Min distance between ground and blade is 12 feet | No part including guy wires closer than 20 feet to boundaries; min set back of height of tower plus length of blade from any structure or property line | 60 dba |
| Wellington (village) | Moratorium on construction to draft new zoning legislation | | | | | |

**Lucas County Wind Ordinances**

| Government; Type of Wind Turbine | Conditionally Permitted? | Size Limit (Max.) | Height Limit (Max.) | Height Limit (Min.) | Fall Zone/Setback | Noise Restriction (Max.) |
|---|---|---|---|---|---|---|
| Harding Township | Permitted as Special Use in agric. district with ≥ 3 acres | ≤ 15 kW | 100 ft | Min distance between ground and blade is 15 ft | 1.25 x height away from property line, dwelling, righ-of-way; no part closer than 10 ft to property line; transmission lines underground | 65 dba |
| Richfield Township | Special Use Permit in Agric. and agric./resid. when ≥ 2 acres | | 120 ft | No less than 15 ft between lowest point of blade and ground | Must be free standing, no guy wires; 1.25 x height away from property lines, residence, building and right of way; no part of system can be within 10 feet of boundaries | 65 dBA |
| Spencer Township | Permitted special use in all districts; notify ODNR, US F & WS, Toledo metro parks | ≤ 20 kw in P/O, A, R-A, R-3, MHP, no max for others | 120 feet in P/O, A, R-A, R-3, MHP; 150 feet in all others | No less than 20 feet between lowest point and ground | 1.25 x height from property line, dwelling, occupied structure and right-of-way | 55 dba at nearest property line for P/O, A, R-A, R-3, MHP, hospital, library or school; 65 dba for rest |
| Springfield Township | Small turbines permitted in RA-3 and RA-4 districts of 3 acres or more, only service one residence | | 125 feet | No less than 15 feet between lowest point of blade and ground | 1.0 x height from any property line, dwelling or right-of-way; no part of system can be within 10 feet of property line; need a 6 ft fence around base unless not climbable for 12 feet | 65 dba |
| Toledo (city)<br>Free standing small wind systems | | In resid. ≤ 10 kw, in mutli-dwelling, comm, indus, instit., more is allowed with SUP | 65 feet for commercial; 120 feet for industrial and institutional zoned | No party within 20 feet of ground, utility lines, parking area, driveways or sidewalks | 1.2 x height; no part including guy wires mas be closer than 10 feet to property line; not in front yard | 30 dba from closest property in residential and 55 dba in non-residential |
| Toledo (city)<br>Micro Wind Systems | | In resid. ≤ 10 kW, in mutli-dwelling, comm, indus, instit., more is allowed with SUP | | No party within 20 feet of ground, utility lines, parking area, driveways or sidewalks | 0.5 x height; no part including guy wires mas be closer than 10 feet to property line; height for building mounted can't exceed max permitted building height by more than 30%; not in front yard | 30 dba from closest property in residential and 55 dba in non-residential |
| Washington Township | Permitted as a Special Use in all zoning districts, must notify ODNR, Fish and Wildlife Dept., Toledo metroparks | in the P/O, R-1A, R-2, R-3, R-4 and MHP Districts, not more than 20 kW; no max in others | 120 feet in P/O, R-1A, R-2, R-3, R-4 and MHP; 150 feet in all others | No less than 20 feet between lowest point of blade and ground | Depends on zoning district | 55 dba when abutting A, R-1A, R-3, R-4 and MHP or abutting hospital, library or school; all others 65 dba |

