Southwest Detroit Wind Feasibility Study

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As fossil fuel prices become increasingly volatile and evidence of global climate change mounts, governments at the local, state, and national levels have adopted policies to encourage alternative energy investment. At the same time, urban neighborhoods in Rustbelt cities have continued to grapple with the environmental and economic effects of their industrial legacies.

Southwest Detroit is representative of an industrial landscape in a post-industrial society. According to the Detroit Free Press, the area is home to three of the ten most polluted zip codes in Michigan (Lam 2010). Air quality in the area has failed to meet Federal Clean Air Standards for several of the last six years (Michigan Departments of Environmental Quality and Natural Resources 2008, 7). Home to the western end of the Ambassador Bridge—the busiest freight crossing point on the U.S.-Canadian border—Southwest Detroit experiences constant traffic and noise from freight trucks, as well as unsafe diesel fume concentrations. Compounding the area's environmental concerns, an even larger bridge (the Detroit River International Crossing or DRIC) is proposed to run through Southwest Detroit's Delray neighborhood in the years ahead.

In light of the State of Michigan's goal to develop a green jobs sector through the promotion of wind energy, we explore the incorporation of a wind energy component that might mitigate some of the DRIC project's negative impacts in Southwest Detroit. Michigan is among the top fifteen states for wind energy generation potential and is the second best state for such projects in the Midwest region (Kavanaugh 2008). Before recommending that significant energy and resources be diverted toward attracting and developing wind energy, it was necessary to assess the applicability of these statewide statistics to the unique urban industrial setting of Southwest Detroit. This paper outlines the process of developing and siting wind energy projects and specifically relates that process to Southwest Detroit. It appraises the most feasible options for developing wind energy projects in Southwest Detroit and begins with a classification of Southwest Detroit into three site types: the DRIC bridge, vacant industrial sites along the Detroit River, and vacant land in residential areas. This allowed us to consider each class according to the turbine technology it can accommodate, the wind resource that it would require, the regulations that would enable or prohibit turbine installation, and the most promising sources of financing. We concluded that industrial land along the waterfront offers the most promising site type for wind energy investment due to its relatively unobstructed wind exposure and its ability to accommodate property-line setbacks as suggested in the Michigan Land Use Guidelines for Siting Wind Energy Systems (Klepinger 2007).

Wind Turbine Basics

Wind turbines convert the kinetic (moving) energy in the wind into electrical energy. Wind generates kinetic energy in the form of rotating blades, which is transferred to the generator and converted into electricity. To operate efficiently and safely, wind turbines must respond to changing wind conditions. The on-board anemometer and wind vane keep track of wind speed and direction, respectively. When conditions are suitable, the computers activate the yaw components to rotate the nacelle assembly so that the attached blades face the wind directly. The brake is then released and the computers adjust the pitch on the blade to generate maximum aerodynamic lift. The lift creates torque to turn the rotor, low-speed shaft, gearbox, and high-speed shaft. The process is similar to that which occurs when one blows air toward a pinwheel to make it spin around.

As the blades and rotor spin, alternating current electricity is generated and transmitted via large cables that are housed inside the tower. Larger generators produce more electricity and require greater force to turn the rotor; hence, taller towers are required to access faster moving wind, and bigger blades are needed to produce sufficient torque. Conversely, smaller generators produce less electricity and require less force to turn, calling for smaller tower heights and blade lengths.

