THE OHIO STATE UNIVERSITY

Onsite Renewable Energy Incentives

Green Memo III: Action B.2

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School of Environment and Natural Resources

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EXECUTIVE SUMMARY:

Based on our interests in sustainability, our group elected to research the Green Memo III action B.2 Project 3, which is to "create an incentive program for onsite renewable energy systems for residential and/or commercial buildings" for the City of Columbus (Green Memo III, 2015). This action intended to contribute to the overall goal of objective 2 in the Energy portion of Green Memo III. This objective is as follows, "Increase the mix of energy consumed from renewable sources to 10% over the next five years" (Green Memo III, 2015). We were given four months to research, collect data, and make recommendations to the Mayor's Green Team for how this action could be accomplished. Our group consisted of 5 senior students, Colleen Bloss, Ali Clunk, Rayan Harfouche, Vanessa Lopez and Rebecca Mellino, who attend The Ohio State University's School of Environment and Natural Resources. An onsite renewable energy incentive program is just one of nine actions listed in the Green Memo to achieve its objective 2 goal. To narrow the scope of this project, we decided to focus on solar as our renewable energy choice, as it is best suited for this region of Ohio in terms of solar kilowatt hours (kWh) available and cost effectiveness. We then identified 3 objectives to research in order to make the best possible recommendations on how to achieve this action:

- Research Midwest city sustainability plans as examples to recommend an incentive and marketing plan for onsite energy systems that is well suited to Columbus's goals.
- Evaluate the minimum amount of onsite solar installations needed to meet the goals in Objective 2 of Green Memo III.
- Determine the cost savings of a renewable energy incentive program to the City of Columbus and its residents.

The first objective was completed using internet resources and various in-person, email, and phone interviews. The information for our second objective was obtained by utilizing the International Council for Local Environmental Initiatives (ICLEI) carbon calculator tool, provided by the City of Columbus. We drew our results for the third objective by completing an analysis of the monetary cost savings of renewable solar energy installations and the payoff over time. Our recommendations include encouraging energy audits to improve energy efficiency, taking advantage of the current state and federal incentives before their expiration in 2016, and implementing a community aggregation strategy based on the Chicago, Illinois model.

INTRODUCTION:

Our team looked to find ways to implement an incentive program for renewable energy for the City of Columbus and to make a recommendation for the next steps the city could take to achieve their goals. In order to give accurate information to the Mayor's Green Team, we were encouraged to utilize the ICLEI carbon calculator to estimate the carbon outputs for different scenarios by the year 2020. The city has opted to use this tool because it stores their energy consumption information and allows users to run scenarios on how different reduction strategies can impact the city's carbon emissions. The ICLEI calculator uses current and future energy consumption patterns for Columbus, Ohio, to estimate carbon output for both the residential and commercial sectors, making it an effective tool for our scope of analysis. We were also advised to examine other energy programs across the country in order to understand how to create a similar plan for the City of Columbus. Both of these methods of research enabled us to come up with recommendations for the Green Team about how it would be possible to make onsite renewable energy incentives a viable option for Columbus.

The overall goal in our portion of Green Memo III was to decide if onsite renewables would be feasible for Columbus as an effective tool for reducing carbon in the future. We then decided which programs would be recommended to implement this action. After deciding on solar energy, we determined the following three objectives to focus on: 1) find examples of other renewable energy programs from other Midwest cities to study, 2) collect data specific to Columbus, Ohio, to measure the impact on carbon output using the ICLEI calculator, and 3) examine the cost savings to the city by investing in renewable energy programs. These are important components of the project to answer questions about the feasibility of implementing an onsite renewable energy program in Columbus. Our research indicated that it would not only be possible to implement onsite renewables in Columbus, but that it would also be highly beneficial and efficient in reducing the amount of carbon emissions from the residential and commercial sectors by 2020.

The choice to focus on solar energy rather than geothermal or wind energy was decided because both geothermal and wind energy cost more than photovoltaic solar panels in terms of material and installation fees. It was also determined that in most other metropolitan and residential areas, solar energy has had the most success as an incentive program. Solar panels have a less invasive installation process than geothermal wells, are more aesthetically pleasing, and take up less space than wind turbines. These are important considerations to take into account when working in the urban region of Columbus. When many people think of solar energy, they think of the leading country in solar installations and renewable energy generation, Germany. Contrary to popular belief, Columbus has more solar potential than the entire country of Germany (Figure 1). The decision to focus on solar energy helped us to be more specific in

our project and to be able to effectively compare other programs in the Midwest that also utilize solar energy programs.