## Ottawa County Wind Ordinances for Low Impact or Small Systems

| Government; Type of Wind Turbine | Conditionally Permitted? | Size Limit (Max.) | Height Limit (Max.) | Height Limit (Min.) | Fall Zone/Setback | Noise Restriction (Max.) |
|---|---|---|---|---|---|---|
| Allen Township Low impact | Permitted in A; conditional in R-1, C-1,C-2 | ≤100 kW | 150 ft | | 1.25 x height to property line, off-site residence, right-of-way | 60 dBA |
| Allen Township Small Farm (2 or more turbines) | Conditional in A | < 5 MW | | | Submitted with conditional use permit | |
| Benton Township Low Impact | | ≤ 100 kW | | | 1.25 x height away from property line, right-of-way; can get fall zone easement next to agric | 60 dBA |
| Benton Township Small Wind Farm | Yes | < 5 MW | | | 1.25 x height away from off-site residence, public road, school, church, building of public gathering; can be waived; need liability insurance policy | 60 dBA |
| Catawba Island Township | Permitted use or Conditional in A and R-1; each with specific location parameters | <100 kW | 150 ft | | 1.25 x height from property line, off-site residence, right-of-way | 60 dBA |
| Clay Township Low Impact | | ≤ 100 kW | | | 1.25 x height away from property line, right-of-way; can get fall zone easement next to agric | 60 dBA |
| Clay Township Small Wind Farm | Yes | < 5 MW | | | 1.25 x height away from off-site residence, public road, school, church, building of public gathering; can be waived; need liability insurance policy | 60 dBA |
| Danbury Township Low Impact | Permitted in A; conditional in R-1, C-1, C-2 | ≤ 100 kW | 150 ft | | 1.25 x height away from property line, off-site residence, right-of-way | 60 dBA |
| Danbury Township Small Wind Farm | Conditional in A, M-2; 2 or more turbines | < 5 MW | | | 1.25 x height away from property line, off-site residence, right-of-way, school, church, building for public gathering | 60 dBA |
| Harris Township Low Impact | Yes | ≤ 100 kW | | | 1.25 x height from property line, residence, right-of-way | |
| Harris Township Small Wind Farm | Yes | < 5 MW | | | 1.25 x height from property line, residence, right-of-way, school, church, building for public gathering | Anticipate number provided to Board for review |

| | | | | | | |
|---|---|---|---|---|---|---|
| Oak Harbor (village) | Yes, in all zoning, commercial wind in Heavy Industry only (more than one turbine) | ≤ 100 kW | | Blade 30 feet about foundation or any structure within 30 feet | 1.3 x height from property line, right-of-way, utility corridor and overhead utilities; none in front yard | 45 dBA measured from 100 feet |
| Portage Township Low Impact | Uses Permitted for all districts | ≤ 100 kW | 150 ft | | 1.1 x height away from property line and right-of-way | Shouldn't interfere with normal conversation at property line |
| Put-in-Bay Township Low impact | Yes, in district A | <100 kW | 150 ft | | 1.25 x height away from property line, off-site residence, right-of-way | 60 dBA |
| Salem Township Low Impact | Yes, Residential, agricultural | ≤ 100 kW | 150 ft | | 1.25 x height away from property line, off-site residence, right-of-way | 60 dBA |
| Salem Township Small Wind Farm | Yes, agricultural; approved by US F & WS and ODNR | < 5 MW | | | 1.5 x height away from property line, off-site residence, right-of-way; school, church or public gathering building | 60 dBA |

## Ottawa County Wind Ordinances for High Impact or Commercial Systems

| Government; Type of Wind Turbine | Conditionally Permitted? | Size Limit (Max.) | Height Limit (Max.) | Height Limit (Min.) | Fall Zone/Setback | Noise Restriction (Max.) |
|---|---|---|---|---|---|---|
| Allen Township High Impact | Permitted in M-2, Conditional in M-1 | >100 kW | | | 1.5 x height to property line, off-site residence, right-of-way | 60 dBA |
| Allen Township Small Farm (2 or more turbines) | Conditional in A | < 5 MW | | | Submitted with conditional use permit | |
| Benton Township High Impact | | >100 kW | | | 1.5 x height from property line and right-of-way, can get fall zone easement next to agric. | 60 dBA |
| Benton Township Small Wind Farm | Yes | < 5 MW | | | 1.25 x height away from off-site residence, public road, school, church, building of public gathering; can be waived; need liability insurance policy | 60 dBA |
| Catawba Island Township | Permitted use or Conditional in A and R-1; each with specific location parameters | <100 kW | 150 ft | | 1.25 x height from property line, off-site residence, right-of-way | 60 dBA |
| Clay Township High Impact | | >100 kW | | | 1.5 x height from property line and right-of-way, can get fall zone easement next to agric. | 60 dBA |

