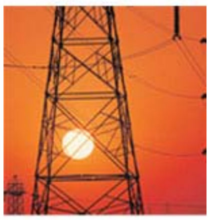
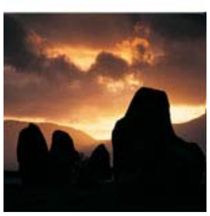



July 2011

REPORT ON
ALTERNATIVE ENERGY FEASIBILITY STUDY SUTTON NEIGHBORHOOD

Shaker Heights OH

PREPARED FOR

City of Shaker Heights
Shaker Hts OH

File No.
37569-000

Haley & Aldrich I 5755 Granger Road, Suite 320 I Cleveland, OH 44131 I 216.739.0555

Haley & Aldrich, Inc.
5755 Granger Road
Suite 320
Cleveland, OH 44131-1442

Tel: 216.739.0555
Fax: 216.739.0560
HaleyAldrich.com

29 July 2011
File No. 37569-000

City of Shaker Heights
3400 Lee Road
Shaker Heights, Ohio 44102

Attention: Kamla Lewis

Subject: Alternative Energy Feasibility Study - Final
Sutton Neighborhood
Shaker Heights, Ohio

Ladies and Gentlemen:

We are pleased to submit this report summarizing our findings of the Alternative Energy Feasibility Study for the Sutton Road Neighborhood and an apartment building at 14101 S. Woodland Ave. in Shaker Heights, Ohio. The study focused on feasibility of installing geothermal, solar thermal, and solar photovoltaics on residential construction. Evaluations were made with the City of Shaker Heights' goal of making their residences more energy efficient to lower the cost of ownership and increase marketability of housing stock. The report recommends that a geothermal system would provide the most gains for individual residences. In addition, a district geothermal system that provides a standard financing mechanism is an effective means to create widespread adoption and maximize its potential gains. In cases where modifications to the buildings to install geothermal are extensive and therefore raise the cost above the system savings, solar thermal and solar photovoltaics can be used as additions to the geothermal system to create savings that exceed the cost of installation over the lifetime of the system.

Please contact us if you would like to discuss or have any questions.

Sincerely yours,
HALEY & ALDRICH, INC.

Kathleen A. Dorsey
Senior Engineer

David J. Hagen
Senior Vice President

EXECUTIVE SUMMARY

Haley & Aldrich, Inc. (Haley & Aldrich) evaluated the feasibility of three alternative energy technologies on select residential buildings in the City of Shaker Heights, OH ("Shaker Heights"). The study area included Sutton Road, Sutton Place, and an apartment building at 14101 S. Woodland Ave. in Shaker Heights. These areas were selected because they represent common building types in Shaker Heights, which include single- and two-family residences, condominiums, an older apartment building, and a new multi-family, townhouse-style residences.

Geothermal refers to using ground source heat pumps to heat and cool the building by using the ground as a thermal storage battery. Solar thermal systems produce hot water by converting the sun's energy into thermal energy (or heat). Solar photovoltaics convert the sun's energy into electricity. All three technologies are low maintenance and have proven track records. Their use offsets either the electricity or natural gas purchased from the utility with the benefit of lowering the cost of ownership and reducing environmental impact.

City officials expressed the goal of using alternative energy technologies to increase competitiveness of Shaker Heights' residences by applying the technologies that lower the cost of ownership, increase market value, improve the home environment, and promote Shaker Heights's sustainability principles. Our evaluation focused on determining which alternative energy technology(s) would fulfill these goals.

Installing the technologies on new construction is recommended to reduce the lifecycle cost of the residence. Residences built before 1970 would need to complete an energy audit and upgrade the building shell and electrical systems to make installing geothermal or solar photovoltaic systems viable.

Implementing solar photovoltaic and solar thermal systems would be dependent on access to unshaded, south-facing areas. Residents who install solar may wish to seek solar easements from Shaker Heights and other residents to protect their access to sunlight. Aesthetics is a common issue with solar installations that can be overcome with a case-by-case review. Solar photovoltaic is a promising option at Sutton Crescent due to amount of available space and the site orientation. We would recommend evaluating solar photovoltaic for any future development on this site and/or at the Onaway Station.

For single and two-family residences, geothermal creates the most improvements to the house value because it pays for itself in the least time, creates long term savings, easily allows the addition of air conditioning, improves aesthetics, and improves indoor air quality by reducing combustion in the furnace. Creating a low-cost financing mechanism through creation of a district geothermal system either through an energy developer or a geothermal utility should be investigated to produce widespread gains through the community.

In the case of apartment buildings, priority should be given to the technology that offsets the owners' costs. For example, if the residents pay for heating and cooling individually, then geothermal would be less preferable to solar photovoltaic producing the electricity to lower the owner's lighting bill. The next most influential criteria would be the number of modifications required.

In the case of 14101 S. Woodland, the building has hot water heating and no central air conditioning. Geothermal would require installing new ductwork or piping throughout the building that raises the cost to greater than the savings the geothermal system produces over its lifetime. Installing geothermal may be desirable if the owner believes that installing central air conditioning is necessary to maintain the building value. Both solar thermal and solar photovoltaic are viable. Solar thermal would pay for itself in a shorter period of time but solar photovoltaic creates more total savings over the lifetime of the system.

Going forward, Shaker Heights should consider promoting alternative energy and energy efficiency by taking the following actions:

Action 1 – Educate stakeholders on study findings

- Disseminate the study findings to Shaker Heights residents, businesses, construction firms, real estate developers, housing rehabilitation companies, public services, and government agencies.
- Promote available energy tax credits, financing mechanisms, and other incentives.
- Assess if the existing permitting and Architectural Board of Review processes need to be revised or how they should be applied to alternative energies considering the study information.
- Encourage energy efficiency through the Shaker Heights' website, magazine and other publications.

Action 2 – Make Residences More Energy Efficient

- Partner with Dominion East Ohio Home Performance with Energy Star program to offer low cost energy audits to eligible residents and promote weatherization assistance from Dominion East Ohio and Ohio Department of Development to eligible residents.
- Assess if existing permitting and Architectural Board of Review processes need to be revised and how they can be applied to Alternative Energy given study information.
- Create contract terms or an ordinance requiring that City sponsored home rehabilitations include energy efficiency upgrades.
-

Action 3 – Promote use of Alternative Energy for Shaker Heights Projects

- Require all new projects to evaluate the energy efficiency of the building and to be designed to use less energy than an established baseline.
- Require design and construction teams to evaluate alternative energy for every Shaker Heights project.
- Determine specific energy efficiency baseline, such as Energy Star label or ASHRAE 90.1-2010, on which to evaluate design and construction projects.

Action 4 – Research Geothermal Utility

- Investigate establishing a city-wide geothermal utility that is available to any building owner.
- Discuss potential of NEO alternative energy district creating a geothermal utility.

Action 5 – Continue Transit Village Alternative Energy Project

- Use NOPEC funds to offset costs of energy efficiency upgrades to existing residences in Transit Village and pilot geothermal project at Sutton Condominiums.
- Strengthen community outreach component of project to ensure success.

Action 6 – Create Alternative Energy Gateway at Transit Village

- Work with RTA to evaluate opportunities at Onaway Station.
- Investigate solar PV covered parking or lighting along RTA and/or Sutton Crescent.
- Seek out opportunities to incorporate alternative energy as public art.

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES

1. INTRODUCTION

The City of Shaker Heights, Ohio contracted with Haley and Aldrich, Inc. to conduct an Alternative Energy Feasibility Study for the Sutton Road neighborhood. Haley & Aldrich partnered with REPower Solutions, a solar photovoltaic design and contracting firm to perform this study. This report presents the findings of the study and is prepared and presented in accordance with Alternative Energy Feasibility Study contract effective date of 31 November 2010. We would like to express our gratitude and acknowledge City of Shaker Heights Neighborhood Revitalization, Building, Planning, Law, and Public Works Departments, Shaker Heights City Council, Brian Stack of Stack Heating and Cooling, Select Investment Group and the Sutton Road and Sutton Place homeowners for their assistance in creating and performing this study.

2. STUDY OBJECTIVES

The City of Shaker Heights ("Shaker Heights") is focused on making their neighborhoods more energy efficient to reduce environmental impact and providing highly desirable housing stock that complements many of the other community assets. The objective of this study is to evaluate the feasibility, costs and benefits of installing residential solar photovoltaic, solar thermal and/or district geothermal systems. The study sites included one apartment building and one residential street but the findings can be applied to other similar residential construction in Shaker Heights and Cuyahoga County. Haley & Aldrich, REPower and city representatives met the first week of the project to identify Shaker Heights' goals for improving the study area. All the technologies can reduce a carbon dioxide emission, which is a greenhouse gas, and improve efficiency; however Shaker Heights's objectives also included the following:

a. Lower costs of operating the home/apartment building;
b. Add market value to the home/apartment building;
c. Improve the living environment of the house; and
d. Enhance the sustainability brand of Transit Village.

A summary of the costs and benefits for solar photovoltaic, solar thermal and/or geothermal system technologies is provided in the following table.