For the first objective, we researched cities in the Midwestern United States that have created successful renewable energy programs. This included projects in areas as large as Cleveland, Ohio, and Chicago, Illinois, and as small as Athens, Ohio and Clintonville, Ohio. Chicago proved to be the most influential in our research, as it has a very successful and unique large scale program. In our second objective, we used the ICLEI calculator to establish a baseline analysis for 2020 if no renewable energy was utilized. We then compared the baseline to six different scenarios including a highly optimistic case of a 6% reduction in both the residential and commercial sectors, as well as a reduction of 6% and 3% in each sector alone. For our third objective, we considered the cost savings to Columbus if solar was implemented by looking at the cost of photovoltaic solar panels and the savings in utility bills by the owners. The reduction in carbon outputs from using solar energy was also calculated.

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OBJECTIVE 1:

Research Midwest cities' sustainability plans as examples to recommend an incentive and marketing plan for onsite energy systems that is well suited to Columbus's goals.

i. Methods:

Research began online to identify cities similar to Columbus in solar hours and population. We found large and small scale programs in Columbus suburbs, different Ohio cities, and other cities throughout the country that undertook the expansion of onsite renewables in the form of solar energy in a variety of unique ways.

ii. Means of data collection:

Our group reached out to solar energy groups in the Midwest with populations similar to Columbus to find information and to learn from professionals about their expertise. The information we gathered was through personal interviews, emails, and phone calls. Our data collection was as follows:

- In person interview with Clintonville co-op members Greg Pace and Eugene Cherry.
- In person interview with Sarah Straley, at Ecohouse Solar, a Columbus solar installer.
- Phone interview with Roger Wilkens, a leader of the aggregation programs in Athens County.
- Phone interview with Matthew Gray from Sustainable Cleveland, representing the City of Cleveland.
- Email communications with Michael Berkshire of the City of Chicago who gave us a report on the current solar program of Chicago.

iii. Data collected:

The Clintonville co-op is a small scale group of individuals who live in the Clintonville neighborhood and install solar panels on each other's houses at a lower cost than professional installations. They had a unique beginning because a professional energy installer who lived in the neighborhood was interested in changing his career to be more focused on renewable installations. This professional installer believed in the Clintonville Co-op's idea of "backyard solar" and was essential in their projects when tying the systems into the grid and connecting them to a battery back-up. We gathered that the structure of the co-op worked because of how small scale the program was. The members we interviewed said they were not interested in expanding the scope of the group because of the tight knit community that exists. The members currently feel a sense of responsibility to continue to help the others because of the relationship.

One of their main goals is to have at least one solar installation on every street in Clintonville, to create visibility and to encourage neighbors to support the cause.

Sarah Straley, who works at Ecohouse Solar, provided information on what the typical solar panel installation would look like on a house in Columbus (Figure 2). The information provided us with knowledge on how their company advertises solar panels to an interested resident. She explained that their average installation on a home is a 6.7 kW system. Sarah Straley explained that the lifespan of solar panels coincides with the lifetime of a roof, so the two projects should be done around the same time period. While discussing costs and benefits of the system, she presented the broad issue with their solar installations is that their customers do not seek them out because they are concerned with cost savings, but rather because they care about their carbon footprint and the pollution they are creating from their traditional electricity consumption. She hopes to see conversions because of cost savings because that would pertain to a broader audience than the environmentalists that all of their customers have been.

Roger Wilkens provided us with information on how the residents of Athens County passed a law to allow community aggregation. He explained that the aggregation program was loosely based on the plan in Cleveland, Ohio, and one of its main goals is to deregulate the electric utilities. They created the Southeast Ohio Public Utilities Council (SOPEC) and had companies bid on providing renewable energy to their group as a public utility. Empower Energy and Gas won this proposal process and will be helping the energy council to coordinate the installation of a solar farm at an old landfill site. Roger disclosed that the planned site would provide energy to 324 homes in the SOPEC area.

Matthew Gray of the City of Cleveland explained the type of community choice aggregation program they have. This program allows residents to choose whether their energy

was provided from one hundred percent renewables, conventional energy sources, or if they wanted to opt out of both programs entirely. If customers chose the renewable aggregation program they saved up to 21% off of their electric bills, and if they chose conventional sourcing, they saved 24%. This is provided by the local energy provider, FirstEnergy and will be renegotiated this summer. The high savings from this program are likely to be changed to a smaller percentage.