| | | | | | | |
|---|---|---|---|---|---|---|
| Clay Township Small Wind Farm | Yes | < 5 MW | | | 1.25 x height away from off-site residence, public road, school, church, building of public gathering; can be waived; need liability insurance policy | 60 dBA |
| Danbury Township High Impact | Conditional in M-1; permitted in M-2 | >100 kW | | | 1.5 x height away from property line, off-site residence, right-of-way | 60 dBA |
| Danbury Township Small Wind Farm | Conditional in A, M-2; 2 or more turbines | < 5 MW | | | 1.25 x height away from property line, off-site residence, right-of-way, school, church, building for public gathering | 60 dBA |
| Harris Township High Impact | Yes; Location pre-approved by Fish & Wildlife and ODNR | >100 kW | | | 1.5 x height from property line, residence, right-of-way | |
| Harris Township Small Wind Farm | Yes | < 5 MW | | | 1.25 x height from property line, residence, right-of-way, school, church, building for public gathering | Anticipate number provided to Board for review |
| Oak Harbor (village) | Yes, in all zoning, commercial wind in Heavy Industry only (more than one turbine) | ≤ 100 kW | | Blade 30 feet about foundation or any structure within 30 feet | 1.3 x height from property line, right-of-way, utility corridor and overhead utilities; none in front yard | 45 dBA measured from 100 feet |
| Portage Township High Impact | Uses permitted in M-1, M-2 | >100 kW | | | 1.25 x height from property line, right-of-way | |
| Put-in-Bay Township High Impact | Yes, in district A; approved by US F & WS and ODNR | >100 kW | | | 1.5 x of height away from property line, off-site residence, right-of-way | |
| Salem Township High Impact | approved by US F & WS and ODNR; commercial, manufacturing, agricultural | >100 kW | | | 1.5 x height away from property line, off-site residence, right-of-way | 60 dBA |
| Salem Township Small Wind Farm | Yes, agricultural; approved by US F & WS and ODNR | < 5 MW | | | 1.5 x height away from property line, off-site residence, right-of-way; school, church or public gathering building | 60 dBA |

## Local Governments that do not have ordinances regulating wind turbines

| County | Government |
|---|---|
| Erie | Berlin Heights Township |
| Erie | Kelley's Island Village |
| Erie | Milan Village |
| Lorain | Amherst City |
| Lorain | Brighton Township |
| Lorain | Camden Township |
| Lorain | Eaton Township |

| | |
|---|---|
| Lorain | Grafton Township |
| Lorain | Huntington Township |
| Lorain | New Russia Township |
| Lorain | Wellington Township |
| Lorain | Grafton Village |
| Lorain | Kipton Village |
| Lorain | Rochester Township |
| Lorain | Rochester Village |
| Lorain | South Village |
| Lorain | Oberlin City |
| Lucas | Maumee City |
| Lucas | Oregon City |
| Lucas | Sylvania City |
| Lucas | Holland Village |
| Lucas | Ottawa Hills Village |
| Ottawa | Port Clinton City |
| Ottawa | Elmore Village |
| Ottawa | Marblehead Village |
| Ottawa | Put In Bay Village |
| Ottawa | Rocky Ridge Village |

## Erie County Solar Ordinances

| Government | Conditionally Permitted? | Notes |
|---|---|---|
| Sandusky City | No | Must comply with chapter 23 of Ohio Residential Code |

## Lorain County Solar Ordinances

| Government | Conditionally Permitted? | Size Limit; Mounted on Existing Structure (Max.) | Size Limit; Ground Mount (Max.) | Setback |
|---|---|---|---|---|
| Penfield Township | Yes | 35 feet | 8 feet | Front Yard - 70 feet from road right-of-way; Side Yard - 15 feet from property line; Rear Yard - 15 feet from property line |
| Wellington Village | Moratorium on construction to draft new zoning legislation | N/A | N/A | N/A |
| Lagrange Village | Yes | No solar panel shall exceed the height of the roofline on a pitched roof; Solar panels installed on a flat roof shall be installed at an angle that is not more than three feet above the roof line, provided that the height of the solar panel not exceed 35 feet in Residential, Business, and Industrial Districts; and 40 feet in Institutional Development and Transitional Districts | 15 feet; Ground arrays permitted solely for the purpose of heating swimming pools; not permitted in front yards; must be oriented so glare is directed away from adjoining property; shall not exceed 9 square feet in size | Ground arrays are subject to the setback distances prescribed for the residential zoning district in which the array is constructed |

**Table 20: Lucas County Solar Ordinances**

| Government | Conditionally Permitted? | Notes |
|---|---|---|
| Toledo City | Special Use approval is required when the solar system is a stand-alone facility; not permitted in historic district unless approved by the Historic District Commission | Permitted when attached to building and not visible from street or when visible they must be parallel to roof slope and project no more than 12 inches |