GEOTHERMAL	SOLAR THERMAL	SOLAR PHOTOVOLTAIC
Pros		
Energy Conservation	Energy Conservation	Energy Generation
Provides heating and air conditioning	Creates hot water and can be used for space heating	Generates electricity
Natural gas bill is eliminated or lowered significantly	Reduces natural gas or electric bills	Reduces electric bills
Lower utility bills	Lower utility bills	Lower utility bills
Low maintenance	Low maintenance	Low maintenance
Reduces noise	N/A	N/A
No visible outside equipment	N/A	N/A
Lowers greenhouse gas (GHG) emissions	Lowers greenhouse gas (GHG) emissions	Lowers greenhouse gas (GHG) emissions
Environmentally friendly	Environmentally friendly	Environmentally friendly
Cons		
Needs heating back up	Needs heating back up	Electric utility connection remains as back up
Electrical panel upgrade may be required	N/A	Electrical panel upgrade may be required
Operates only when thermal battery charged	Operates only when daylight available	Operates only when daylight available
Electricity bill will increase	N/A	N/A
Landscaping restoration post installation	Roof or exterior house restoration post installation	Roof or exterior house restoration post installation
Additional or replacement HVAC installed in house	Additional tank and pump installed in house	Additional electrical equipment installed inside and/or outside house
N/A	Affects aesthetics	Affects aesthetics
Building shell (e.g. insulation) must be improved first	N/A	N/A

Table I. Comparison of Technology Application in Study Area

3. FIRST STEP – IMPROVE BUILDING ENERGY EFFICIENCY

Before installing alternative energy systems, homeowners and building owners should conduct an energy audit and implement the recommended maintenance and upgrades to reduce the amount of energy consumed for heating, cooling, and electricity. Highly efficient alternative energy systems alone cannot compensate for energy wasted by uninsulated attics or incandescent light bulbs. Typically buildings constructed before 1970 need to be improved to bring their energy consumption to average or better. Adding alternative energy systems after these improvements would lower the energy demand and monthly utility bills below average. Below average operating costs can increase market value of the house.

In our evaluation, we determined that spending approximately $8,000 to $12,000 in the older single- and two-family homes to improve the energy efficiency of the building shell would be necessary to make installing the geothermal system for heating and cooling economically viable. Without improving the building shell, a larger, higher cost heat pump would be required. The energy savings would not overcome this extra cost for a larger unit and the cost of the geothermal system would not pay for itself within 30 years.

Energy reduction is not necessary for installing solar photovoltaic; however reducing the demand would decrease the amount that needs to be bought from the utility and would increase the excess electricity that would be purchased by the utility. Solar photovoltaic systems sell any electricity not consumed at the home to the electric utility. The electrical consumption of a household is most influenced by human behaviors and thereby using powered equipment less and turning off and/or unplugging items when not in use would make a difference. The greatest consumption in a typical house is the accumulation of appliances. Reducing the constant draw by a great deal of small loads would have a significant impact.

Older electric appliances, second or third refrigerators and great quantities of electronic devices continually plugged in can be targeted for improvement. Utilizing Energy Star rated appliances and minimizing the number of appliances plugged in continuously can reduce the electricity consumption. Lighting can account for almost 10% of an electricity bill. An easy change to reduce costs of usage is to remove incandescent bulbs and replace them with compact fluorescent or LED lights. Lighting controls, such as dimmers and timers, can further help reduce electricity consumption.

Similar to solar photovoltaic systems, solar thermal systems do not require reducing demand to make installation economically viable. If the homeowner needs less hot water then it is more likely that the backup natural gas or electrical heating would be required less. This would result in lower costs and less greenhouse gas emissions.

4. GEOTHERMAL – GROUND SOURCE HEATING AND COOLING

Geothermal is a term that in the common vernacular is used to describe two different uses of the ground, the first being geothermal for production of electric power and the second being ground source heating and cooling. This study addresses only ground source heating and cooling because the high temperature earth necessary for electricity production is too deep below our study areas to currently be financially feasible. Geothermal power production is typically financially feasible in locations where the high temperature earth is closer to the earth surface than normal, such as locations where there are geysers, hot springs, volcanoes, and seismic activity. Ground source heating and cooling is a technology where the earth is used as a thermal energy (heat) storage battery.

The borehole field acts as a thermal battery that stores heat rejected from the building by the cooling system to be used for building heating uses. The ground has a finite capacity for thermal storage that is defined by the amount of heat that can be removed without freezing the ground or the geothermal supply and the amount of heat that can be stored before the geothermal supply temperature from the ground exceeds the temperature at which the heat pump can cool efficiently over the design life of the system. If the amount of energy removed by heating is equal to the amount of energy added by the cooling then the amount of earth to be used is the smallest possible.

4.1 History

Geothermal systems have been utilized in the United States since the 1930s. The vertical closed loop geoexchanger with heat pumps has been increasing in popularity since the 1980s. In 2009, approximately 115,000 geothermal heat pumps were shipped in the United States. Local mechanical contractors interviewed had experience of up to twenty years in installing geothermal systems in northeast Ohio. Industry standards have progressed and the borehole field and piping loop should be installed by a local drilling and mechanical contractors who have International Ground Source Heat Pump Association (IGSHPA) certifications.

4.2 Local Usage

There were five existing ground source geothermal system in Shaker Heights as of May 2011. Local systems that have been installed in urban and suburban locations in Cleveland include Trinity Commons on Euclid Avenue, Baldwin Wallace College in Berea, and the Adam Joseph Lewis Environmental Center in Ohio City. These examples are single building geothermal systems.

4.3 Geologic and Hydrogeologic Assessment

The two study sites are in urbanized areas located in the Lake Plain which consists of silts and fine sand above the Devonian age Chagrin Shale, which is a member of the Ohio Shale. Topography of the Lake Plain is generally flat and upwardly sloping from lake inland with occasional ridges that represent former lake boundaries. Within the Lake Plain there are former beach ridges, which consist of sand and fine gravel that run parallel to the lakeshore. The Ohio Shale is gray to black, organic sedimentary, consolidated shale, which breaks along the grain and is considered an oil shale. Bedrock is approximately 50 feet below ground surface and is composed primarily of sandstone, shale, siltstone, conglomerate, with some limestone. Because the area is urbanized, there is topsoil and/or fill near the ground surface.

Geology typical of the area is impermeable and groundwater boreholes typically yield 3 to 10 gallons per minute less than 30 feet below ground surface. The undisturbed groundwater temperatures found at nearby geothermal borehole testing in Cleveland and the eastern suburbs, range from 55°F to 60°F. For a preliminary assessment of the number of boreholes prior to site confirmation, we estimate the thermal conductivity of the formation to be between 1.0 and 1.4 Btu/hr*ft*F. From the 14101 S. Woodland Rd. site, there are no registered oil or gas wells within a 1.0 mile radius of the site. From the Sutton Place site, there is one registered oil or gas well; #22043, within a 1.0 mile radius of the site. There are five registered groundwater wells greater than twenty (20) feet deep that are used for environmental monitoring within 1.0 mile of the S. Woodland Rd. site. Including the well listed that is within one mile of the study area, there are a total of six gas wells installed in Shaker Heights.

4.4 System Recommendation

We recommend using a vertical closed loop style geoexchanger for these sites because there is sufficient space, the bedrock geology has better thermal characteristics than the overburden soils, and the water yield is too low for an open system. We do not recommend open systems for residences that do not already have a groundwater well because the maintenance and permitting are too cumbersome for a residential application. Geothermal boreholes are typically 500 feet deep or shallower and the gas wells in the area are typically greater than 2000 feet deep. If a borehole is anticipated to enter a gas producing region, the driller should be required to follow the Ohio Department of Natural Resources guidance for drilling for gas in urban areas.

5. SOLAR THERMAL

Solar thermal systems collect the sun's energy, convert it into thermal energy (or heat), and produce hot water. The produced hot water can be used as domestic hot water and/or for home heating. In both cases, the cost of creating the hot water is less than using electric or fossil fuels and the greenhouse gas emissions generated from producing electricity or burning the fossil fuel are avoided.

The systems are very common in frost free, sunny climates such as the southern United States, countries around the Mediterranean Sea, India and southern China. In some locations, such as southern Spain they have become the standard for new construction[1]. Although not as common in colder climates, systems suitable for Shaker Heights' weather can be installed and there is sufficient solar resource to provide hot water.

Flat plate or evacuated tube solar thermal collectors which would either drain to a tank inside the building or use antifreeze are best suited for Shaker Heights. There is a residence in Cleveland Heights that has installed a solar thermal system. Nearby larger, non-residential systems are installed at the Great Lakes Brewing Company, the Geauga YMCA, and the City of Cleveland Fire Station #20.

---

[1] http://www.estif.org/st_energy/technology/solar_domestic_hot_water_heating_sdhw/ European Solar Thermal Industry Association Solar Domestic Hot Water preparation (SDHW)

6. SOLAR PHOTOVOLTAIC

Solar photovoltaic modules use sunlight to create electricity. The oldest technology is a crystalline silicon cell. The individual cell is made of semi-conductor grade silicon that responds to sunlight and causes electrons to move within the material. The electricity created by electron movement is captured and directed to provide power. Solar photovoltaic systems have been available in the marketplace for over 40 years. Developments in thin-film solar photovoltaic have generated new materials and installation options, such as roofing. However we would urge caution in using these materials because their performance has not been proven and the cost per unit of electricity produced may be greater.

Cleveland's solar resource is approximately 75% of the solar resource of Los Angeles and equal to or greater than Germany. Germany, in 2009, was the largest generator of solar photovoltaic power. There are a few residential solar photovoltaic installations in Shaker Heights and several dozen more in Cuyahoga County. Examples of local commercial installations include Progressive Field, Great Lakes Science Center, Ferro Shared Services building, and Jewish Federation of Cleveland.

Most solar photovoltaic systems currently implemented reduce the electricity consumed by a home or facility. Whenever the sun is available, electricity is being created. When the sun is not available, more electricity is purchased from the existing electric utility and therefore batteries are not required. Battery systems are available but generally the cost does not pay for itself and are not typically installed in areas that have a reliable electric utility, such as Shaker Heights.

Solar photovoltaic systems are supplied in modules that most often consist of glass with an aluminum frame. The glass and backing material contains the solar cells. Electricity generation for homes requires several modules and some corresponding electrical conditioning equipment.