The City of Chicago provided the outline for their sustainability plan. A component of their plan involved the development of the Solar Chicago pilot program. The City launched the program in July 2014 with the goal of advancing the adoption of residential solar photovoltaic systems by lowering the costs through a group buy-in model. The group buy-in model allows for a continuous drop in pricing as more customers sign solar contracts. Overall program components consisted of tiered group buying discounts, community outreach through participating towns and organizations, a selected solar installation team, and a program offer end date that motivates customers to take action. Results for the Solar Chicago program included 156 signed solar contracts, over 660 Kilowatts (kW) of total contracted solar photovoltaic installations, and a cumulative savings of over $850,000 with the average customer saving $5,600 off of the installation of their system.

iv. Data analysis:

We used the information from the Clintonville Co-op to see how successful a small scale program could be. They introduced us to the small scale management system of time banking. Time banking is a system that keeps track of how many hours of work members donate to projects and they are then able to redeem those hours for help with projects of their own. While we ultimately decided not to include this as part of a recommendation to the City of Columbus, it

is a very effective platform for small scale projects and could be introduced to an interested neighborhood in the City of Columbus.

The collaborative group in Athens County and the City of Cleveland provide large scale examples of how the City of Columbus could aggregate their energy demand and advertise to a company to bid on a project to provide their energy from a renewable source. Community aggregation programs are allowed by law in Ohio, though it is just one of six states where this law has been passed. The case studies research provides an insight to the variety of programs that are available as options to the City of Columbus. The City of Chicago's group buy in program could be well suited to the City of Columbus. It would make solar energy available to a larger group of customers because of the discounted cost and would benefit the business community with increased business. Since community engagement is important to the City of Columbus, the Chicago model of a group buy in program could be very effective because of their focus on outreach through church and community groups. The cost of this program would be minimal because discounts come from bulk purchasing of supplies through companies that already exist in Columbus and would have a specific timeline of completion. This is also suitable to the 2020 timeline.

OBJECTIVE 2:

Evaluate the minimum amount of onsite solar installations needed to meet the goals in Objective 2 of Green Memo III (increase mix of energy consumed from renewable sources to 10% over the next five years).

i. Methods:

This objective relied heavily on the use of the ICLEI calculator tool. This tool is able to calculate Greenhouse Gas (GHG) emissions based on electricity consumption. The electricity

consumption is input into the ICLEI database from the energy providers Columbus Municipal Power, American Electric Power, and Columbia Gas. The calculator tool can also use different growth rates to show projections of GHG emissions into future years. Once a baseline is estimated, different planning scenarios aimed at reducing consumption and GHG emissions can be applied and projected.

ii. Means of Data Collection:

We collected information on what type of data is stored in ICLEI for the City of Columbus and learned what we could do with it through conference calls with J.R. Killigrew, a customer service representative for ICLEI's corporate members. As noted above, the input variable of consumption in ICLEI comes from the electricity providers of Columbus Municipal Power, American Electric Power, and Columbia Gas.

iii. Data Collected:

The ICLEI calculator was used to project a baseline and six different planning scenarios. These scenarios included two looking at improving the residential sector alone, two improving the commercial sector alone, and two using a combination of both sectors. The City of Columbus would like to have 10% of their energy consumption coming from renewable sources by the year 2020. As of 2013, they had met 4% of this goal, meaning an additional 6% needs to be added. Energy consumption is measured in kWh and the energy production possibility, or the solar potential from an individual's solar panels, is typically measured in kW. For this reason both forms are given in the data. To find that 6% consumption reduction, the total kWh were added up from each electricity provider in the respective commercial and residential sectors. This proved to be a total of 7.88 million kWh in residential consumption and 11.87 million kWh the commercial sector. These total kWh consumed were used to find a total reduction of 6% in

each sector as well as a scenario with a 3% reduction in each sector. These calculations can be found in Figure 6.

The ICLEI tool was able to account for the specific potential of photovoltaic solar panels in the Columbus region, giving more accurate results for reductions in GHG emissions. The reduction of GHG is calculated in CO2 equivalent (CO2e). This converts all of the different GHGs like methane and nitrous oxide to one single number, making overall consumption easy to compare.