**Table 21: Local Governments that do not have Ordinances Regulating Solar Energy Systems**

| County | Government |
|---|---|
| Erie | Berlin Township |
| Erie | Berlin Heights Township |
| Erie | Florence Township |
| Erie | Huron City |
| Erie | Huron Township |
| Erie | Kelley's Island Village |
| Erie | Margaretta Township |
| Erie | Milan Township |
| Erie | Milan Village |
| Erie | Oxford Township |
| Erie | Perkins Township |
| Erie | Vermilion City |
| Erie | Vermilion Township |
| Lorain | Amherst City |
| Lorain | Amherst Township |
| Lorain | Brighton Township |
| Lorain | Brownhelm Township |
| Lorain | Camden Township |
| Lorain | Carlisle Township |
| Lorain | Eaton Township |
| Lorain | Grafton Township |
| Lorain | Grafton Village |
| Lorain | Huntington Township |
| Lorain | Kipton Village |
| Lorain | La Grange Township |
| Lorain | New Russia Township |
| Lorain | Oberlin City |
| Lorain | Pittsfield Township |
| Lorain | Rochester Village |
| Lorain | South Amherst Village |
| Lorain | Wellington Township |
| Lucas | Harding Township |
| Lucas | Holland Village |
| Lucas | Maumee City |
| Lucas | Monclova Township |
| Lucas | Oregon City |
| Lucas | Ottawa Hills Village |
| Lucas | Richfield Township |
| Lucas | Spencer Township |
| Lucas | Springfield Township |
| Lucas | Sylvania City |
| Lucas | Sylvania Township |
| Lucas | Washington Township |
| Ottawa | Allen Township |
| Ottawa | Bay Township |
| Ottawa | Benton Township |
| Ottawa | Carroll Township |
| Ottawa | Catawba Island Township |
| Ottawa | Clay Township |
| Ottawa | Danbury Township |

| | |
|---|---|
| Ottawa | Elmore Village |
| Ottawa | Erie Township |
| Ottawa | Genoa Village |
| Ottawa | Harris Township |
| Ottawa | Marblehead Village |
| Ottawa | Oak Harbor Village |
| Ottawa | Port Clinton City |
| Ottawa | Portage Township |
| Ottawa | Put-in-Bay Township |
| Ottawa | Put-in-Bay Village |
| Ottawa | Rocky Ridge Village |
| Ottawa | Salem Township |

## Local Governments that are not zoned

| County | Government |
|---|---|
| Ottawa | Bay Township |
| Ottawa | Carroll Township |
| Ottawa | Erie Township |

## Local Governments that did not Respond to Inquiries for Zoning Information

| County | Government |
|---|---|
| Erie | Groton Township |
| Erie | Bay View Village |
| Erie | Castalia Village |
| Lorain | Henrietta Township |
| Lorain | Rochester Township |
| Lucas | Jerusalem Township |
| Lucas | Berkey Village |
| Lucas | Harbor View Village |
| Ottawa | Clay Center Village |

# Appendix C: Loans and Incentives for Residential Energy Efficiency Projects

| **Name** | **Heritage Home Program** |
|---|---|
| **Description** | Low-interest loan for energy efficiency (and other) improvements to historic homes |
| **Sponsor** | Cleveland Restoration Society |
| **Utility Type** | Gas, Electric |
| **Coverage Area** | Participating cities (includes Oberlin) |
| **Website** | http://www.clevelandrestoration.org/heritage_homes/loans.php |
| **Funded By** | KeyBank |
| **Interest Rate** | Typically 3% below market |
| **Loan Term** | 5-12 years |
| **Categories** | Energy audits |
| | Insulation |
| | Storm windows |
| | Storm doors |
| | HVAC upgrades |
| | Other energy efficiency improvements |
| **Limitations** | Home constructed prior to 1961 |
| | Zoned exclusively residential (no mixed-use) |
| | For rentals, 3 units or less |
| | Remove vinyl/aluminum siding |
| | Remove vinyl windows |

