A Green Energy Village in Detroit's Eastern Market: Establishing a Strategy for Scalability and Integrated Assessment

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[1] Dr. Bai accepted a position at another university shortly after the project was funded. He was replaced by Dr. Wencong Su, who has remained on the project.
[2] Dr. Newell had to drop off the project soon after it was funded because of too many demands on his schedule.
[3] Dr. Newell was initially replaced by Dr. Tony Reames, but he also had to recuse himself due to other commitments.

Project Summary

The goal of this project was to build an interdisciplinary team of researchers from UM-Dearborn (UMD) and UM-Ann Arbor (UMAA), working with community partners CAN Art Handworks (CAH) and Eastern Market Corporation (EMC) to evaluate the potential energy output, environmental impact, and socioeconomic benefits of a proposed Green Energy Village (GEV) demonstration project to be established within the Eastern Market District in Detroit. The first phase of the project involved the installation of two unique hand-built windmills within the Eastern Market District, one on the public plaza outside of Shed 5 on Russell Street and the other located in the Market Garden urban farm adjacent to the Dequindre Cut entrance at the intersection of Wilkins and Orleans Streets. These highly flexible windmill designs, fashioned from used truck axles, satellite dishes and other found objects and materials through a process called 'upcycling', had several functions: to provide charging stations for public use in the Market, and to serve as an alternate source of electricity in the Market Garden. The second phase of the project involved testing the energy output of the wind turbines in each site. The third phase of the project involved public demonstrations and community engagement concerning the potential applicability of the wind turbine design in institutional and community settings around Detroit as well as in other resource-stressed communities. In the course of the year-long partnership, several clear outputs were produced. In addition to both wind turbines being successfully installed, the collaboration achieved the following: 1) a patent application was submitted to the Wayne State University Patent Procurement Clinic for the wind turbine design, protecting CAH's intellectual property throughout the experimental public installation phase; 2) a set of standardized schematic diagrams were produced, enabling the production of electrical storage units for future installations; 3) measurements of wind power output were taken from one of the public wind turbines and these were modeled using MATLAB™ and incorporated into a research poster produced by UM-Dearborn engineering students and shared with CAH; and 4) community engagement activities related to the wind turbines were carried out throughout the year, producing both insights and connections for CAH. In terms of outcomes, the feasibility of the Low Altitude Wind Turbine as an off-grid sustainable energy source was established with the generation of hard data, and challenges to scaled-up production and widespread public installation as proposed in the original GEV concept were also identified.

Background and Approach

This project sought to address multiple interconnected challenges faced by post-industrial cities such as Detroit, especially those related to energy, environment, employment and equity. In spite of recent investment in the city's downtown core and a few other areas that have been targeted for growth and development, much of the city continues to suffer from concentrated unemployment, lack of opportunity, inadequate educational and transportation systems, the detrimental environmental impact of concentrated industrial production, and aging water and energy infrastructure. Widespread blackouts serve as regular reminders of the grid's fragility. Significant state-level reinvestment in public services and spaces would be an ideal response to these interconnected crises, but such a commitment has not been forthcoming.

Carlos Nielbock, master metal craftsman and founder of CAN Art Handworks (CAH), began developing his low altitude wind turbine---now known as the Detroit Windmill—to address challenges posed by this environment. Detroit Windmills would be constructed locally from castoff materials, creating jobs and teaching useful skills to urban youth who are alienated from the educational system, while generating energy locally, making people less dependent on systems that had failed them. In 2017, Nielbock entered into partnership with the Eastern

Market Corporation (EMC) to install two of the windmills in public spaces. EMC embraces a model of inclusive redevelopment, and its geographical proximity to Nielbock's CAH workshop on Wilkins Street made this a natural extension of each partner's mission and purpose. When the Catalyst Grant was awarded, plans were already underway to install the first two windmills, and CAH wanted to explore expanding this concept into a larger demonstration project, tentatively called the Green Energy Village (GEV). The original goal of the Catalyst Grant was fairly straightforward: the formation of a multidisciplinary research team that could both measure the energy output for the first two windmills and define necessary criteria for the scaled-up GEV concept.