Wind Turbines in Southwest Detroit

Several necessary conditions must be met for wind energy to be feasible in Southwest Detroit. The most fundamental condition is the presence of an adequate wind resource. Wind turbines operate most efficiently in smooth, steady winds. Turbulent wind flow is unsteady,

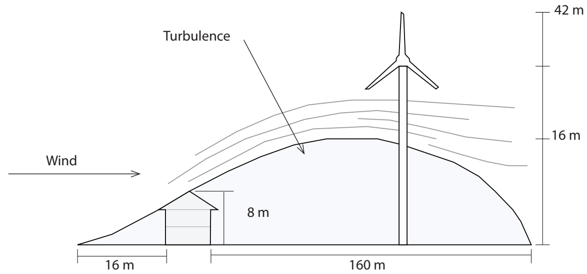

Figure 1: Turbulence Pocket Around a House with a Small Turbine

characterized by rapid changes in direction, velocity, and pressure. Local obstructions, such as a house, can create turbulence that compromises turbine performance. For example, a house 8 meters in height can create a pocket of turbulence 160 meters long and 16 meters high (see figure 1). Even if regional wind data indicates that an area has adequate wind resources, turbulence pockets may render certain urban sites unsuitable for wind development.

The direction of wind and the position of wind turbines relative to local obstructions are important to siting wind turbines. Turbulence will not adversely affect a wind turbine that is located upwind from an obstruction as severely as it will affect a turbine located downwind. On a given site, it is important to determine the prevailing wind direction relative to local obstructions before investing in wind turbines. In addition, the area of a site is not by itself an indication that the site is large enough to accommodate wind turbines. A site must be large enough to accommodate a wind turbine that can reach above whatever turbulence pockets may exist. A very large site may be inadequate for turbine siting if it is adjacent to a tall obstruction. Sites that are free of obstructions are particularly promising as potential wind turbine locations. Portions of Southwest Detroit that fall along the Detroit riverfront are free of local obstructions to the east and southeast. If wind typically blows from these directions, these sites may be attractive locations for turbines.

Wind speeds are another factor that impact wind turbine siting. Wind speeds increase exponentially with height, so wind maps at a height of 80 meters may not reflect the wind resource available at the height of small, residential wind turbines. Residential turbines tend to reach a height of 30 meters or less, so a prevailing wind speed of 6 m/s at a height of 80 meters may correspond to speeds of 2 m/s or less at the height of residential turbines (California Energy Commission). This, in addition to the prevalence of local obstructions in residential areas, limits the potential for small, residential wind energy generation in Southwest Detroit.

Currently, wind data for Detroit is available only at the regional level. Data collection is ongoing at several sites in and around the City, such as the Chrysler Proving Grounds in Washtenaw County, where the Washtenaw Wind Project has collected wind data at heights between 50 meters and 80 meters (Washtenaw County). However, for the reasons outlined above, this data does not necessarily reflect the wind resources at residential sites in Southwest Detroit. To determine whether those resources are adequate for wind power production, they must be measured directly.

The first step in determining the feasibility of wind power in Southwest Detroit is conducting detailed wind surveys of the area's riverfront industrial sites with respect to wind direction, velocity, and turbulence using anemometers. Several states, including Michigan, have anemometer loan programs to encourage wind mapping (San Francisco Urban Wind Power Task Force 2009, 6). Because wind patterns vary according to the season, it typically takes at least 12 months to gather sufficient data on a site to accurately determine whether it can support wind power (San Francisco Urban Wind Power Task Force 2009, 6). The National Renewable Energy Laboratory (NREL) compiles wind data and creates wind resource maps and other guides. The NREL produced the first wind atlas maps in 1979 and 1980 using data from the Pacific Northwest Laboratory. Recently, the NREL produced 12 regional wind resource atlases using data from approximately 3,200 stations in the United States. Ideally, wind data would be collected at either the 10-meter (33 feet) or 50-meter (164 feet) level. In actuality, this is rarely the case. To overcome this limitation, researchers use the relationship between height and wind speed to adjust for discrepancies in the heights of collection stations. The atlases map the geographical variation in wind power density rather than wind velocity. Power density is a function of both wind speed and density. As a result, the atlases reflect the combined effect of both wind characteristics on power generation. The Wind Energy Resource Atlas presents macro-level wind data. While we could not conduct a site-specific wind study, an attempt was made to use data from