The following data show a reduction in the residential sector alone. In the 6% reduction scenario, total kWh reduced needs to be 472,783,800 kWh. This translates to a total of 53,971 kW installed. This would also reduce GHG emissions by 995,188 metric tons (MT) of CO2e annually. In the 3% reduction scenario these numbers are half as much, meaning the total kWh needed to be reduced is 236,391,900 kWh or 26,985 kW installed and a prevention of 497,594 MT of CO2e.

In the commercial sector data there were again two scenarios, 6% reduction, and 3% reduction in consumption. A reduction of 6% commercial alone would require 712,189,560 kWh, or 81,300 kW. This would prevent 1,563,357 MT of CO2e from entering the atmosphere. In the commercial scenario using a 3% reduction strategy, a total of 356,094,780 kWh needed to be reduced, or 40,650 kW. This would save 781,679 MT of CO2e from being emitted yearly.

A reduction in both sectors would help spread the investment costs between the two. A reduction of 6% from both sectors was calculated, needing a reduction of 1,184,973,360 kWh or 135,271 kW. The reduction in this scenario would reduce emissions by 2,558,546 MT of CO2e. This scenario would achieve more than what was wanted from Green Memo III. Calculations from a 3% reduction from both sectors found a reduction of 592,486,680 kWh or 67,635 kW. By

making these reductions a decrease in emissions of 1,279,274 MT of CO2e will be gained. The calculations of total kWh for each sector as well as the reduction in total consumption can be found in Figures 3 and 6. For a visual of the reduction in GHG, Figure 4 shows the data of each sector and scenario in graph form.

iv. Data Analysis:

The installation of different amounts of solar panels could help to reduce carbon emissions as well as work to meet the goal of 10% renewable sources in Green Memo III. The kWh stated earlier give a total amount that would need to be added in order to meet this overall goal. This could be achieved in three different ways.

The first of these options would be to implement a program similar to the one mentioned previously in Chicago. The average household in Columbus installs about 6.7kW of solar on their home. For the 6% reduction, this would mean that 8,055 households would need to install a system of 6.7kW. For the 3% reduction, a total of 4,028 homes would be required. The number of houses needed for this program could change depending on the amount of solar installed on each house. If a house added a higher kW system, fewer houses would need to participate, and if a house installed a smaller kW system, then more households would need to participate. The range for commercial rooftop solar installations covers 10 kW to 300 kW systems. This wide range comes from the energy intensity of the business, the amount of roof space, and the amount of money that can be invested. To show calculations for the number of firms that would need to install solar panels, a 40 kW system was chosen as a safe average. This would mean for the 6% reduction scenarios, 2,033 firms would need to participate, and for the 3% strategy, 1,016 firms. A chart of these options can be seen in Figure 3 of the appendix.

Reaching the desired amount of renewable sources does not need to all come from rooftop solar installations. This leads to the second option for creating renewable energy to meet

the Green Memo goal. Reaching the target amount of kW installation could come from an aggregation program with group renewable energy prices like that of Cleveland. An aggregation program investing in acres of solar energy similar to the example seen in Athens is also an option for the City of Columbus, but this may run into the problem of green space needed for such a large project.

The last option to reach the renewable energy sources would be to implement a combination of the programs previously mentioned. This would offer programs for people who are unable to install solar on their rooftops for reasons such as lack of financial ability, poor roof space due to shading or crowding, or limitations of apartment living or renting.

OBJECTIVE 3:

Determine the cost savings of a renewable energy incentive program to the City of Columbus and its residents.

i. Methods:

The monetary values of cost savings were determined after calculating the amount of solar in kW needed to create the desired planning scenarios. These values came from the average savings per kW installed for the first five years up to the year 2020, when this goal is meant to be reached. The estimated cost and payback period of a solar photovoltaic installation for an average house in the City of Columbus was also determined, taking into account solar hours for the region.

ii. Means of Data Collection:

Our group had an in person interview with Sarah Straley, who as previously mentioned works at Ecohouse Solar, a Columbus solar installer. She provided valuable local information about solar installation in the City of Columbus found in Figure 2. We were able to use these

valuations to determine the cost of the different situations associated with multiple amounts of solar installations from 2015 to 2020.

iii. Data Analysis:

The solar PV Economics and Returns table, Figure 2, is a cost estimate and payback period for an average house in the City of Columbus, taking into account solar hours for the region. We were given this data based on a 6.7kW installation, which is the average size for a typical PV installation in Columbus. This came from Columbus's Ecohouse Solar, based on data they have collected from numerous installations. The total cost of this system is estimated at $23,990 but after various incentives and benefits offered by the government, the cost could be reduced to $16,793. Within the first year the system is estimated to save $1,322, and over the course of 25 years $55,809 can be realized in net savings. This information is illustrated in Figure 2. It takes 8.8 years for the average household system to pay for itself.