External Partners

CAN Art Handworks (CAH) is a small family-owned company directed by master metalworker Carlos Nielbock, while Eastern Market Corporation (EMC) is a nonprofit management and economic development corporation that also hosts the Murals in the Market, one of the top five mural festivals in the world, according to *Smithsonian Magazine.* The combination of art, design, and environmental sustainability represented by the GEV Project fits perfectly with the EMC vision of a revitalized food district based on values of cultural authenticity and development equity. In the fall of 2018, CAH and EMC moved their partnership forward with the awarding of a second Knight Arts Challenge Grant for the Detroit Gallery of Metals project. UMD and CAH also continued their partnership, potentially involving multiple faculty and a campus installation of a wind turbine. In the course of the year-long project, several potential corporate community partners for pilot projects and public installations were identified, including the Fiat Chrysler Jefferson North Assembly Plant, Dassault Corporation, Walker-Miller Energy Services, Chandler Park Conservancy, EcoWorks, and Feedom Freedom Farms.

Activities and Process

We began our process by convening a series of meetings using a Design Thinking format involving the community partners and members of the research team on site at CAH and EMC, and on the campuses of UM-AA and UM-D, in the summer of 2018, followed by a community engagement session at Eastern Market. In the end, we conducted multiple meetings at all of these settings, except for UM-AA, due to the distance and the lack of involvement by UM-AA faculty, as well as community engagement session at the Eastern Market in February 2019. The project received several extensions due to changes in personnel within the community partner organizations as well as the University team, and also due to shifting external factors related to everything from building permits and contractor availability to weather conditions and site accessibility. The principal investigator became involved in almost every dimension of the windmill project, from securing salvaged materials to identifying electrical engineers and electricians, writing proposals, and coordinating events and installations. A great deal was learned from this process, though it did not follow the course outlined in the original proposal. The university investigators certainly came to appreciate the challenges faced by small businesses working close to the margins in the creative fields.

Findings

As stated above, the Green Energy Village (GEV) project sought to address the intertwined challenges of access to renewable energy (i.e. energy justice), resource recovery (i.e. upcycling), and workforce development (i.e. manual arts) though furthering development of a pilot project between CAN Art Handworks (CAH) and Eastern Market Corporation (EMC) and bringing the University's research capability bear on establishing the feasibility and scalability of

this project. We did establish the potential of the combined wind/solar design of the Detroit Windmill to produce consistent power (see research poster, in **Appendix 1**), although we were not able to complete the comparison to the commercial wind turbine due to electrical contractor availability. We also generated a set of concrete community suggestions for potential uses of the windmill as well as questions for future research (see **Appendix 2**).

Outputs, Outcome & Impacts

There were several concrete outputs from this partnership, including the installation of two of the wind/solar devices in Eastern Market District (Shed 5 Windmill in September 2018 and the Garden Windmill in October 2018), the submission of a patent application protecting intellectual property for CAH, and the development of a replicable schematic diagram for the electrical production and storage system for the Garden Windmill, and a research poster produced by engineering students as part of the National Science Foundation-funded Research Experiences for Undergraduates (REU) program supervised by Dr. Draus and Dr. Su in the summer of 2019. The principal investigator also contributed to a Knight Arts Challenge grant proposal for the Detroit Gallery of Metals (funded for $100K match in late 2018), and proposals for two Kresge Placemaking grants on Detroit's East Side, one focused on Chene Street and the other at Chandler Park (both unfunded). Other outputs took the form of public presentations (Sustainable Detroit Forum, October 2018); feedback sessions (Eastern Market Shed 5, February 2019); community benefits meetings (Boggs Center, July 2019); student internship programs (EcoWorks Youth Energy Squad summer 2019), panel discussions (Detroit Design Month September 2019); and informational displays (Sustainable Detroit Forum, October 2019). Dr. Draus also included a section on the Detroit Windmill in a book chapter for an upcoming edited volume entitled *Sustainable Responses of UNESCO Cities of Design.* The **outcomes** of this project included the establishment of a community-based collaboration involving multidisciplinary UM researchers engaged with linked sustainability issues in Detroit, and an enhanced understanding of the challenges confronting such locally-based sustainability solutions. We have a revised set of goals and questions related to efficient electricity production, storage and manufacturing supply chain costs that will be the focus of upcoming collaborative research involving CAH and UMD. Our long-term goal remains to secure external funding for large-scale implementation of a pilot project to implement multiple Detroit Windmills in resource stressed areas. The long-term impact will be the establishment of the GEV and the achievement of affordable, localized sustainable energy production, enhanced grid resilience, and equitable economic development.