| **Name** | **ECO-Link** |
|---|---|
| **Description** | Partnership between the Ohio Treasurer of State and participating state banks to provide reduced-interest rate financing to Ohio homeowners for weatherization projects and energy efficient appliances in their homes |
| **Sponsor** | Ohio Treasurer of State |
| **Utility Type** | Gas, Electric |
| **Coverage Area** | State of Ohio |
| **Website** | http://www.tos.ohio.gov/ForYou/Default.aspx?Section=ECO |
| **Funded By** | KeyBank (statewide) |
| | US Bank (statewide) |
| | Huntington Bank (statewide) |
| **Interest Rate** | 3% below market |
| **Loan Term** | 5 years, 7 years if >$25,000 loan |
| **Categories** | Energy Star certified products |
| | Appliances |
| | Water Heaters |
| | HVAC |
| | Insulation and Air Sealing |
| | Roof Products |
| | Windows, Doors, Skylights |
| **Limitations** | Homeowners only |
| | Single family home |
| | Certified products/installers |

| | |
|---|---|
| **Name** | **PowerSaver Program** |
| **Description** | Low-cost loans to qualified borrowers living in certain parts of the country to make energy-saving improvements to their homes |
| **Sponsor** | US Housing and Urban Development (HUD), Federal Housing Administration (FHA) |
| **Utility Type** | Gas, Electric |
| **Website:** | http://portal.hud.gov/hudportal/HUD?src=/press/press_releases_media_advisories/2011/HUDNo.11-062 |
| **Funding Cycle** | 2-year pilot program |
| **Funded By** | All loans backed by Federal Housing Administration (FHA) |
| List of Banks | http://portal.hud.gov/hudportal/HUD?src=/press/press_releases_media_advisories/2011/HUDNo.11-062 |
| **Interest Rate** | 5-7% |
| **Loan Term** | Up to 20 years, up to $25,000 loan |
| **Categories** | Insulation |
| | Duct sealing |
| | Replacement doors and windows |
| | HVAC systems |
| | Water heaters |
| | Solar panels |
| | Geothermal systems |

| | |
|---|---|
| **Name** | **Charter One Energy Efficiency Loan** |
| **Description** | Small, low-interest loan for energy efficiency improvements |
| **Sponsor** | Charter One |
| **Utility Type** | Gas, Electric |
| **Funded By** | Charter One |
| **Interest Rate** | 3%, $1,000-3,000, 5% for larger loans, customizable |
| **Loan Term** | 36 months - 7 years, customizable |
| **Categories** | Weatherization and energy efficiency improvements |

| | |
|---|---|
| **Name** | **Consumer Energy Efficiency Tax Credit: Basic Energy Efficiency Improvements** |
| **Website** | http://www.energystar.gov/index.cfm?c=tax_credits.tx_index |
| **Tax Credit** | 10% of cost up to $500 total or a specific amount from $50-300 (still $500 limit) |
| **Expires** | December 31, 2011 |
| **Utility Type** | Gas, Electric |
| **Categories** | Biomass stoves (specific amt: $300) |
| | HVAC systems (variable specific amt) |
| | Insulation |
| | Qualified roofs |
| | Water heaters (non-solar) |
| | Windows/doors (windows capped at $200) |
| **Limitations** | Must be existing home |
| | Must be principal residence |
| | No new construction or rentals |

# Endnotes

## Introduction

[1] US DOE, Strategic Plan, May 2011.
[2] Union of Concerned Scientists, "Burning Coal, Burning Cash: Ranking the States that Import the Most Coal," May, 2010.
[3] Pew Charitable Trusts, "The Clean Energy Economy: Repowering Jobs, Businesses and Investments Across America," June, 2009.
[4] Ohio Department of Development, "Ohio: We Make Wind Work," http://development.ohio.gov/wind/Documents/WindEnergy_Brochure.pdf, May, 2011.
[5] Solar Energy Industries Association, http://www.solarworksforamerica.com/States/ohio.html
[6] Environmental Law and Policy Center "The Solar and Wind Energy Supply Chain in Ohio," January 2011
[7] Ibid
[8] Kaplan, S., et al, "Ohio's Green Energy Economy: The Energy Efficiency Industry," Environmental Law and Policy Center, January 2010.
[9] Oak Ridge National Laboratory, "Biomass Energy Data Book, Edition 3," 2010.
[10] Friedrich, K., Eldridge, M., York, D., Witte, P., & Kushler, M., 2009. Saving Energy Cost-Effectively: A National Review of the Cost of Energy Saved through Utility-Sector Energy Efficiency Programs. Report Number U092. Washington, DC: American Council for an Energy-Efficient Economy. Accessed at http://www.aceee.org/pubs/u092.htm.
[11] Kaplan, S., et al, "Ohio's Green Energy Economy: The Energy Efficiency Industry," Environmental Law and Policy Center, January 2010.
[12] Lauren Randall, Environment Ohio Research and Policy Center, "Dirty Energy's Assault on Our Health: Ozone Pollution, March 2011
[13] Randall, L. and Vinyard, S., Environment Ohio Research and Policy Center "Dirty Energy's Assault on our Health: Mercury
[14] Ibid.
[15] Environmental Integrity Project, "Getting Warmer: US CO2 Emissions from Power Plants Emissions Rise 5.6% in 2010," Feb 18, 2011**.**
[16] National Conference of State Legislatures, "Climate Change and the Economy: Ohio—Assessing the Costs of Climate Change," 2008.
[17] "Combating Climate Change: Clinton Climate Initiative," http://www.clintonfoundation.org/what-we-do/clinton-climate-initiative/cities/climate-positive