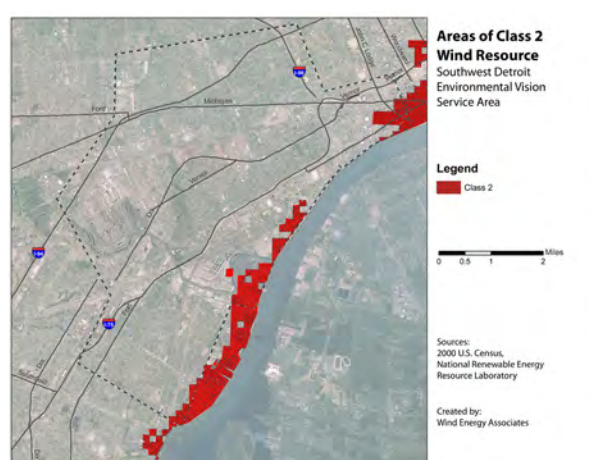

Figure 2: Areas of Class 2 Wind Resource and Potential Siting of Large Wind Turbines Along the Detroit River. Source: Kristin Baja and Julie Schneider

local weather stations to generate wind resource maps for the Southwest Detroit. Because stations report data on wind direction as well as velocity, we generated micro-level maps report both measurements.

The Department of Energy (DOE) rates a region's wind power generation potential in terms of wind classes. Classes range from 1 (Poor) to 7 (Superb). In terms of wind class, the Lower Peninsula can be divided into four areas: offshore, the coast, the northern half of the Lower Peninsula, and southern half of the Lower Peninsula. Areas offshore have wind class ratings of 3 (Fair) or higher. Offshore areas along the coast of Lake Michigan and the northern coast of Lake Huron have the highest ratings at 6 (Outstanding). These ratings drop quickly as wind travels inland. Just 100 meters inland, the wind power class along every coast drops to 3 and then 2 (Marginal).

The northern half of the Lower Peninsula has a fairly uniform rating of poor. Though there are small pockets of marginal wind along the western coast, as a whole this area has the poorest wind resource potential. Wind resources are more varied in the southern half of the Lower Peninsula. Large areas are only marginal or poor. Urban areas tend to be poor. For example, the regions surrounding Detroit, Grand Rapids, Lansing, Kalamazoo, Ann Arbor, and Jackson are all within or adjacent to areas with poor wind resources. The largest such area surrounds Detroit.

Nearly all of Southwest Detroit is considered to have a poor wind resource. Only small patches in the southern and northern areas along the Detroit River are marginal. Prevailing wind patterns in Southwest Detroit are from the west throughout the year. The U.S. Department of Energy (DOE) and the NREL have each issued recommendations for turbine siting. The DOE recommends Class 4 or higher at the 50-meter height and 3 or higher at the 80-meter height. Meanwhile the NREL recommends that wind power classes of 3 or higher are suitable for most wind energy applications, and that areas of Class 2 may have potential for wind power development at a height of 80 meters.

If velocity rather than power class is used to determine the potential for wind power development, the NREL suggests that wind speeds of 6.5 m/s are necessary to power 80-meter commercial turbines. For residential wind power development, many turbine manufacturers suggest wind speeds of at least 5.3 to 5.6 m/s. NREL maps suggest that there are few, if any, suitable locations for wind energy generation within the area. Meanwhile, our study suggests that the area is suitable for wind energy development. Both studies suggest that the most suitable areas for wind energy development are in the southwest, especially along the Detroit River. The NREL power class rating is marginal along the river at the 50-meter height, but because velocities increase with height, it is possible