Budget & Personnel

As noted above, several changes were made to the budget, timeline and personnel as the project proceeded. Some funds were reallocated to cover costs incurred by CAN Art Handworks for providing equipment, personnel and meeting space. In addition to the shifts in faculty committed to the project, we had several changes in student research assistants on the University end, and there were also personnel changes at CAN Art Handworks and Eastern Market Corporation. Over the course of the project, research assistants included the following: Adetokunbo Ajao; Shannon Haupt; David Liang, and Priya Ganesh. On the CAN Arts side, consultants who worked on the project included Tom Kim, Kegan Scannell and Arthur Bledsoe. Janai Gilmore, Tanya Stephens and Belinda Nielbock all served as project managers. Tony Biundo was the invaluable contractor who poured the cement and helped with every other aspect of windmill installation. Mike Conshafter of Advantage Electric also provided consulting services for the project. At EMC, Lydia Levinson worked on the project through the Fall of 2018, and David Tobar was involved with the project throughout its duration.

2019 NSF REU Site: Undergraduate Research in Sustainable Energy (U-RISE)

Low Altitude Wind Turbines

Faculty Advisor: Dr. Paul Draus, Dr. Wencong Su

REU Students: Priya Ganesh, David Liang

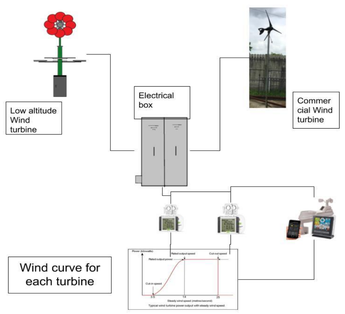
Background:

- Detroit-based craftsman inventor Carlos Nielbock has developed low-altitude wind turbines, built from upcycled materials, the blades of the turbines are made from satellite dishes and the posts from lamp-posts.[1]
- These turbines could provide a localized source of wind power that would also be manufactured in the city of Detroit.
- Currently there is one turbine mounted in the Market Garden of Eastern Market and one turbine mounted near Shed 5 at Eastern Market.

Approach:

- By observing power output of these turbines, the feasibility of replacing commercial turbines with CAN Arts Low-Altitude Wind Turbines can be assessed.
- Power output data must be collected, and data must be compared to the power output of commercial wind turbines.
- Data Analysis can be used to determine whether CAN Art Handworks' Low Altitude Wind Turbines are capable of producing enough power to be consistently dependable for users as well as whether they are a marketable commercial replacement.

Figure 1.
Schematic shows data collection process for experiment described above



Methods:

Collection:

- There is currently an Arduino installed in Market Garden Turbine being used to collect power output data.
- Data has been collected per second including power output, voltage, current, along with wind speed/RPM capabilities in one week increments.
- The data can be compared to local wind speeds, making it useful for estimating general specifications of CAN Arts Wind Turbines.