These framed modules can be mounted on roofs or other structures. In the northern hemisphere, the sun moves through the southern hemisphere. As a result, modules should face the southern sun for greatest generation of kilowatt-hours. Depending on the particular site, the modules are tilted between 5 and 60 degrees in this region.

The available suitable space and electrical consumption would dictate the number of modules that can be installed. Typically a residential installation would use on the order of 5-40 modules, while a utility-scale project would use thousands of modules. Ten modules would produce approximately 2400 kilowatt- hours per year which typically is enough to power a 10-year-old refrigerator and average household lighting for a year. Each additional single 220W module might make 240 kilowatt-hours in one year in Cleveland. This is enough electricity to offset the use of a computer for 3.5 hours a day, every day.

7. SINGLE FAMILY AND TWO FAMILY HOMES

Housing stock in Shaker Heights consists of multi-story brick apartment and condominium buildings along the main throughways of Shaker Heights such as Van Aken and Warrensville Boulevard, and single family or two-family residences on side streets. The majority of the housing stock was constructed from 1910 through 1960. The study area of Sutton Road includes a combination of single family, two family and condominium units. Sutton Road consists of thirty-five residences which are typically two family residences, but there are a few single-family and one three-family residence. Sutton condominiums were constructed in the 1970s and are metal construction, multi-family structures. The neighborhood is at the border of Shaker Heights and Cleveland with easy access to the light rail transit. Shopping, downtown, offices, and schools are easily accessed by the light rail station.

Figure 1 - Sutton Road Neighborhood Study Area

7.1 Geothermal

Geothermal is installed to heat and cool a home by using the ground as a thermal storage battery. Heat is removed from the ground in the winter to heat the building, leaving a cool ground to accept heat removed from the building through the summer. At the end of summer, the warm ground is ready to heat the building. The home is connected to the ground through a geoexchanger, which is a piping loop installed between the building and the ground to transport thermal energy and transfer the energy to and from the ground. There are many types of geoexchanger designs but typically the most suitable for Shaker Heights, given its urban land use density and location on a geologic formation that produces very little water, is a vertical closed loop type of geoexchanger.

A vertical closed loop geoexchanger consists of a horizontal loop of piping that connects the building to a group of vertical boreholes drilled into the ground, with each borehole containing a piping loop that directs water down to the bottom of the borehole. Water is circulated between the building and the earth through the geoexchanger piping loop. In the Shaker Heights climate, freeze protection methods must be employed. The most common freeze protection method is to have antifreeze mixed with the water circulating through the geoexchanger, but other means, such as controlling the water temperature with electric resistance heating and insulation, can be implemented instead.

Inside a residence the heating and cooling could be accomplished with geothermal heat pumps that can be supplied and maintained by local mechanical contractors. Heat pumps have similar components, operations, and maintenance as air conditioners, furnaces and refrigerators. Geothermal used for heating and cooling is a proven, reliable technology. Electricity is the source of power for the heat pump. Natural gas or another fossil fuel is required only if it fuels a furnace that is a heating back-up or a supplement to the geothermal system. Areas where the boreholes are located can be landscaped or covered to match the surrounding ground surface because the boreholes and pipe trenches would be grouted and backfilled.

In Shaker Heights, because a typical residence uses significantly more heating than cooling, the geothermal systems are installed with electric resistance heating or natural gas furnace as a supplement to keep the borehole field a reasonable size and cost. These are referred to as dual-fuel systems.

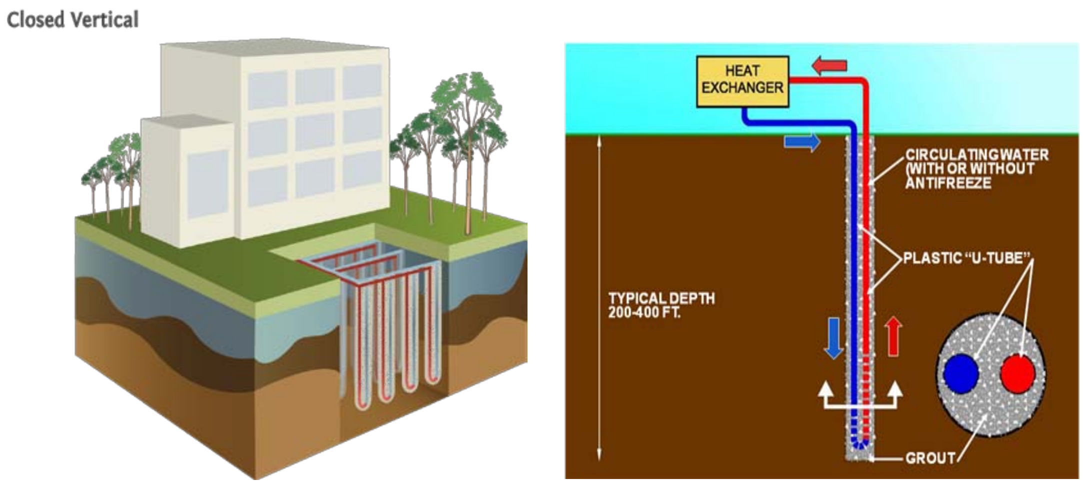


Figure 2 - Vertical Closed Loop Geoexchanger– Haley & Aldrich 2011

A typical geothermal installation would include:

- Inside the Building
  - Heating/cooling equipment such as a heat pump
  - Ductwork, piping, or tubing to distribute through the house
  - Pump to circulate water through boreholes
  - Valves and manifolds
  - Controls systems

- Outside the Building
  - Boreholes that are 5" diameter
  - Underground piping from boreholes into building
  - Compressor if no room is available inside the building

7.1.1 Benefits

Geothermal systems are installed because they provide the following benefits at a reasonable cost:

- Provides heating and air conditioning
- Lowers utility bills
- Low maintenance
- Quiet

- Aesthetically pleasing
- No visible outside equipment
- Uses electricity only
- Lowers greenhouse gases emissions
- Environmentally friendly
- Eliminates or lowers natural gas bill

Geothermal ground source heating and cooling systems are more energy efficient than conventional heating and cooling using electricity and/or fossil fuel. Higher energy efficiency results in lower utility bills which lowers the cost of operating the home and increases the home market value.

The initial upfront cost of installing geothermal heating and cooling is more than this cost for installing conventional heating and cooling, such as a natural gas furnace with air conditioning. But, the extra cost to install geothermal can be paid back to the owner through utility bill savings. The reason that a geothermal system costs less to operate is that it produces more heating or cooling for each unit of energy purchased from the utility than other typical heating and cooling appliances used in Shaker Heights. For example, if you buy 100 kilo-watt hours electricity, then a room heater would provide 98 kilo-watt hours of heat to the room but a geothermal heat pump would deliver, on average, 350 kilo-watt hours of heat.

A straightforward comparison of heating and cooling operating costs between different types of equipment/systems is difficult because some equipment uses electricity and others use natural gas. Electricity is purchased in kilo-watt hours and natural gas is purchased in MCF. Furthermore, buying one therm of gas does not produce one therm of heat. To create an apples-to-apples comparison, we would compare them on the amount of heat produced and cost of heat produced. In this case, 100 heating units are equal to 1 therm. Sutton Road residents' 2010 utility rates: $0.127/kilo-watt hour and $1.00/therm were used to estimate costs.

Heating Appliance Type	Heating Units Purchased from Utility	Heating Units Delivered in the Home	Comparative Cost per 100 Heating Units
Geothermal Heat Pump	100	350	$1.06
Natural Gas Furnace or Boiler (80% Efficient.)	100	80	$1.25
Natural Gas Room Heater (65% Efficient, Vented)	100	65	$1.54
Electric Baseboard/ Room Heater	100	100	$3.72
Electric Furnace or Boiler	100	98	$3.80

Table II. Heating System Cost Comparison[1]

Typically, energy savings range from 15% to 70%, depending on the type of system it is replacing (electric boiler, natural gas furnace). Utility bill savings would be less than energy savings percentages quoted herein because there are fixed fees and taxes that would not change when more or less gas or electricity is purchased. However, the part of the utility bill cost that is directly controllable by the resident would decrease by the percentages shown.

In Shaker Heights, the carbon emissions are reduced from 25% to 35% by using geothermal instead of a natural gas furnace and window air conditioners. The carbon emission reduction could be over 50% if using geothermal instead of electric heating systems. Carbon savings could be more than these estimates if the home was using a cleaner source of electricity than FirstEnergy. Examples of cleaner sources of household electricity would be a household producing electricity using wind or solar, or if a household purchased renewable energy credits. Carbon emissions refer to carbon dioxide which is a greenhouse gas associated with contributing to global warming.

Geothermal systems can improve aesthetics because, if room is available, equipment can be installed in the building, eliminating having to see or hide air conditioners. Additionally, the noise and dripping water from outside air conditioning equipment is eliminated, creating a quieter environment. Besides aesthetics, replacing fossil-fuel-burning equipment creates less dry air in the home which can feel more comfortable and eliminates risk of carbon monoxide build-up. If geothermal can be combined with a renewable electricity source such as wind or solar, a home can be heated with very little to zero carbon emissions.

7.1.2 Important Considerations

Boreholes, Piping, and Outdoor Equipment Locations

Closed loop-vertical boreholes would be drilled on the resident's property, underground piping would be laid from the boreholes to the house, and mechanical equipment would need to be installed as part of installing a geothermal system. Actual number, depth, and spacing of boreholes and the piping route would be specific to each home and should be reviewed with a geothermal contractor at the home prior to signing a contract. If there is not room inside the house for the geothermal heat pump, it may be installed outside. Locations need to be:

- Within property lines;
- Outside of property easements;
- Outside of the right of way;
- Areas that do not interfere with existing underground utilities;
- Areas with overhead clearance that is not obstructed by a structure, trees or overhead power lines;
- Areas accessible to the drilling equipment;
- Areas that can easily be returned to pre-installation condition;
- Areas permitted by Homeowners or Condominium Association Bylaws; and
- Screened, out of view and near the structure in a manner similar to air conditioning equipment (applicable to outdoor heat pump, not boreholes).