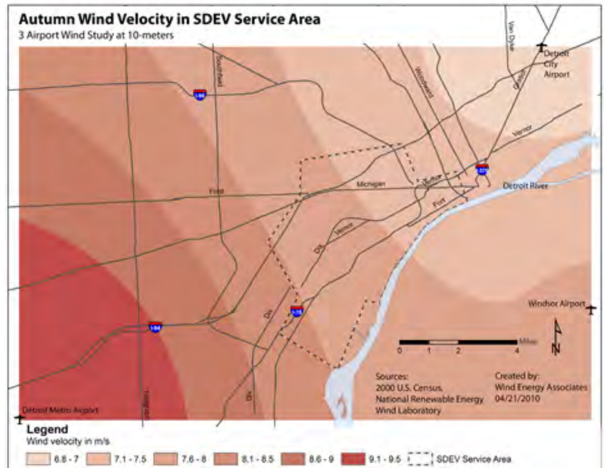

Figure 3: Interpolated Wind Velocities in the SDEV Service Area. Source: Julie Schneider

that the wind resource is better at the 80-meter height, the standard height of commercial wind turbines. Neither the NREL maps nor our personal wind study provide conclusive evidence that wind energy generation is feasible on specific sites in Southwest Detroit. They do suggest that if the Southwest Detroit community pursues wind energy in the area, its first step should be to conduct wind studies of sites along the waterfront.

Based on local wind resources, large-scale turbines at heights around 80 meters are the most feasible option for wind energy in Southwest Detroit. While towers at such heights may surmount the problem of marginal wind speeds in the neighborhood, they also conflict with Detroit's Zoning Code and raise significant concerns about safety, aesthetics, and environmental protection (National Renewable Energy Laboratory 2007).

Siting Considerations

A stand-alone wind ordinance or a zoning code amendment is the best method to assure that dimensional restrictions (e.g. height limits) and use restrictions do not prevent wind energy projects in Southwest Detroit. Many issues besides dimensional restrictions such as aesthetics, engineering standards, setbacks, shadow flicker, and noise also pertain to the siting of wind turbines, and should also be included in any legislative changes to the zoning or municipal code. While height and use restrictions will frame the discussion of zoning code changes below, subsequent sections of this chapter address the importance of other siting factors that a wind-specific zoning code amendment or a stand-alone wind ordinance must address.

The State of Michigan has not enacted statutory law that prescribes siting conditions for wind energy systems. However, the Energy Office of the Michigan Department of Labor and Economic Growth has developed model guidelines—the Michigan Siting Guidelines for Wind Energy Systems—to inform the adoption of local wind ordinances (Energy Office, Michigan DELEG 2007). Although the State guidelines offer important insight into the safety and technical concerns associated with wind energy system siting, the Energy Office does not have legal authority to regulate wind energy systems. This "hands off" approach to physical siting requirements is likely to continue into the foreseeable future; the Michigan Public Service Commission just issued a report concluding that "these matters should be decided at the local level where feasible so that the needs of local citizens can be appropriately considered. No evidence presented to the Commission suggests that a one-size-fits-all approach would work for the entire State" (Isiogu, Martinez and White 2010, 2). The City of Detroit does not have a local wind energy systems ordinance or wind-specific zoning regulation. In Detroit, existing zoning code provisions addressing height, setback, noise, and use parameters for general structures also apply to wind energy generation systems (Klepinger 2007, 1).

As currently written in Article XIII of the Detroit zoning code, the dimensional restrictions on most parcels in Southwest Detroit preclude the erection of wind turbines (Detroit Municipal Code 2008, §61-13). If Southwest Detroit chooses to pursue wind energy projects, it will have to pursue one of the following zoning procedures to overcome legal barriers in the zoning code:

1) Make variance applications on a per-project basis
2) Petition for passage of a stand-alone wind energy ordinance or wind-specific amendment to the zoning code
3) Petition for passage of a minor amendment to the zoning code that would apply existing antenna provisions to wind energy systems

Because of the proximity of residential and industrial districts in Southwest Detroit, there is not one site type alternative that would result in wind turbines being sited at significant distances from dwelling units. The community of Southwest Detroit will have to decide the conditions that would make it acceptable for the placement of turbines— large or small—within 1,000 feet of residential dwellings. Before the adoption of any local zoning or municipal code amendments, or before a particular wind energy project is sited, community input meetings should be held to facilitate this process. In particular, issues of turbine noise, viewshed degradation, and shadow flicker should be explicitly addressed. Ironically, although the proximity of residential and industrial uses in the Southwest Detroit complicates the siting process, the rugged industrial landscape may make residents more amenable to turbine towers that are no more imposing than existing smokestacks and offer potential reductions to residents' energy cost without the pollution associated with factories.