## Chapter 1: Renewable Energy

[18] J. Deyette and B. Freese, "Burning Coal, Burning Cash: Ranking the States that Import the Most Coal," Union of Concerned Scientists, May, 2010.
[19] EIA, "State Renewable Electricity Profiles," 2009, http://205.254.135.24/cneaf/solar.renewables/page/state_profiles/r_profiles_sum.html
[20] Bentley, G. **"**180th Solar field shines with expansion," Ohio.gov, Jan. 8, 2010.
[21] Because the 9th Congressional District is not an island unto itself, and energy travels throughout the region, the energy *consumed* by District residents is probably closer to 53% coal, 42% nuclear, and 1% hydro (with 4% listed as "unknown," according to First Energy Solutions, the third-party sales arm of FirstEnergy that supplies the vast majority of the District's consumers.
[22] N. Pfund and B. Healy, "What Would Jefferson Do: The Historical Role of Federal Subsidies in Shaping America's Energy Future," DBL Investors, Sept., 2011, http://www.dblinvestors.com/documents/What-Would-Jefferson-Do-_Final_September2011.pdf
[23] Ohio Department of Development, Advanced Energy Fund: All Projects Funded as of Sept. 1, 2011, http://development.ohio.gov/Energy/Incentives/documents/AEF_Report_Website_Fonts.pdf
[24] American Wind Energy Association, "Wind Energy Facts: Ohio," May 2011, http://www.awea.org/learnabout/publications/upload/1Q-11-Ohio.pdf
[25] J. Perlaky, "Ohio's 9th District: Existing and Future Job Creation Opportunities, PV and Wind Supply Chains," July, 2011.