A homeowner can find property boundary and easement information from their real estate records or from the Cuyahoga County Recorder Office. Boreholes can only be located in areas that are accessible with the drilling equipment and should be reviewed at the home with a drilling contractor prior to signing a contract. Rigs have drilling masts that need to be kept a safe distance from overhead power. Underground utilities should be located and marked prior to drilling to prevent damaging them.

Qualifying for Rebates and Incentives

There is a federal tax credit available to homeowners for 30% of the total cost of the geothermal system (borehole field plus mechanical system upgrades). Obtaining the credit would significantly reduce the system cost and overall savings. Important considerations for the tax credit as of January 2011 include:

- It is a tax credit that reduces taxes owed dollar for dollar;
- System must be installed in a home owned by the taxpayer but primary residency is not required;
- System must be brought into service between 2008 and 2016;
- Heat pump must meet the Energy Star performance criteria;
- There is no limit to amount of the credit or the number of times the credit can be claimed;
- Tax credit can be combined with other tax credits;
- If the tax credit exceeds the value of taxes owed, the credit can be applied forward for a limitless number of years;
- The tax credit would not create a tax refund; and
- Credit is calculated as a percentage of total system cost including equipment, piping, and labor.

A rebate of up to $600 for an Energy Star rated geothermal heat pump can be obtained from FirstEnergy if a FirstEnergy certified installer is used and the system is installed between March 23, 2011 and December 15, 2012. There currently is no rebate or incentive from local or state governments for geothermal. Tax laws and their interpretation change frequently. A homeowner should verify the most up-to-date tax rules with a tax advisor or internal revenue service prior to purchasing the system. Additionally, homeowners should ask their local government, utility, and contractor for available rebates and other incentives before purchasing a system because the programs frequently change.

Existing Home Conditions

Older homes typical of Shaker Heights would require energy efficiency upgrades to make a geothermal system viable. Before installing alternative energy systems, homeowners and building owners should conduct an energy audit and implement the recommended maintenance and upgrades to reduce the amount of energy consumed for heating, cooling, and electricity to be equivalent to average modern construction.

A good time to consider installing geothermal is when the heating and cooling equipment needs to be replaced either because of age or poor efficiency, or if air conditioning needs to be added to a home. Replacing a newer, high efficiency furnace, boiler or air conditioner would generate lower utility bills savings than older, inefficient units. Additionally if the cost of natural gas is expected to increase then heating with geothermal may become less expensive than even a new, highly-efficient boiler or furnace.

The feasibility and cost of installing geothermal on an existing home is directly dependent on the condition and type of heating and cooling equipment currently being used in the home. Existing equipment would determine if it should be completely replaced, or a geothermal heat pump should be added onto the existing unit. Ductwork, piping, cooling units and other items may need to be modified or added. Details on modification options are explained in the Modification to Existing Homes section of this report.

Contractor Selection

Even though geothermal has been in residential applications for more than 50 years, many HVAC contractors and drilling contractors do not have significant experience installing such systems. It is important to select a contractor(s) with:

- References for multiple residential installations;
- Experience installing vertical closed loop geothermal systems for at least five years;
- Contractor licenses and/or registrations with the State of Ohio and the City of Shaker Heights;
- Well drilling registration with the State of Ohio;
- Geothermal installer and heat fusion certification from the International Ground Source Heat Pump Association (IGSHPA);
- Containers, pumps, and discharge permits to manage drilling water generated; and
- Distribution agreement with a geothermal heat pump manufacturer.

7.1.3 Size and Costs

For the study area of Sutton Place and Sutton Road, we examined the conditions of the existing homes, reviewed past utility bills and ran energy and geothermal models on these homes to estimate the size, cost, and economically viability of installing a geothermal system. A summary of our findings is given in the following table.

	Single Typical Household
Est. # of boreholes /KW	3 - 4 u-tube boreholes
Peak Heating/Cooling	66,000 - 81,000btuh/ 3 - 5 tons
Capital Cost (excludes cost to make homes energy efficient)	$18,000 - $34,000
Estimated Rebates and Incentives	$5,400 - $10,200
Est. capital cost after rebates & Incentives (excludes making homes energy efficient)	$12,600 - $23,800
Extra Cost for Geothermal vs. Standard Equipment	$6,100 - $16,000
Payback year w/incentives	9 - 16
First year energy cost reduction	$600 - $840
30 yr Lifetime Savings	$17,000 - $31,700
% Greenhouse gas emissions reduction	29% - 32%

Table III. Individual Household Sutton Road Neighborhood Geothermal

The costs given in the above table cover the range of drilling costs, range of typical equipment capacities for the homes in the study area, and range of costs for ancillary work, such as ductwork, that may be required. As an example, after improving the energy efficiency of their home, a Sutton Road single family homeowner would install an Energy Star rated geothermal heat pump that delivers 81,000 btuh of heating and 3 tons of air conditioning, a circulating pump, and a piping loop that runs from the heat pump underground through the boreholes installed in the yard and back to the heat pump. The system would either be installed in addition to their existing furnace or as a total replacement. Additional work that may be completed, depending on the specific conditions of each house, could include adding or modifying the ductwork, installing new thermostat and controls, and installing a larger electrical panel. Landscaping would need to be done to return the areas where the boreholes and piping were installed to their pre construction state. The entire project could typically be completed in one to two weeks.

The homeowner would pay $18,000 - $34,000 for this work. Thirty percent of the total cost of the geothermal system, which is $5,400 - $10,200, would then be returned to the homeowner through tax credits at a later date. The homeowner would need to collect paperwork identifying the cost of the system and the Energy Star rating of the geothermal heat pump from their contractor for their tax records and to complete the IRS tax forms. Once the homeowner received the tax credits, the net cost would be $12,600 - $23,800. The extra cost for installing geothermal over the cost that a homeowner would have incurred replacing their furnace and air conditioning with a newer furnace equipped with air conditioning is $6,100 - $16,000.

Once the system is operating, the homeowner would have air conditioning and heating. The outside air conditioning equipment would be removed and there would be no noise from air conditioning in the summer. A homeowner would see $600 to $840 annual savings in their total utility bills a year, from reduced costs for heating and cooling. This is equivalent to $50 to $70/month. Total savings over the 30 year lifetime of the equipment, assuming the cost of utilities increases an average of 3% per year and the 30% tax credit was received, would be $17,000 to $31,700. It takes 9 to 16 years for the utility bill savings to exceed the extra cost of $6,100 - $16,000 that was paid for installing geothermal instead of a natural gas furnace.

The natural gas bill would decrease but the electric bill may increase because the sum heating cost would now be shifted to the homeowner's electric bill. Overall the utility bill should decrease. If the homeowner had no air conditioning previously, the electric bill would increase and the total savings would be less but that would be the price for gaining air conditioning. Another benefit is carbon emission savings. Because the homeowner consumes less electricity and natural gas to heat and cool their home, the amount of carbon emissions generated from heating and cooling their home decreases 29% - 32%.

7.1.4 Permitting

Water, gas, and oil well drilling are regulated by Ohio Department of Natural Resources (ODNR). Closed loop geothermal boreholes are considered to be wells and must be installed by a well driller licensed in the State of Ohio. The well driller must submit a Well Log and Drilling Report to the ODNR for each borehole after it is completed. The horizontal piping system from the boreholes to building should be installed in accordance with the Ohio Mechanical Code and City of Shaker Heights building code. Permits for HVAC and geothermal borehole installation would be required from the City of Shaker Heights Building Department. If an electrical panel upgrade is done, then an electrical permit would be required from the Building Department also.

Geothermal borehole drilling generates water and drilling cuttings. Whether the drilling cuttings are to be reused to reach final grading at the site or contained for offsite disposal or reuse should be identified in the construction documents. We would recommend containing the cuttings in roll-off containers onsite to make moving the cuttings easy, or having temporary piles that are located outside of the borehole drilling area because this allows the drilling to progress on this congested site.

Drilling water is generated from water being utilized for dust control, water used for some types of drilling methods, by groundwater in the borehole being displaced upward to ground surface, and water used for hydrostatic and flow testing of the piping. Given that the sites are each less than one acre in area, stormwater control would not be required unless there is a specific directive by Shaker Heights or the Owner. It is good practice for the contractor to contain water either in pits or tanks, install barriers to prevent silt and mud from entering neighboring properties, the street or storm drains.

Drilling water management should be incorporated into the overall site construction stormwater permitting and stormwater pollution prevention plans if they are required. The site is located in an area served by combined sewers. The stormwater catch basins are maintained by the Northeast Ohio Regional Sewer District (NEORSD). Any water that cannot drain back into the ground would be discharged into catch basins after obtaining a permit from the NEORSD. NEORSD would confirm discharge location and identify if any treatment is required.

A temporary discharge permit must be obtained from NEORSD at least 48 hours prior to drilling water or water from hydrostatic or flow testing of the piping being discharged to a catch basin or sanitary sewer. NEORSD would require that discharge flow be monitored to determine the amount of water discharged and may require sampling and laboratory analysis of the water as well as a fee of $48.00/mcf. Generally, NEORSD requires that no mud or turbid water be discharged into the catch basins and therefore settling and/or filtering of the water to remove solids prior to discharge would likely be required. Typically, this is done with sediment traps, portable tanks, bag filters and/or silt bags.

Geothermal Permit Summary

Vertical Closed Loop Systems installed at this site would require:

- Utilizing a State of Ohio licensed driller/installer;
- Permits for geothermal wells (boreholes), HVAC and/or electrical from City of Shaker Heights Building Department;
- Obtaining a Temporary Discharge Permit from NEORSD and meter if the water would be discharged into a catch basin, sanitary or combined sewer; and
- Submitting of the Geothermal Well Log and Drilling Report to the ODNR.