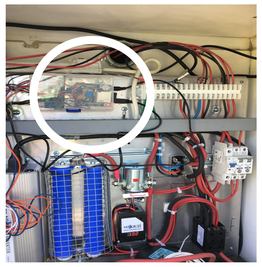


Figure 2. Arduino currently collecting data in Market Garden Turbine, indicated by white circle

Comparison:

- In order to compare power outputs between CAN-Arts Low-Altitude Wind Turbines and commercial turbines, two turbines need to be selected, power output measured, and data analyzed.
- In order to accurately address outside factors affecting the turbines, weather conditions in the spot of power output testing.
- A commercial turbine and a weather station have been installed on a tower near Eastern Market, near multiple Low-Altitude Wind Turbines at CAN-Art Handworks in Detroit.

Figure 3.
NPower commercial turbine being used in experiment

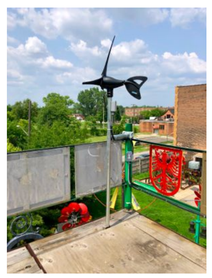


Figure 4.
Shows installation mechanism of commercial wind turbine

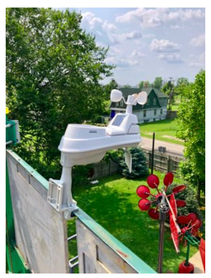


Figure 5.
AcuRite 01036M Wireless Weather Station used for wind speed data

Findings and Future Work:

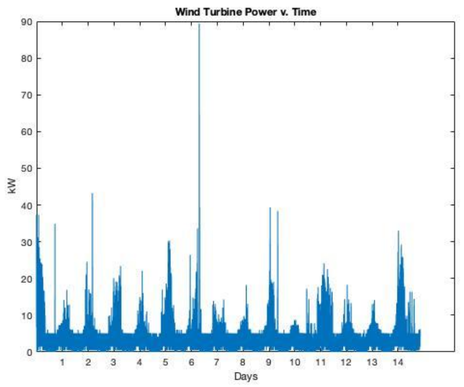


Figure 6.
Original data set of only wind power between 7-11-19 and 7-18-19, only graphs power output being read by Arduino in Market Garden Turbine

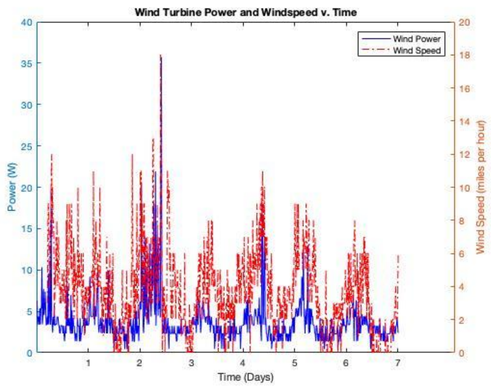


Figure 7.
Data set of wind power and wind speeds between 7-18-19 and 7-25-19, showing that wind power and wind speeds relate closely and correlate, with about twice as much power (in W) being produced as wind speeds (in mph)

References:

[1] Nielbock, Carlos. "A Fully Sustainable, Upcycled Wind Turbine + Microgrid. Made in Detroit." *DETROIT WINDMILL*, CAN Art Handworks, detroitwindmill.com/.

Acknowledgments:

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Appendix 2: Community Input

How would your community use a wind turbine?

- Get some batteries from busted electric cars and power my house
- Power space heaters in basements for winter so pipes don't freeze
- Electrical uses (low level)
    - Charging (i.e. cell phone)
    - Warming station
    - Small scale events (i.e. readings, meetings)
- Provide power for events hosted at our site that would include:
    - Air compressors (bounce house)
    - Stereo and speakers
    - Popcorn machine
    - Cell phone charging
    - Projector (movies)
    - Security lights
- Power small parks in neighborhoods
- Power neighborhoods with a lot of empty property (for security)
- Provide power for irrigation for my urban farm and charge my tools and maybe a heater for my small greenhouse
- Use as an energy source for a community development space
- Security in common shared area (lights, communication, cameras, etc)
- Efficient (faster) composting
- I would use the turbine to power the light that may be put in our park
- As a backup generator to individually get off the gride
- To service our vineyards
- Highland Park Street Lights!
- As a marketing tool

How can we make this project inclusive & accessible?