The residential and commercial values of costs savings in utilities per year were calculated for all of the reduction strategy scenarios. In the first of these scenarios, 6% in residential alone can save residents $73,175,010. In the case of a 3% decrease in the residential sector, residents could potentially save up to $36,586,827 on utilities over 5 years. For the commercial sector even more savings could be realized. For a 6% and 3% increase in commercial alone, $110,228,23 and $55,114,11 could be saved respectively. Alternatively, a 3% reduction from both the residential and commercial sectors combined would amount to a cost saving of $91,700,946. Figure 5 of the appendix highlights the 5 year savings plan.

All of these cost savings are applied on a household or business level. Once the individual houses and businesses start seeing the benefits from their installations and the cost of the installation being reimbursed, it will encourage other to do the same. The City of Columbus

will have minor costs from a solar installation program. The city will only need to pay the costs of marketing the program to residents and business owners.

CURRENT INCENTIVES:

Our initial research brought to us to explore current state and federal incentives that were being offered in the state of Ohio. We strongly believe that it is important for the City of Columbus to advertise these incentives as they can make installing solar more economically feasible for both the residential and commercial sector. The incentives that we highlighted and that could be useful for the city of Columbus to advertise include:

- Green Energy Ohio - GEO Solar Thermal Rebate Program: Green Energy Ohio (GEO) is offering rebates on residential properties in Ohio for solar water heating systems purchased after April 1, 2009. The rebates are based on the projected energy output from the solar collectors and are calculated at $30 per kBtu/day (based on SRCC rating for "Clear Day/C Interval"). The maximum amount is 20% of the contracted solar thermal project cost. (Green Energy Ohio)
- Qualified Energy Property Tax Exemption for Projects 250 kW or Less: Ohio's Renewable and Advanced Energy Project Property Tax Exemption, enacted with the passage of Ohio S.B. 232 in the summer of 2010, exempts qualified energy projects in Ohio from public utility tangible personal property taxes and real property taxes. Before passage of S.B. 232, a renewable energy facility in Ohio that sold electricity to a third-party was considered a "public utility" for tax purposes. (Green Energy Ohio)
- Energy Conservation for Ohioans (ECO-Link) Program: The Energy Conversation for Ohioans (ECO-Link) program offers Ohio homeowners reduced rate financing for energy efficiency and renewable energy home upgrades. Administered by the Ohio Treasury,

qualifying homeowners are eligible for a 3% loan rate reduction through participating banks. (Green Energy Ohio)

- Energy Loan Fund: The Energy Loan Fund provides low-cost financing for energy efficiency and renewable energy improvements to Ohio-based businesses with less than 500 employees, manufacturers enrolled in the Energy Efficiency Program for Manufacturers, nonprofits, and public entities. (Green Energy Ohio)

Although these incentives expire in 2016, it is still important for the city to make their citizens aware that these are available and can be taken advantage of before their expiry date. This could potentially lead to many households making use of these incentives and thus increasing the amount of homes in the city that use renewable energy as a main source of energy.

RECOMMENDATIONS:

Recommendation 1:

We encourage the City of Columbus to support energy efficiency through energy audits. This suggestion was pinpointed by the energy professionals we interviewed and was considered a vital first step in determining how the City's residents could achieve energy savings. A home energy audit helps owners determine where their house is losing energy and how problems can be corrected to make the home more energy efficient. When determining the energy demand of a home and determining how many solar panels would be needed to meet the demand, efficiency options are often found. If a consumer is considering alternative energy, they are already concerned about their carbon footprint and energy efficiency can be achieved through the use of energy audits through the local providers of electricity (AEP and Columbia Gas offer low cost audits in Central Ohio). By reducing total energy consumed, they will decrease their impact regardless of their source being renewable or nonrenewable. For this reason energy audits could be an extremely beneficial tool to a broader audience in the City of Columbus.

Recommendation 2:

We also suggest that the City of Columbus promote the US Federal Renewable Energy Incentives to reduce the costs of renewable energy installations. As briefly mentioned, through the use of these incentives individual households can claim up to 30% on their renewable energy system. Although these Federal incentives end in 2016, they contribute to large discounts and low interest rate loans and allow for the installation of solar to be more economically feasible to homeowners as well as small businesses.