7.1.5 Modifications to Existing Homes

Existing homes can be retrofitted to use geothermal either by modifications or full replacement to the existing HVAC equipment. Homes built before 1970 generally do not have energy efficient construction and need to be upgraded with insulation, sealing, and/or windows to make geothermal a viable option. Modifications would be dependent on the type of heating system.

7.1.5.1 Natural Gas Forced Air Furnaces

Homes with forced air furnaces can be retrofitted several ways. In the Shaker Heights climate, a dual fuel system to provide back-up heating is recommended. A geothermal split system that includes a geothermal coil can be placed in the supply ductwork, the existing furnace remains as the air handler with the natural gas system as back up or supplemental heat for peaks, a geothermal heat pump without a fan unit is connected. Ductwork and the fan may need to be modified. Another option is to remove the existing furnace and install a new water to air geothermal heat pump with electric resistance heating strips installed in the ductwork for back up heating. Below is a picture of a split system. If a water-to-air geothermal heat pump was used instead, the small unit to the right would not exist.

Figure 3 – Geothermal Split System

7.1.5.2 Boiler with Steam or Hot Water Radiators

Houses that use steam or hot water systems that operate over 120°F would require a full replacement because they would not work at the lower temperatures of the geothermal hot water system and cannot be used for air conditioning. Air conditioning can be provided with a geothermal water-to-air heat pump or new variable refrigerant flow (VRF) or variable refrigerant volume (VRV) systems, commonly known as ductless mini-split systems (mini-split).

Because both geothermal water to air and mini-split systems can provide heating and cooling, the heating is now provided by these systems and the boiler system is either removed or left in place as a back-up heating system. The geothermal water to air system would be a geothermal water-to-air heat pump and new ductwork would need to be installed throughout the house. A mini-split system would require a unit to be installed in each room and tubing installed from the heat pump to each mini-split unit. If the boiler system is removed, electric resistance heat strips should be installed in the ductwork for back-up heating.

Figure 4 - Mini-Split System Units

7.1.5.3 Radiant Floor Systems or Low Temperature Hot Water

Geothermal heat pumps are available as water-to-water units which are installed with radiant floor, fan coil, or hot water radiators distribution systems. The heat pump would be installed in addition to the existing boiler or electric hot water tank. Radiant floor systems are typically new construction because floor replacement or modifications are expensive.

7.1.5.4 Desuperheater Option for Hot Water

Heat pumps can be supplied with desuperheaters which are heat recovery components that transfer waste heat from the borehole return to generate hot water. Desuperheaters are optional and are not recommended in Shaker Heights because they divert the heat that would be stored in the ground for the winter to being used for making hot water. This exacerbates the imbalance of significantly more heating required than cooling and would cause the borehole field size to increase. All the heat extracted from the system should be directed to the borehole field for use in the heating season. This conclusion is true for traditional house construction in Shaker Heights. Desuperheaters would be practical in cases where a building construction was super-insulated requiring more cooling than heating or potentially for a passive solar house design.

7.1.6 Installation Considerations for Adding Geothermal

Items that need to be considered by the owner and/or HVAC contractor when converting to geothermal are:

- Check that existing electrical service can support new loads and upgrade as required;
- Existing air handler fan and motor are variable speed and/or can deliver geothermal design air flow rates;
- Ductwork size is suitable for geothermal heat pump design air flow rates;
- Sufficient room exists in supply duct to insert cooling coils;
- Return air is ducted to the unit;
- Existing air handler can accommodate new refrigerant;
- Thermostats are replaced to serve a multi-stage or variable speed fan; and
- Outside air is available for ventilation with heat recovery

7.2 Solar Thermal

Solar thermal is installed at a home to create hot water. The major components of a solar thermal system are a bank of solar collectors, a pump, and a heat exchanger which transfers the heat collected from the sun to a hot water heater or a geothermal ground loop. When there is enough sunlight, the pump circulates water through the solar collectors to capture the sun's heat.

The solar collectors themselves, known commonly as "flat-plate" collectors, are clear plates with tubes running through them. Other types of solar collectors include unglazed collectors, which are tanks painted black to absorb sunlight, and evacuated tube collectors, which consist of a double layer of tubes with a vacuum between them. The flat-plate type collectors were chosen over other styles because they are the ones most commonly used for hot water-heating applications in this region and offer the best tradeoff between cost and performance.

As the water passes through the tubes in the collectors, it absorbs the sun's energy and heats up. After passing through the collector, the warm water is piped into the building and through a heat exchanger, where it gives up its heat and cools down. Once cold, the water is pumped back into the solar collectors and the cycle starts over again. If the solar thermal system is used to heat water, then the heat exchanger is a storage tank similar to a conventional water heater. The heat added from the solar thermal system significantly reduces the amount of natural gas or electricity required to heat hot water. If the solar thermal system is used to assist a geothermal heating system, the solar heat is added to the ground loop, which improves the performance of the geothermal system and decreases the number of boreholes which need to be drilled.

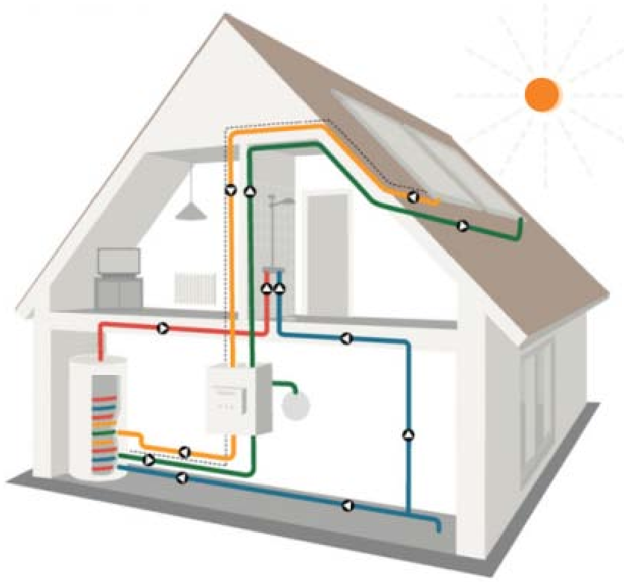


Figure 5 - Residential Solar Thermal for Hot Water Heating

7.2.1 Important Considerations

Location and Orientation

Solar thermal collectors require an unshaded area facing south for maximum gain. A roof surface that faces east or west can be utilized if the collector can be tilted to face south. Areas where they are unlikely to be damaged are best. Areas which would remain unshaded through all seasons and into the future are ideal for solar installations. Roof mounted systems are typical for Cuyahoga County because they are less intrusive from an aesthetic standpoint, yard space is not lost, and damage from incidental contact is less likely. The roof and structure must be examined to verify they are in good repair and able to support the collectors.

Ideally for year- round domestic hot water production, a collector should be tilted at an angle equal to Shaker Heights latitude; 41 degrees, however studies have shown that performance is not degraded significantly by reducing the angle. A collector could be installed at the angle of the roof for aesthetics and ease of installation. Depending on the particular site, the modules are tilted between 5 and 60 degrees in this region. Figure 6 (*next page*) shows potential locations for solar equipment at Sutton Place in yellow, and areas where trees would need to be trimmed in red.

Figure 6 - Identification of Suitable Space for Solar Collectors for Sutton Place

Water Storage and Backup System

In the Shaker Heights climate, solar thermal does not produce hot water at all times when it is demanded. A backup system for creating hot water and a storage tank should be installed to make hot water available any time. A well-insulated storage tank designed for solar hot water use that has at least 1.5 gallons of storage for each square foot of collector should be installed. In the Shaker Heights climate, antifreeze protection by either using antifreeze solution or by having the system drain to a tank inside whenever not in use is required. Larger tanks may be required for drain back designs.

Number of People in the Household and Purpose

Evaluation herein focuses on a typical-sized household of 2.5 people, but the amount of hot water needed by a home increases directly with the number of people. If more people are in the household then a larger collection area and larger storage tanks would be needed to deliver the same percentage of savings and usage.

Pool and Hot Tub Heating

Solar thermal is a cost-effective means of heating a pool in the summer. If the solar thermal system would be used for heating a pool or a hot tub, then a larger area of panels is required than stated herein for domestic hot water production only. The area of solar collectors required would range from 50% to 100% of the pool area, depending on the exact collector selected. The federal tax credit and the Green Energy Ohio credit, as well as many other rebates and incentives do not apply to systems used for heating a pool or a hot tub

Qualifying for Rebates and Incentives

There is a federal tax credit available to homeowners for 30% of the total cost of the solar thermal system. The requirements for this credit are explained in the previous Geothermal section. Requirements specific to solar thermal are that the solar water heater must provide at least half the energy used to heat the dwelling's water and be certified by the Solar Rating Certification Corporation (SRCC), a non-profit organization that administers a certification, rating and labeling program for certain solar-thermal systems sold in the United States or an equivalent state rebate certification. A rebate from Green Energy Ohio is available of up to $2,400. Obtaining these credit and rebates would significantly reduce the system cost and increase overall savings. Important considerations for the Green Energy Ohio (GEO) Solar Thermal Rebate as of January 2011 include:

- Rebates would continue until the fund is depleted and as of December 2010, the funding is still available;
- System must be installed by a GEO Solar Thermal Certified Installer;
- System must be installed in a residential for supplemental domestic hot water heating;
- System must be brought into service after January 1, 2009;
- Rebate is dependent on application being approved and the system passing an inspection after installation; and
- Rebate not provided until after system passes operating inspection

State of Ohio Treasurer's office offers an ECO-Link loan to provide reduced-interest rate financing to Ohio homeowners for weatherization projects and energy efficient appliances in their homes. Participants receive a 3% interest rate reduction on bank loans for five years (or seven years if the loan amount is greater than $25,000). Homeowner must be eligible for a loan from a participating bank and provide receipts from contractors and product information within 60 days of receipt of the loan. A homeowner would go directly to a participating bank to participate in this program.