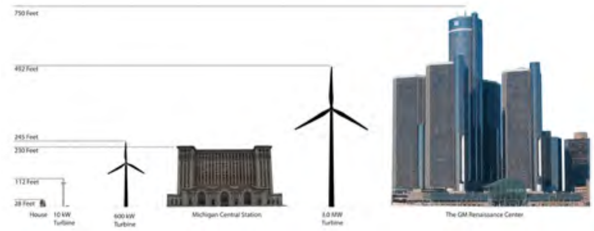

Figure 4: Large Wind Turbine Height Comparison. Source: Kristin Baja

The most common quality of life concerns that arise during the approval process for wind turbine projects relate to the impacts that turbines might impose on adjacent property, especially shadow flicker and noise. Shadow flicker is the phenomenon of alternating shadow patterns caused by the rotation of wind turbine blades between a property and the sun. This phenomenon is especially disturbing when shadows are cast through windows at a dwelling (Energy Office, Michigan DELEG 2007, 2).

Noise produced by wind turbines—either mechanical from the internal gear mechanisms or aerodynamic from blades passing through air—should not be a major concern since the highest average noise levels attributable to turbines experienced in homes will be no more than 55 decibels. This noise level will be barely if at all noticeable; the noise accompanying a home computer or an electric fan is louder. The industrial uses already present in Southwest Detroit contribute ambient sound levels higher than those produced by large turbines.

One of the primary considerations that should be taken into account before selecting a site for wind energy development is whether and to what degree a project might negatively impact the surrounding environment or ecological systems. At a very basic level, a site should be inventoried to account for any wetland, forested area, or other natural features. However, after an initial inventory that might eliminate particular sites due to obvious visible environmental constraints, all wind energy projects must take care to undertake any required or recommended environmental assessment procedures and permitting processes.

A significant regulatory consideration for any wind energy project is whether an Environmental Assessment (EA) is required pursuant to the National Environmental Policy Act (NEPA) (NEPA 1970, §4321-4347). Since 1970 when NEPA was signed into law, the environmental impact of all actions undertaken by federal agencies—including private projects that require federal agency action—must be determined prior to any decision-making on such actions (NEPA 1970, §4332(2)). If a project requires NEPA review, then the federal and state agencies involved in that project must conduct an initial Environmental Assessment. If a significant environmental impact is likely, then a more in-depth Environmental Impact Statement (EIS) is necessary. Additionally, although federal agencies are responsible for conducting NEPA review and preparing required EA and EIS documents, the wind energy project developer should support the investigative process by conducting environmental studies of the project and providing documents and data to the appropriate federal agency (American Wind Energy Association 2008, 4-7). As a result, the NEPA review process could significantly increase the completion time for wind energy projects in Southwest Detroit.

If Southwest Detroit chooses to pursue the most feasible alternative for wind energy development in the area—large-scale wind turbines on vacant industrial sites—it is likely to trigger a NEPA review. Large-scale turbine projects always have a high potential of impacting migratory birds, and ignorance is not an excuse to avoid liability for the unpermitted incidental taking of endangered species. Therefore, consultation with the FWS with respect to the Endangered Species Act and the Migratory Bird Treaty Act is always recommended (American Wind Energy Association 2008).

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The authorities with electric regulation jurisdiction over a wind energy project depend on the energy generation capacity of the project, the ownership structure of the project, and the identity of the intended end-users of the electricity generated by the project. Regardless of the size or type of a wind energy project, some degree of federal or state energy regulation is unavoidable. In general, the level of regulatory involvement is directly proportional to the size/generation capacity of the wind energy project and to the amount of the electricity generated that will be sold on the grid.