[26] American Wind Energy Association, "Wind Energy Facts: Ohio," May 2011, American Wind Energy Association, "Wind Energy Facts: Ohio," May 2011.
[27] Sunwheel Energy Systems and Sustainable Community Associates, "Wind Power Demonstration Project Report for Oberlin, Ohio and Other AMP-Member Ohio Communities," March 1, 2011.
[28] Sunwheel Energy Partners and Sustainable Community Associates "Wind Power Demonstration Project Report for Oberlin, Ohio," March 1, 2011.
[29] Ohio's Clean Energy Report Card: How Wind, Solar, and Energy Efficiency are Repowering the Buckeye State, Environment Ohio Research and Policy Center, March, 2011.
[30] Green Energy Ohio, "Evaluation of the Wind and Solar Resources for Ohio's 9th Congressional District," July 8, 2011.
[31] Green Energy Ohio, "Evaluation of the Capacity to Deploy Solar & Wind Technologies in Ohio's 9th Congressional District," September 30, 2011.
[32] Sunwheel Energy Partners and Sustainable Community Associates, "Solar Power Demonstration Project, Solar Farm Installations: Oberlin, OH and other AMP Ohio Communities," June 1, 2011.
[33] U.S. EIA, Renewable Energy Consumption and Electricity Preliminary Statistics 2009 Table 6, Total Renewable Net Generation by Energy Source and State, 2009, Released August 2010
[34] NRDC, "Renewable Energy in Ohio," http://www.nrdc.org/energy/renewables/ohio.asp
[35]U.S. EIA, Renewable Energy Consumption and Electricity Preliminary Statistics 2009 Table 6, Total Renewable Net Generation by Energy Source and State, 2009, Released August 2010
[36] Solutions in Sustainability, "Final Report: Oberlin College Energy Transmission and Infrastructure Northern Ohio, Department of Energy, National Energy Technology Laboratory Grant," Aug. 23, 2011.
[37] IPCC Fourth Assessment Report, Table 2.14, Chap. 2, http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter2.pdf
[38] These estimates may be slightly high, as they include data for all of Lorain County, although only a portion of Lorain County, albeit the more rural portion, is in the 9th Congressional District.
[39] AgSTAR Program, US EPA, http://www.epa.gov/agstar/projects/index.html July 14, 2011.
[40] Net Present Value is the sum of all cash flows (e.g., revenues from electricity minus capital and variable costs) over the life of the project.
[41] N. Key and S. Sneeringer, Economic Research Services, "Climate Change Policy and the Adoption of Methane Digesters on Livestock Operations," USDA, Economic Research Report no. 11, Feb, 2011.
[42] D. Sullivan, "Hiring the Unemployed: With the Help of Ohio Renewable Energy Standards, First Solar Brings Economic Security to Families and Communities," NRDC, Sept. 14, 2011. http://switchboard.nrdc.org/blogs/dsullivan/hiring_the_unemployed_with_the.html
[43] M. Anunike, "Solar Industry and Supply Chain Opportunities and Resources in Ohio," Ohio Dept. of Devt.
[44] George Sterzinger/Matt Svrcek, "Component Manufacturing: Ohio's Future in the Renewable Energy Industry, REPP Renewable energy Policy Project", Technical Report, October 2005. http://www.repp.org/articles/static/1/binaries/Ohio_Report_Long_Appndx_ABC.pdf ; the growth was probably even larger as the 67 companies listed in the 2005 report included industries in all of Lorain County rather than just the portion of the County that is part of the 9th Congressional District.
[45] Bolinger, M. et al, "Preliminary Evaluation of the Impact of the Section 1603 Treasury Grant Program on Renewable Energy Deployment in 2009," Lawrence Berkeley National Laboratory, April, 2010.
[46] Toledo Blade, "PUCO allows FirstEnergy to miss solar requirement," August 10, 2011.

## Chapter 2: Energy Efficiency

[47] Energy Information Administration, DOE, "State Electricity Profiles 2009,"
[48]DOE Office of Energy Efficiency and Renewable Energy, "Ohio Energy Summary Fact Sheet"
[49] Ohio Clean Energy Report Card
[50] Palmer Energy Company, "Energy Demand/Consumption in Ohio's 9th District," September, 2011.
[51] Efficiency Smart, "Welcome to Efficiency Smart, an Energy Efficiency Program for OMLPS in cooperation with AMP," spring, 2011.
[52] PSI, "Oberlin Downtown Sustainability Study," August, 2011.

[53] The entire team included Ohio Partners for Affordable Energy, the Center on Wisconsin Strategy (COWS), Policy Matters Ohio, and the Oberlin Project's Energy Committee.
[54] All OMLPS information from S. Dupee "Community Energy Transformation," presented at Northern Ohio's Clean Energy Future: Regional Prosperity, Opportunity, Leadership, Sept. 16, 2011.
[55] Final Report 2009. Rapid Deployment Energy efficiency (RDEE) Toolkit: Planning and Implementation Guides. Developed by the National Action Plan for Energy Efficiency, with support from the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE), prepared by Peter Lemoine, Tyler Huebner, David Pickles, Bill Prindle, and Nora Buehler of ICF International, Dec.9, 2009.

## Chapter 3: Transportation

[56] Center for Neighborhood Transportation, "Oberlin Transportation Profile," May 27, 2011.
[57] CNT, "Energy Efficient Transportation Plan for Oberlin and Northern Ohio," Aug. 26, 2011.
[58] U.S. Environmental Protection Agency, *Regulatory Impact Analysis: Renewable Fuel Standard Program*, April 2007, http://www.epa.gov/otaq/renewablefuels/420r07004.pdf
[59] SCA, Recent Press Release, Sept. 23, 2011, http://sustainableca.com/2011/09/recent-press-release,

## Conclusions

[60] N. Pfund and B. Healy, "What Would Jefferson Do: The Historical Role of Federal Subsidies in Shaping America's Energy Future," DBL Investors, Sept., 2011, http://www.dblinvestors.com/documents/What-Would-Jefferson-Do-_Final_September2011.pdf

## Appendix B

[61] Green Energy Ohio, Appendix B of "Evaluation of the Capacity to Deploy Solar & Wind Technologies in Ohio's 9th Congressional District," September 30, 2011.