Contractor Selection

Even though solar thermal has been in residential applications for several years, many HVAC contractors do not have significant experience installing it. It is important to select a contractor(s) with:

- References for multiple residential installations;
- Experience installing solar thermal systems for at least three years;
- Contractor licenses and/or registrations with the State of Ohio and the City of Shaker Heights;
- Certifications from Green Energy Ohio;
- Solar Thermal Installer Certification from National American of Board Certified Energy Practitioners (NABCEP); and a
- Distribution agreement with a Solar Thermal Manufacturer.

7.2.2 Size and Costs

A typical solar thermal water heating system installed on the roof of a house on Sutton Road or Sutton Place would utilize two solar flat plate collectors with associated piping and insulated hot water storage tank. This would provide the majority of hot water for an average sized household of 2.5 people. The savings vary depending on whether the system would replace the use of natural gas water heater or an electric water heater. A summary of the cost and savings can be viewed in the following table:

	Replacing Natural Gas Water Heater	**Replacing Electric Water Heater**
System Size	2 Panel – 15 MMBTU/yr	2 Panel – 15 MMBTU/yr
Extra Cost for Solar Thermal Vs. Hot Water Tank	$3,600	$3,600
Capital Cost Excludes Cost to Make Homes Energy Efficient	$9,800	$9,800
Estimated Rebates	$5,400	$5,400
Capital Cost After Rebates/Credits	$4,400	$4,400
Payback Year w/Incentives	17	8
Annual Cost Savings ($/yr)	$260.25 (>75%)	$556.27(>75%)
Lifetime Savings	$6,500	$13,900
Annual Energy Savings	24.3 MMBTU/yr	4,279 kilowatt-hours/yr
Life Cycle Energy Savings (30 year)	729 MMBTU	128,730 kilowatt-hours
Carbon Savings MTCE/yr	1.3	3.0

Table IV. Summary of Estimated Costs and Benefits for Solar Thermal

The homeowner would pay between $9,800 +/- 15% for installing a two collector system of approximately 20 sq. ft, which is equivalent to the size of a twin mattress, to replace their natural gas hot water heater. A tax credit of thirty percent of the total cost of the solar thermal

system, which is approximately $3,000 and up to $2,400 from the Green Energy Ohio Rebate, would be returned to the homeowner after the system has been installed and inspected.
The homeowner would need to collect paperwork identifying the cost of the system and the energy performance of the solar thermal equipment from the contractor for their tax records and to complete the IRS tax forms. Additionally, the contractor should submit the GEO Solar Thermal Part 2 application and perform any work necessary for the system to pass the inspection. Once the homeowner receives the tax credits and rebates, the net cost would be approximately $4,400. The extra cost for installing solar thermal over the cost that a homeowner would have incurred replacing their natural gas hot water tank with a similar tank is approximately $3,600.

A single system would offset an estimated 24.3 MMBTU of natural gas annually. These energy savings translate into an estimated carbon emission reduction of 1.3 metric tons per year and an annual cost savings of $260 or $22/month. The cost savings achieved by offsetting natural gas consumption would pay for the cost of installing a solar thermal system instead of a natural gas hot water heater in 17 years. Further incentives may be needed to encourage the homeowner to make an investment to replace a natural gas hot water heater since it is typical that they may not plan to remain in the home for the 17 year payback period.

Installation of the recommended two panel system for an individual household can be completed is less than one week if the work is done consecutively. The GEO Solar Thermal Rebate inspection may take 4 to 6 weeks after submitting the application. The tax credit would be gained at the time of tax payments.

7.2.3 Permitting

The installation of the collector is an exterior improvement which would have to be submitted to Shaker Heights Planning and Development Department for consideration by the Architectural Board of Review (ABR). After a plan review is completed, permits would need to be obtained from Shaker Heights Building Department for the mechanical and electrical work.

7.2.4 Modifications to Existing Homes

The space available for the solar thermal storage tanks would likely dictate the type of modifications made inside the existing homes. A back–up source of creating hot water is needed for solar thermal in Shaker Heights. The existing hot water tank may be left in place to provide this back-up if there is sufficient area available for the solar thermal tank and the existing hot water tank. Otherwise a new solar tank which acts as a heat exchanger and storage may be necessary. This issue should be carefully reviewed by homeowners and their contractors.

Collectors would either be located on the roof or in the yard. Both would require restoration immediately after installation.

7.3 Solar Photovoltaic

7.3.1 Benefits

Solar photovoltaic modules would be installed on the home to produce electricity that replaces the electricity purchased from FirstEnergy whenever sunlight is available. The benefits provided by installing Solar Photovoltaic are:

- Generates electricity;
- Lowers utility bills;
- Requires little maintenance;
- Lowers greenhouse gas emissions; and
- Environmentally friendly.

7.3.2 Important Considerations

Location and Orientation

To maximize usage of the Shaker Heights solar resource, the panels should be placed facing south. Panels placed facing east or west would have 20%-25% less solar resource than a south-facing panel. When homes are not oriented to face south, as is the case for most of the homes on Sutton Road, then modules can be placed on hip or side south-facing roof areas but these often are smaller and have limited space. Another option is to install on the east- or west-facing roof areas and tilt the panels to face the south. Some garages that support the modules may offer solar space if the interference from trees at the rear property lines can be mitigated. The individual homes might be made to accommodate approximately 2kW of photovoltaic modules. It is imperative that the solar installer examines the structure to confirm it can support the system.

Figure 7 - 3372 and 3374 Sutton Road. The front of the house faces east.

Figure 8 - Modules tilted to face south on an east-facing roof. (Photo from civicsolar.com)

Ideally, a collector should be tilted at an angle equal to Shaker Heights latitude; 41 degrees, however studies have shown that performance is not degraded significantly by reducing the angle. A collector could be installed at the angle of the roof for aesthetics and ease of installation. Depending on the particular site, the modules are tilted between 5 and 60 degrees in this region.

Aesthetics

Aesthetics would need to be evaluated regarding the surrounding area and context. Modules visible from the street at a historic house in a landmark or historic district may not be acceptable to the neighbors or the Shaker Heights Planning Department. Integrating solar photovoltaic onto a more modern house construction such as the Sutton Place condominiums may be acceptable to the neighbors and the Planning Department. Homeowners should consider that many people view static flat panel modules as less intrusive than ground mounted systems, systems with tracking mechanisms, and parabolic-shaped systems. The Planning Department or a homeowners association may require screening or choosing a location on the property to prevent the solar photovoltaic system from being visible from the street. A balance between aesthetics and the right to access solar power would be determined in the plan review process.

Access to Daylight

Trees and neighboring structures that shade the solar modules would reduce the solar resource and likely energy production. The extent of trimming, demolition or building renovation to provide unobstructed daylight to the modules needs to be defined prior to installation. Careful review of the likelihood that an unshaded location now would continue to be unshaded for the 25 year life of the system needs to be completed. A homeowner does not have the right to trim or remove trees on surrounding properties, a condominium association common, nor in the tree lawn. Ohio does not have a shading law, similar to California that prohibits tree growth from shading a solar system after it is installed. However, Ohio law allows a homeowner to create a solar easement. An owner of a solar photovoltaic system has the right to negotiate an easement to provide unobstructed daylight onto their property with adjacent property owners and the City of Shaker Heights. A solar easement can only exist if both the solar photovoltaic system owner and the property owners who are affected by the easement agree.

Qualifying for Rebates and Incentives

There is a federal tax credit available to homeowners for 30% of the total cost of the solar photovoltaic system. The requirements for this credit are explained in the previous Geothermal section. There are no specific requirements for solar photovoltaic.

State of Ohio Treasurer's office offers an ECO-Link loan to provide reduced-interest rate financing to Ohio homeowners for weatherization projects and energy efficient appliances in their homes. Participants receive a 3% interest rate reduction on bank loans for five years (or seven years if the loan amount is greater than $25,000). Homeowner must be eligible for a loan from a participating bank and provide receipts from contractors and product information within 60 days of receipt of the loan. A homeowner would go directly to a participating bank to participate in this program.

Contractor Selection

Because many electrical contractors do not have significant experience installing solar photovoltaic, it is recommended to select a contractor(s) that has:

- References for multiple residential installations;
- Experience installing solar photovoltaic systems for at least three years;
- Contractor licenses and/or registrations with the State of Ohio and the City of Shaker Heights;
- Solar Photovoltaic Installer Certification from National American of Board Certified Energy Practitioners (NABCEP); and a
- Distribution agreement with solar photovoltaic manufacturer.

7.3.3 Modifications to Existing Home

In the simplest and most efficient grid-interactive system, major components include the modules, rack, inverter(s) and relevant electrical equipment. The modules generate the electricity and the inverter converts and synchronizes the electricity to match that of the utility's grid. Whether on the roof or on the ground, the modules are held down to some sort of rack or rail assembly made of aluminum or steel. As a result, appropriate attachments to the building or foundations are required to insure structural stability over the expected 25+ year service life of the modules. It is imperative that the structure be examined to verify that it can support the solar photovoltaic system.

Electrical conduit and wiring travels from the roof to the main electrical panel. The panel is typically located in the basement. The age and condition of the electrical service and infrastructure are also important considerations with respect to the size of a proposed solar photovoltaic array. Fuse boxes, older non-UL listed breaker panels, and undersized service conductors might require replacement. More recently upgraded electrical services can sustain some solar input with little changes required to the electric system.

Modules would either be located on the roof, exterior well or the ground. Any of these areas would need to be restored to pre-installation condition and/or to match their surroundings.