- Focus on outreach towards community focus. Focus on access to materials and relationships to spread more interest
- Provide information to neighborhood organizations (i.e. block clubs) who have land available to assist with this project
- Create a neighborhood/affinity networks organizing strategy to invite and engage broader Detroit audiences in this conversation
- Go to neighborhoods and have this workshop
- Cost sharing options to plug in
- Make large scale investment opportunity for the public small scale investor instead of large scale or multinational corporations
- Offer the template of what are requirements for a llc/co-op group to be ready to build systems and sell
- Develop community/collective purchasing programs that local municipalities could potentially put money toward
- Develop workforce/trade skills curriculum (maybe certifications?) that participants would receive and that can transfer to other employment opportunities

- Give people information about the turbines, have them pass it on
- There needs to be a stronger marketing campaign and community outreach
    - What is the cost?
    - What are the benefits?
    - Can the windmills be customized?
    - Where are the best locations?
- Documentation of process and findings: making this information available to public, community groups, block clubs, etc.
- MANY future community sessions needed to EDUCATE how, why, where, this amazing device is needed in our city
- Structure the business model in such a way that for each turbine purchased privately by businesses, or individuals finance one turbine to be built for a neighborhood or community based application in which the community that receives the turbine supplies labor/support to build it and in the process learn hands on skills

What's in it for me?

- Partnership to further the science
- Reduce Energy Cost
- Partnership I guess; help place in different neighborhoods who could use them
- Reducing my energy bill and my carbon footprint
- Creating a more green environment :)
- A reliable resource for power (not dependent on the grid or $)
- Learning opportunity (more understanding, new skills)
- How can I as an individual + as a part of a community in this project? How can this project be funded by THE PEOPLE?
- Less cost on energy
- No electric bill
- Power my home
- Partnership, educational experience, improvement on environmental focus
- Gathering future potential for mass expansion and innovative idea
- It's aesthetically appealing, a conversation starter and an engaging tool for community building
- It's something that brings the community together, that sparks wonder, curiosity, innovation, and inspires people to think outside the box when it comes to developing and caring for their community
- Reduced DTE bill
- Energy for power outtage
- Reduced operating costs, possible jobs for affordable housing and residents
- Possible co-op development project(s)
- Community engagement, vibrancy
- Neighborhood sustainability

What are we missing?

- The step between (community organizing and technical knowledge) and (full blown energy coop + microgrid wind turbine education system + community)
- Advertisement
- Energy measurements (input and output)
- Getting more people involved
- Youth voice
    - Youth's ability to give ideas and perspective
- Different colors :)
- Cultural organizing and awareness campaign
- More advertisement, possibly give info to city council so they can share with community leaders and spread the word. This would be great for many areas. Thank you for having this :)
- How long does it last?
- What is the cost to maintain it?
- What is the cost of replacing or upgrading?
- Beautifully crafted and aesthetically appealing
- Specific asks to the community; how can people get involved? There's a lot of interest but don't want to lose momentum if people aren't able to participate in some way
- Everything was perfect, we just needed more heat
- Finding an existing inverter - hybrid system component that can handle the spec requirements while being grid ready
- Looking into building custom battery packs that operate on level of a powerwall - what are specs (design) that can allow you to not have to fully discharge (mimic or design to standard)
- Your own business modelling for sustainability, freedom from grant funders.
- Understanding costs to produce windmill
    - Recycled items
    - New items
    - What is base costs to produce?
- How this work can connect with other sustainability and community building projects → connecting to neighborhood wide planning efforts and understanding how wind energy contributes to more resilient communities
- Open source designs → share the opportunities for others to double your impact and encourage creativity & variety