Recommendation 3:

We propose that the City of Columbus use a combination of community aggregation programs. Using community aggregation programs such as the Chicago Solar Pilot Program and the Athens County Community Aggregation Agreement would allow the Columbus community access to renewable resources and reduce the City's overall GHG emissions. In the example of the Chicago model, local installers are asked to bid on the project and if a certain number of customers sign up to install solar panels, they are able to offer them at a discount rate that is previously agreed on. This model could be replicated in Columbus the same way or depending on competition and demand in the area could work with a number of solar installers so that small business is not excluded.

The Athens County Community Aggregation Agreement provides residents the opportunity for lower electricity rates. As mentioned, the aggregation program works in an opt-out system, where residents who do not wish to participate have a 21-day period where they can opt out of the program. Customers would still receive their bill from American Electric Power, as AEP would still provide transmission services for the electricity and they would also remain the place to call when the power goes out. A community aggregation model similar to the Athens

County model could be created for the City of Columbus, providing the community with alternative energy options.

CONCLUSION:

After conducting the necessary research, six different scenarios were planned with the use of the ICLEI tool. Through the use of this tool we were able to calculate Columbus' GHG emissions based on their current electricity consumption. Different growth rates were used to determine the amount of solar installations that are needed for Columbus to reach its goals outlined in Green Memo III. We determined that through installation of mixed amounts of solar energy installed and the use of different programs, the City of Columbus could achieve its overall goal of increasing the energy consumed from renewable resources to 10% over the next 5 years.

After researching other cities' plans as examples, evaluating the minimum amount of onsite solar installations needed to meet the goals in Objective 2, and determining the cost savings of a renewable energy incentive program to the City of Columbus and its residents, we determined some of the better solutions for the City would be to first advise its residents to conduct energy audits to better improve the efficiency of their energy usage. After this initial step, the City should consider implementing a community aggregation strategy based on the Chicago and Athens models, push for co-op programs based on the one found in Clintonville, and finally encourage everyone to take advantage of the current Federal offered incentives before they expire in 2016. This will allow the City to significantly reduce its GHG emissions as well as save the City and its residents money in the long term, making it both a socially and economically beneficial strategy.

WORKS CITED

Eigel, K. (2014). Solar Electric Investment Proposal.

"ICLEI Global." Retrieved March 1, 2015, from http://www.iclei.org/iclei-members/member-login.html

Johnson, S., & Wochos, S. (2015). Solar Chicago Program Report. 1-17.

LaPorta, K. (2015) Community Choice Aggregation.

Pace, G. (n.d.). Clintonville Cooperative

Roberts, B. (2009). Photovoltaic Solar Resource: United States-Germany. Web. <http://www.nrel.gov/gis/images/us_germany_spain/pv_map_us_germany_spain.jpg>

Wilkens, R. (2014). Athens County Community Aggregation Agreement.

Green Energy Ohio. Retrieved April 20, 2015 from <http://www.greenenergyohio.org/page.cfm>

DATA DOCUMENTATION

Dataset 1: Solar Electric Investment Proposal

Sources: Eigel, Kyle, EcoHouse Solar

This proposal explains how a Columbus homeowner can achieve the best solar investment in terms of system costs, production, and solar product quality. The proposal was based on calculations that were performed on a particular home in Columbus with an average electric usage with a proposed system size of 6.7 kW, an average of 4.2 sun hours, and an annual average electric usage of 10,500 kWh. This proposal was used to help determine the solar PV cost and returns for the average house in Columbus.

Dataset 2: ICLEI Global Calculator

Sources: ICLEI Global website: http://www.iclei.org/iclei-members/member-login.html

The International Council for Local Environmental Initiatives (ICLEI) holds a combined network of resourceful information from over 1,000 cities. Their calculator was a major component for determining our results and recommendations to the City of Columbus. It was used to help determine the impacts of installing rooftop solar on the residential and commercial sectors of Columbus and the minimum amount of solar energy needed with projected CO2 emissions.

Dataset 3: Solar Chicago Program Report

Sources: City of Chicago

This report was developed by the City of Chicago to illustrate the results of their recently developed Solar Chicago pilot program. The report listed a project overview with the steps they followed to initiate the program, community outreach activities, and the outcomes of their project. This report was used to help determine potential costs, issues, and suggestions that could be used for the City of Columbus.