7.3.4 Size and costs

Electricity demand is highly dependent on human behavior causing it to vary significantly between households. The household consumption baseline is based on statistics published by U.S. Energy Information Administration (EIA). According to EIA, the typical Ohio household consumes 860 kilowatt-hours a month or just over 10,000 kilowatt-hours per year. The households (of which the two-family units contained two) included were at or below this consumption level. Other households may be higher or lower and therefore historical utility bills should be reviewed to gauge the potential savings in each individual case.

A household system might use 10 or more modules that take up just under 200 sq. ft. of space on the roof, which is typically equal to one half or more of one side of a roof. Technically, most hurdles exist with shading avoidance and roof orientation. Electrical conduit and wiring travel from the roof to the main electrical panel, which is most often in the basement. The age and condition of the electrical service and infrastructure are also important considerations with respect to the size of a proposed solar photovoltaic array. The connection to the grid is on the customer side of the meter, offsetting what would normally be purchased from the electric utility. A homeowner should require that the solar installer or another qualified person verify the structure can support the solar panels prior to their installation.

.

Figure 9 - Rooftop Installation. Photo DPW Solar

	Single Home
System Size	2kW
Installation Costs to Owner	$11,700
Estimated Rebates	$5,900
Installation Costs after Rebates	$5,900
Operating Costs over Lifetime	$200
Total Life Cycle Payback (Cash flow compared to net cost)	153%
Energy Savings over 25 Years	$8,900
Expected Payback w/ Rebates	25
Metric Tons of Carbon Avoided	36

Table V. Individual Household Sutton Road Solar Photovoltaic

The homeowner would pay approximately $11,700 for installing a 2kW [10 module] system that would supply approximately 25% of an average household electrical consumption and reduce the amount of electricity purchased from FirstEnergy. A tax credit of thirty percent of the total cost of the solar photovoltaic system and income from selling the Solar Renewable Energy Credits (SRECs), which cumulatively equal approximately $5,900, would be returned to the homeowner when they pay their taxes and over the life of the system, respectively. The homeowner would need to collect paperwork identifying the cost of the system and the energy performance of the solar photovoltaic equipment from the contractor for tax records and to complete the IRS tax forms. To receive SRECs, a homeowner needs to sign an agreement with an SREC purchaser, such as FirstEnergy, or with an SREC broker. Information for completing an SREC agreement should be provided by the solar installation contractor and/or the FirstEnergy website. Deducting the tax credits and rebates from the installation costs, the net cost would be approximately $5,800.

Electricity produced by the solar photovoltaic panels would be supplied to the home electrical panel. Any electricity produced that is not used by the home would flow backwards through the meter into the grid. Estimated savings generated over the 25 year lifetime of the system is $8,900 which is 153% of the cost of the system. This averages to a savings of approximately $30/month. These energy savings translate into an estimated carbon emission reduction of 36 metric tons, which is same as taking one car off the road for six years. The cost savings achieved by lowering the homeowner's electric bill would pay for the cost of installing the solar photovoltaic system in approximately 25 years. Further incentives may be needed to encourage a homeowner to make the investment to install solar photovoltaic because under recent trends, the average homeowner is not likely to remain in the same house for 25 years.

7.3.5 Permitting

The installation of the collector is an exterior improvement which would have to be submitted to Shaker Heights Planning and Development Department for consideration by the Architectural Board of Review (ABR). After a plan review is completed, permits would need to be obtained from Shaker Heights Building Department for the mechanical and electrical work.

Because electricity produced by the solar photovoltaic system is being sold to FirstEnergy, a net metering application must be filed with them. FirstEnergy approval is a two step process which happens concurrently with the Plan Review with Shaker Heights. FirstEnergy's net metering division would review the application and report back to the applicant about feasibility and costs for equipment upgrades that would need to be paid by the applicant. The final agreement with FirstEnergy would be finalized after the installation and an inspection are completed. Once complete, FirstEnergy would install a new meter at the home, recording both the electricity flowing into the home and the electricity flowing out of the home onto the grid. A single home application is a common application but if multiple homes or an entire condominium association, such as Sutton Place, installs a system, the uncommon application may require a longer review.

7.3.6 Modifications to Existing Homes

In the simplest and most efficient grid-interactive system, major components include:

- Modules, installed on the roof, wall or ground mounted;
- Support rack, or rail assembly made of aluminum or steel, secured to the building members, to which the modules are attached;
- Inverter(s), a piece of electrical equipment that converts and synchronizes the electricity to match that of the utility's grid; and
- Relevant electrical equipment, such as additional disconnect switch required by Code.

Figure 10 (below) illustrates a typical single home installation. Electricity would flow from the inverter to the breaker panel where it's distributed to household loads. Any loads not met by the electricity from the inverter are supplied from the utility grid and travel through the meter. In a case where more electricity is flowing through the inverter than is demanded by the household loads, the excess electricity flows backward through the meter onto the utility grid. A new meter, approved by the household electricity provider, that measures and records power flow in both directions would be installed in place of the existing meter. Typically the modules are installed on the roof, the electrical meter is located on outside of the home in place of the existing meter, and the other items are inside the home or garage near the existing electrical panel.

In the case of a two-family home, a similar system would be required for each meter. The owner of the two-family home may want to combine the services into one meter and add more panels in order to:

- Maximize the amount of electricity consumed on site which maximizes the savings;
- Eliminate cost and space required for second set of equipment;
- Process only one permit through FirstEnergy;
- Increase rent or improve cache by including electrical bill in the rental; and
- Increase market value of home by lowering the operating cost or increasing rental income.

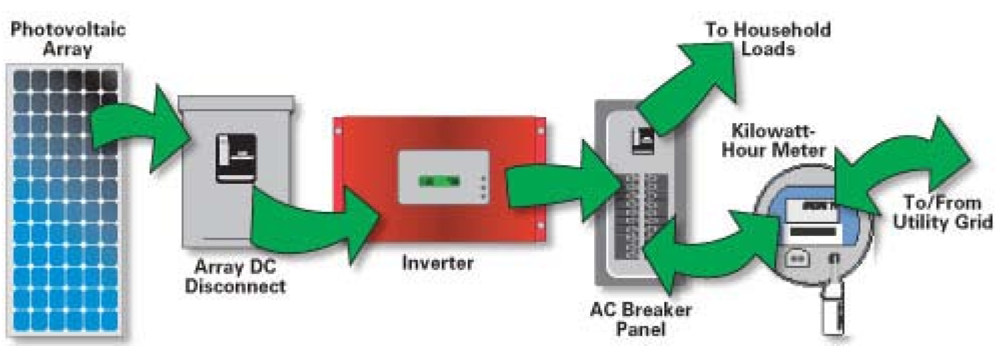


Figure 10 - Solar Photovoltaic Customer Side of Meter Connection. (From Home Power Magazine: http://homepower.com/basics/solar/)

8. DISTRICT SYSTEMS - SUTTON ROAD NEIGHBORHOOD

8.1 District Geothermal

A district geothermal system would be a centralized or interconnected borehole field that serves multiple home and structures in a given area. The system would provide the same general benefits to the homeowners as was detailed in the geothermal section for the single family and two-family homes. The intended benefit of using a district system is to reduce the size of the borehole field due to combining offsetting heating and cooling demands from different locations. However, our analysis revealed there was no diversity amongst the loads in the study area and therefore the borehole field size did not decrease. However a district system may also be beneficial for the following reasons:

- Provides a financing mechanism to homeowners that spreads the installation cost over a long time that can be paid for with savings gained from its use;
- Eliminates or reduces upfront costs for homeowners;
- Takes advantage of tax credits available to the homeowners;
- Creates single source responsibility for the operation, maintenance, and performance of the system;
- Provides guaranteed performance and predictable costs to homeowners;
- Creates an entity for Shaker Heights to manage system installations;
- Reduces utility bills;
- Upgrades HVAC in the homes;
- Provides air conditioning in the homes;
- Can provide source of income to City through use fees; and
- May create new jobs in Shaker Heights.

8.1.1 Important Considerations

Borehole Location and Easements

Modeling shows that consolidating the district boreholes in a single grid at standard spacing in one location creates a heat island in the middle of the borehole field that reduces the overall capacity over time. Creating boreholes in fewer long lines instead of a single block is a better, more cost effective practice. The affect becomes worse when boreholes are further apart and grouped into one larger area because of long term thermal interference between the boreholes.

A long, single line of boreholes has more capacity than a rectangular grid of boreholes. Using the three figures below that show all the potential borehole locations in yellow, we found that there is enough area to locate three boreholes for each Sutton Place residence, four boreholes for each Sutton Road house and 20 to 30 boreholes for the future development at Sutton and Van Aken. The boreholes highlighted in red could be utilized.

On Sutton Road, the boreholes are shown in two parallel rows on each side of the street on the homeowner's property. An easement with each property owner would be required to install these boreholes outside the right of way. To maintain the district boreholes within the public right of way, deeper boreholes or boreholes that are a concentric or specialty design would be required.

A mechanical building could be installed anywhere on the loop but a central location in an open, unoccupied parcel may be best suited for it.

We recommend that if a geothermal district should be created, borehole locations at Sutton Place and the future development would be reviewed by both the Homeowners Association and Shaker Heights of Shaker Heights in order to come to an agreement on whether boreholes should be located in the right of way or a common area. Easements would need to be created if the boreholes are located outside the right of way.

Figure 11 - Sutton Place Preferred and Potential Borehole Locations

Figure 12 - Sutton Road Preferred and Potential Borehole Locations

Figure 13 - Future Development at Transit Village Preferred and Potential Borehole Locations

Energy Improvements

As previously addressed in the Single Family and Two Family Sections, homeowners must conduct an energy audit and make improvements to the building shell to bring the home heating and cooling consumed to be on par with average modern construction. The cost of building improvements to reduce the heating and cooling demand would pay for itself in the cost reduction of the geothermal system. Without energy improvements, the geothermal system size is too large to fit into the existing area and cost cannot be paid for with energy savings over a thirty year lifetime of the geothermal heat pump system components.