Three regulatory authorities may have jurisdiction to impose energy related regulations on potential wind projects in Southwest Detroit:

1) The United States Federal Energy Regulatory Commission
2) The Michigan Public Service Commission
3) The Midwest Independent Transmission System Operator

The United States Federal Energy Regulatory Commission (FERC) either directly or indirectly regulates all electricity generation in the United States, including all wind energy generation systems, regardless of size. FERC does not regulate retail electricity sales to consumers (US FERC). Instead, FERC ensures the safe operation/construction of electricity generating devices, promulgates orders that regulate the nation's electricity transmission systems, and "regulates the transmission and wholesale sales of electricity in interstate commerce" (US FERC). In May of 2005, FERC issued its Small Generator Interconnection Standards that apply to all electric generation systems with a production capacity of less than 20 MW. FERC standards regulate any electric utility company that deals in interstate commerce and provides electricity to the public (US FERC 2006, 1). These standards become relevant to Southwest Detroit in that they require all electric utility companies to provide standard interconnection procedures for wind turbines to connect to the grid and for the utility to grant interconnection in a non-discriminatory manner if those standards are met. These standards have been implemented to ensure power quality, generation safety, and consistency of electrical inspections (Varnado 2009). Because the total generating capacity of wind projects in Southwest Detroit would likely be less than 20 MW, FERC interconnection standards would apply. This means that as long as a wind project meets utility-specified safety and reliability standards, any wind energy project described in the site type alternatives in this study will be allowed to interconnect with the electric grid in Southwest Detroit. Interconnectivity issues will not become roadblocks to achieving the economic and social goals that the Southwest Detroit community stakeholders set out for a wind energy generation project in the neighborhood.

While FERC regulation applies only to electric utilities that deal in interstate commerce, at the state level, the Michigan Public Service Commission (MPSC) is responsible for rate, safety, and interconnection regulation. The MPSC regulates all privately owned electric utility companies, all alternative electric providers, and all electric distribution cooperatives. The only electric utilities in Michigan that are not rate-regulated by the MPSC are those that are municipally owned.

Besides regulating rates for privately owned utility companies in the State, the MPSC also sets forth policy standards that dictate the types of interconnection services and net-metering programs that commercial utilities must offer to non-utility energy generators such as large turbine wind farms, individual sites with large turbines, and small turbine on-site wind generators. While FERC Order 2006 requires the adoption of standard interconnection agreements by every commercial utility participating in interstate commerce, MPSC has gone further to regulate the specific interconnection services and policies that all commercial electric utility companies doing business in Michigan must adhere to. These

Wind Turbine. Photo: Kristin Baja, 2010

interconnection standards play a central role in making distributed generation economically viable in the State. MPSC defines distributed generation as "any small scale electric generation that is located at or near the point of end use. It may be interconnected with a local utility company's distribution system or not" (MPSC). The small residential wind turbines considered in this study fall under MPSC's definition of distributed generation. Large turbines developed at the vacant industrial site type along the Detroit River also qualify as distributed generation if the power they generate is used within the neighborhoods of Southwest Detroit.

The final regulatory authority with possible jurisdiction over wind energy projects in Southwest Detroit is the Michigan Independent Transmission System Operator (MISO). MISO is one of several non-profit regional transmission organizations authorized by the Federal Energy Regulatory Commission in 1996 as a method to provide non-discriminatory access to transmission (US FERC 2010). The issue of non-discriminatory access is especially important in power pools where demand is very near the level of supply capacity, and where agreements that favor transmission to certain utilities over others can lead to major power disruptions. Such was the case with the California power crisis of the mid 1990s, which led to FERC's promulgation of Orders 888/889 requiring non-discriminatory access to transmission in 1996 (OASIS 1996, ¶ 61,078, at p. 61,078). MISO regulation will not affect small-wind projects that provide electricity on-site. However, any project that seeks to install large-scale turbines to distribute electricity commercially through the grid to either customers in the neighborhood or elsewhere will require applications to MISO. Since a non-profit organization like Southeast Detroit Environmental Vision (SDEV) would need to partner with a private utility for such a project, the private utility would handle such regulatory requirements. Although this step of the development process will add a bit of time before a project can begin operation, SDEV or other Southwest Detroit stakeholders do not need to take MISO oversight into account when making a decision about what path to take with respect to the future of wind energy generation in the neighborhood.