Dataset 4: Clintonville Cooperative

Sources: Greg Pace, Member of Clintonville Cooperative. Email: gpace67@gmail.com

The Clintonville Cooperative was created by a community in Clintonville, Ohio to help increase awareness of renewable energy and to help make renewable energy available to the entire community. The co-op's main goal is to increase the number of houses using affordable, renewable energy options through the use of a time bank, where people provide their skills to installing solar panels and then draw on the banked hours to receive the services they need in the future. The information provided by the Clintonville Co-op was used in the project's final recommendations to the City of Columbus.

Dataset 5: Photovoltaic Solar Resource: United States and Germany

Sources: Nation Renewable Energy Laboratory. Website:
http://www.nrel.gov/gis/images/us_germany_spain/pv_map_us_germany_spain.jpg

The data provided by this source compares solar hours from Germany and the US. Although Germany is a leader in solar PV installations, several states in the US (including Ohio) produce more solar hours than Germany. This data was used to explain how the State of Ohio can produce enough solar hours for the production of solar energy.

Dataset 6: Athens Community Aggregation Agreement

Source: Athens County

Athens County recently passed a community choice aggregation program where members of the community have the choice to opt into purchasing their energy from renewable resources. As part of their agreement, Athens County has set aside land for the installment of solar panels. The aggregation program will be part of the County's public utilities and allow for the availability of local renewable energy. Components of this information were used as final recommendations to the City of Columbus.

APPENDIX FIGURES

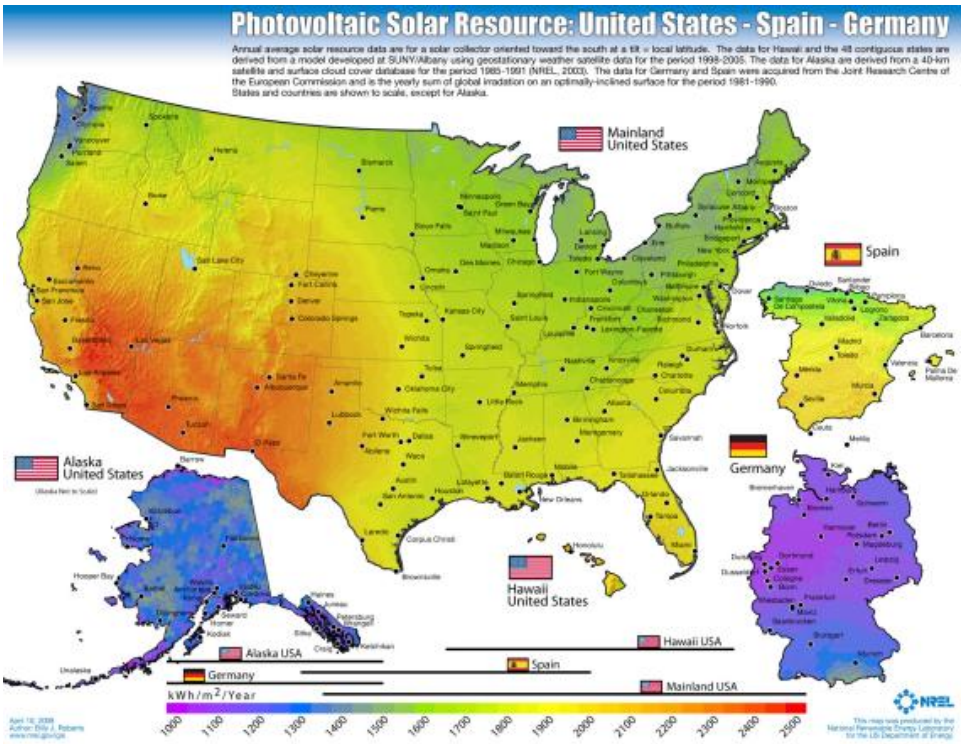

Figure 1. This shows the solar energy potential in the United States compared to the solar energy potential in Germany, one of the leading producers of solar energy. This figure shows that the continental United States has more energy potential than Germany because of a higher amount of kWh/m^2/year. The majority of Germany is in the 1000 range while the United States can mostly be found to be in the 2000s kWh/m^2/year

SOLAR PV ECONOMICS AND RETURNS	
Gross System Price ($3.57 per STC DC Watt)	$23,990
Net System Cost after Tax Benefits & Incentives	$16,793
Estimated First Year Utility Savings	$1,322
Net Savings over 25 years: including bill savings, sRECs, maintenance, & inverter replacement (after-tax)	$55,809
Total Lifecycle Payback (25-year Net Savings divided by Net Cost)	3.3x
Simple Payback	8.8 years
Pre-Tax Compound Annual Rate of Return (IRR) over 25 years	19.2%
Estimated Initial Increase in Property Value	$26,434
Maximum resale value increase occurs at year 11 at a value of:	$36,358

Figure 2. This shows the average cost savings to a typical 6.7 kW solar installation on an average size system in the Columbus area.

	Residential	Commercial	Both
Total Consumption (KW)	472,783,800 kW	712,189,292 KW	1,184,973,092 KW
6% Reduction from Solar (KW)	53,970 kW	81,300 KW	135,270 KW
3% Reduction from Solar (KW)	26,985 kW	40,650 KW	67,635 KW
GHG reduction from 3%	497,594 MT CO2e	781,679 MT CO2e	1,279,274 MT CO2e
GHG reduction from 6%	995,188 MT CO2e	1,563,357 MT CO2e	2,558,546 MT CO2e
Percent Reduction from 3%	4.57%	7.18%	11.76%
Percent Reduction from 6%	9.15%	14.37%	23.51%

Figure 3.This graph shows the amount of kW needed to be reduced to meet the Green Memo III goals. IT also shows the reduction in CO2e emissions and the percent reductions of the total.

Figure 4. These graphs show the CO2e emissions in graph form. The baseline and the 6 planning scenarios are included.

	Residential Scenarios		Commercial Savings		Combined Savings
Year	Annual Savings from Increased 53,970KW (6%)	Annual Savings from Increased 26,985KW (3%)	Annual Savings from Increased 81,300KW (6%)	Annual Savings from Increased 40,650KW (3%)	Annual Savings from Increased 67,635 KW (3%)
1	$13,895,261.19	$6,947,630.60	$20,931,716.42	$10,465,858.21	$17,413,488.81
2	$14,249,691.04	$7,124,845.52	$21,465,626.87	$10,732,813.43	$17,857,658.96
3	$14,620,231.34	$7,310,115.67	$22,023,805.97	$11,011,902.99	$18,322,018.66
4	$15,006,882.09	$7,503,441.04	$22,606,253.73	$11,303,126.87	$18,806,567.91
5	$15,401,588.06	$7,700,794.03	$23,200,835.82	$11,600,417.91	$19,301,211.94
Total Savings after 5 years	$73,173,654	$36,586,827	$110,228,239	$55,114,119	$91,700,946

Figure 5. This figure shows the cost savings of the different scenarios over the course of 5 years.

Residential			
	MMBtu	GWh	kWh
AEP	-	2,373	2,373,000,000
CMP	-	63	62,650,000
Columbia Gas	18,575,972	5,444	5,444,080,000
Total		7,880	7,879,730,000
Residential 6%			
Total with 6% Reduction kW	kWh Reduced	KW	# homes at 6.7kW system
7,406,946,200	472,783,800	53,971	8,055
Residential 3%			
Total 3% Reduction kWh	kWh Reduced	KW	# homes at 6.7kW
7,643,338,100	236,391,900	26,985	4,028
Commercial			
	MMBtu	GWh	kWh
AEP	-	5,209	5,209,150,000
CMP	-	718	717,750,000
Columbia Gas	20,278,090	5,943	5,942,926,000
Total		11,870	11,869,826,000
Commercial 6%			
Total with 6% Reduction kW	kWh Reduced	KW	# firms at 40kW system
11,157,636,440	712,189,560	81,300	2,033
Commercial 3%			
Total 3% Reduction kWh	kWh Reduced	KW	# firmst at 40kW system
11,513,731,220	356,094,780	40,650	1,016
Both Sectors			
	MMBtu	GWh	kWh
AEP	-	7,582	7,582,150,000
CMP	-	780	780,400,000
Columbia Gas	38,854,062	11,387	11,387,006,000
Total		19,750	19,749,556,000
Both Sectors 6%			
Total 6% Reduction kWh bot	kWh Reduced	kW	
18,564,582,640	1,184,973,360	135,271	
Both Sectors 3%			
Total 3%Reduction kWh	kWh Reduced	kW	
19,157,069,320	592,486,680	67,635	

Figure 6. This chart shows the total reduction in kWh as well as kW reduction needed to meet reduction goals for each scenario.