Conclusions

After assessing the feasibility of wind energy projects for three alternative site types in Southwest Detroit, we found that installing large wind turbines on vacant industrial sites along the Detroit River is the most promising method for integrating wind energy into the area. In pursuing wind energy generation projects within the community, we recommend Southwest Detroit take the following actions:

1) *As a community, determine/identify a vision for the environmental, economic, and social benefits that wind energy projects should bring to the community.*

Given the considerable effort it will take to successfully implement a neighborhood wind energy plan, Southwest Detroit residents and stakeholders must decide the benefits they wish to receive as the result of attracting wind turbines to the area. During this process, residents should be aware that wind energy development is not a foregone conclusion. The decision to not pursue wind energy would be a reasonable outcome of the visioning process. We recommend community engagement strategies such as focus groups to facilitate community involvement in determining a vision for wind energy in Southwest Detroit.

2) *Conduct thorough studies of wind conditions on specific vacant industrial sites along the Detroit River to ensure that economically viable energy generation is possible.*

The average wind speed at a height of 264 feet (80 meters) in Southwest Detroit is 6 m/s. Wind speeds of 6.5 m/s and greater are generally considered suitable for wind development. Therefore, the use of anemometers at potential locations is needed to determine the site-specific wind resource. If average wind speeds at a height of 264 feet are not at least 6.5 m/s, an alternative location should be studied. If average wind speeds are below 6.5 m/s throughout the area, Southwest Detroit should not pursue wind energy.

3) *Secure the passage of municipal legislation to provide consistent procedures for the approval of large-scale wind turbines, while addressing environmental, safety, and aesthetic concerns.*

Detroit has neither adopted nor considered a local wind energy systems ordinance or zoning amendment. Existing zoning code provisions that address height, setback, noise, and use parameters for general structures in Detroit would apply to any proposed wind energy project in the City. Based on wind resource availability, the most feasible option for installing wind energy projects in Southwest Detroit involves the construction of turbine towers reaching heights of at least 264 feet (80 meters). Towers built to such heights conflict with Detroit's existing zoning code. This conflict would require every developer to apply for a variance for project approval--a process that is unpredictable and often drives developers to invest their money elsewhere. To create an environment attractive to wind energy developers and to ensure that each turbine project meets the safety, aesthetic, and environmental standards of area residents, Southwest Detroit should pursue the passage of a stand-alone wind ordinance or a wind-specific amendment to the zoning code.

4) *Determine a financing scheme that will allow Southwest Detroit to attract an appropriate industrial, commercial, or institutional partner to develop large-scale turbine projects that will deliver mutual benefits to the partnering entity and the community.*

There are four general methods that Southwest Detroit may employ to finance such a project: loans, tax credits, grants, and tax increment financing. Among available grants, Michigan's Low Income Energy Efficiency Fund (LIEEF) grants are particularly suitable for financing wind energy projects. LIEEF grants provide funds for efforts that provide conservation and efficiency measures to decrease energy costs for low-income persons. Many Southwest Detroit residents are low-income persons, and a wind energy project in Southwest Detroit has the potential to lower their energy costs.

This feasibility study can serve as a starting point for a discussion among community residents about the potential for wind energy projects in the neighborhood. Wind turbines and wind energy projects come in a variety of shapes and sizes. Every turbine design, blade configuration, and generation capacity brings with it specific benefits and costs. The generation capacity and design of a specific turbine determines the site conditions that are most appropriate for its installation. Because of the wide variety of available turbine technologies and their related siting considerations, the development of large-scale turbines on vacant industrial sites along the Detroit River is the most viable wind energy option in Southwest Detroit.

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