Supplemental Heating

Our recommendation for both individual and district geothermal is to install geothermal with supplemental electric resistance or natural gas furnace to supply heat that cannot be provided by the geothermal system. Geothermal modeling and financial analyses were performed on the following scenarios:

- 100% of heating and cooling served by geothermal;
- Partial geothermal with supplemental heating provided by solar thermal; and
- Partial geothermal with supplemental heating provided by natural gas furnace.

Results of these analyses indicate that partial geothermal with supplemental heating provides the most benefit for the least cost.

Geothermal Utility Agreement

Creating district systems or utilities with thermal power purchase agreements is a new mechanism that is beginning to be implemented in the United States. The key to a homeowner gaining the savings identified in the studies is for temperature of the geothermal water entering the home to be within a specified range. Heat pumps can only operate in a certain temperature range and, furthermore, can only produce heating and cooling for less cost than a natural gas furnace if the temperatures are within a certain range. When the borehole supply is too hot or too cold, the heat pump consumes much more electricity and the homeowner's electric bills would increase. To protect the interest of Shaker Heights and residents, we recommend the following engineering and operation controls be considered for the agreement:

- Performance guarantees that water would be supplied to the customer continuously within a specified temperature range;
- Defined rebates would be given to customers in the event that supply temperature is out of compliance with the agreement. Rebate shall be weighted based on the time and temperature. Supplying water at 90F for 2 days would result in a larger rebate than an occurrence of supplying 80F for 2 hours;
- Permanent installations or taps that would allow either injecting heat into the ground or removing heat from the ground in the event they become too hot or too cold;
- Distribution piping design to allow sections of the system to be shut down for repair or maintenance without eliminating service to the entire customer base;
- Customer equipment to be required to have back-up heating from either natural gas or electricity;
- Proof of operating and maintenance capital separate from customer fees that are available;
- Customer equipment shall be rated to perform at or above Energy Star standards for the current year;
- Defined borehole construction guidelines for access, suitable locations and drilling and cutting management;
- Clear definition of what equipment would need to be maintained by the customer and at what time;
- Clarification on rights of home or building owners to install geothermal systems that are not part of the geothermal utility;
- Requirement for standard pipe marking, locating equipment, and recordkeeping of the utility locations; and
- Federal tax credit shall be fully credited to the cost of the system.

8.1.2 Size and Costs

Because the district system in the study area did not reduce the number of boreholes or change the usage at each home, the size and costs for the individual's house is applicable to each home in the district system. The final cost would be dependent on the specifics of the geothermal utility offer. However, in order to make it desirable to the potential customers, costs should be less than or equal to the cost of the single and two-family costs previously discussed.

Installation at an individual house would take 1-2 weeks. Time to install a district geothermal system for the street independent of work at each individual home would be dependent on the amount of infrastructure required by the Geothermal Utility agreement.

8.1.3 Modifications to Existing Homes

The modifications for the district customers are the same as those listed in the Single-Family and Two-Family sections.

8.2 Solar Thermal

A district solar thermal system is not viable. A district system could provide more space and produce a greater percentage of the water used by the households. However, the value gained by this additional hot water is not greater than the cost of centralized storage, pumping, and running insulated distribution pipes from the storage to each individual home.

8.3 Solar Photovoltaic

Under the current cost of installation, Ohio net-metering law, and wholesale electric rates, energy development companies have not found installing a small, non-utility scale district system viable.

8.3.1 Benefits

The intended benefits of a district solar photovoltaic system are:

- To create a large array of modules that can produce more electricity per parcel;
- Produce more electricity with less infrastructure then multiple systems on individual homes;
- Provide electricity for communal power needs, such as area lighting or community buildings;
- Provide a net savings to the owner; and
- Less disruption to the existing homes.

8.3.2 Important Considerations

Ownership

District solar systems that are located in a central location would be connected to the utility grid. For existing residences, installing infrastructure to take the electricity generated at the array and distribute it to the homes separately from FirstEnergy would require the creation of a utility to own, manage and operate this system for all the customers. Shaker Heights has expressed that it is not interested in becoming a utility. A neighborhood or condominium association could potentially become the utility but they typically do not have the capital or organization structure to easily create a utility. An energy developer could install a system and act as the utility but they tend to create larger systems than could be installed in the open spaces available in the study area.

On new construction, such as the future development at Transit Village, a district installation could be designed to connect onto the customer side of the meters and offset the cost of electricity for all the residents equally. The cost of the installation could also be shared amongst the residents.

Interconnection

It is easiest to implement solar photovoltaic projects where there is an existing electricity customer and the solar generation would not exceed the electricity consumed by the property on a regular basis. Permitting is simplest and value of each kilo-watt hour of electricity produced is the greatest under these circumstances. An example of this in our study area could be an array that supplies area lighting at the Sutton Place park area or an array that supplies expected future multi-family development at Transit Village.

Under the Ohio net metering law, the value of electricity returned to the grid would only be a fraction of the value if supplied to the customer side of the meter instead. The wholesale value might be in the vicinity of $0.04-$0.05 cents/kilo-watt hour, significantly less than $0.13/kilo-watt hour the residential customer pays. For this reason, the maximum amount of savings or revenue to be generated would occur when the electricity generated from the solar photovoltaic is consumed on the customer side of the meter. Permitting with FirstEnergy is the simplest process when the amount of electricity flowing to their grid is not significant.

Connection to the grid at a point other than the customer side of the meter requires working with FirstEnergy's wholesale division rather than the net metering division. It is not a common practice in FirstEnergy's territory and in Ohio for anything less than a large utility-scale project such as dozens of large wind turbines. Since the independent district system with no electric service to the property now appears more like an electricity generator that would send a significant amount of electricity to the utility, the permitting process is more rigorous. In accordance with the Ohio net metering law, the payment for each unit of electricity decreases from the retail rate paid by homeowners to the wholesale rate. If virtual net metering existed in Ohio, as it does in some other states such as Colorado, then the homeowners or other customers could own a system that is connected to the grid remotely from their location and receive payment for the electricity produced at the retail rate as if it was located on their side of the meter.

Figure 14 - District Solar Photovoltaic - Ground mount system.
Image from DPW Solar Retrofit

Overall, it is easier to connect a district system on the customer side of the meter because to connect the district system to the grid side of the meter comes with the following financial, legal and regulatory challenges:

- Completing long term power purchase agreements with a purchaser of the electricity, likely FirstEnergy;
- Obtaining permits to connect and use the grid from First Energy;
- Receiving payment at lower wholesale electrical rate due to using First Energy grid; and
- Lengthening time to recoup investment because wholesale lower revenue for each kilo-watt hour generated.

Location

For a community or district system, there is a large array of modules, often on a ground-mounted rack, and commercial sized inverters and electrical switchgear. As a ground-mounted structure can be determined from scratch, facing the modules south is an easy task. In the study area, the groups of vacant lots provide some solar opportunities. Single vacant lots are typically not useful as the house to the south would shade the vacant lot and significantly reduce output. Adjacent lots of two vacant parcels would allow for one lot, approximately 50 feet x 100 feet, to host a solar installation. Three adjacent vacant lots could house solar on two of the three parcels.

All considerations regarding location, orientation, access to daylight, aesthetics, and tax credits and rebates explained in the Single and Two-Family section apply to the District System also.

8.3.3 Size and Cost

Electricity demand is highly dependent on human behavior causing it to vary significantly between households. The household consumption baseline is based on statistics published by U.S. Energy Information Administration (EIA). According to EIA, the typical Ohio household consumes 860 kilowatt-hours a month or just over 10,000 kilowatt-hours per year. The households (of which the doubles contained two) included were at or below this consumption level. Other households may be higher or lower and therefore historical utility bills should be reviewed to gauge the potential savings in each individual case.

If two adjacent empty parcels were available for a district system, the space could host a 40kW solar system and create the electricity needed by 5-6 households. Therefore, if four adjacent empty parcels were available, three of the four lots would likely be unshaded and could host modules totaling to 120kW, offsetting 15-24 households' electrical usage. The two groups of adjacent vacant lots would serve as district solar photovoltaic locations. These usable lots include 3378 and 3382 Sutton Road, as well as 3332 Sutton Road

The expectation for the Transit Village Development was that these new efficient units would use only 725 kilowatt-hours/month in electricity that *included* heating and cooling. For a 10-unit development, the annual consumption would be 87,000 kilowatt-hours. These expectations should be checked and adjusted when design of the development progresses.

In all cases, some tree trimming and maintenance would need some attention. For the future expected multi-family development at Transit Village, constructed rooftop space of 9,600 sq. ft. was assumed. This amount of space could host a system between 76kW on a flat roof and 115kW on a pitched roof facing entirely south. A metal roof that is expected to last 30 or 40 years might be a suitable substrate for such a photovoltaic installation. This could translate into 83,600kilowatt-hours annually or as much as 126,500kilowatt-hours, respectively. This is on par with generating all of the estimated electricity required by the 10 new efficient units. Creating a net zero energy development could be possible.

Full detailed proposals for an individual house and a Sutton Road district system are attached in Appendix A.

	District System	**Future Multi-Family in Transit Village**
System Size	40kW	80kW
Installation Costs to Installer	$243,700	$434,500
Estimated Rebates	$207,100	$388,900
Installation Costs After Rebates	$36,600	$45,700
Operating Costs Over Lifetime	$2,700	$3,100
Total Life Cycle Payback (Cash Flow Compared to Net Cost)	193%	486%
Energy Savings Over 25 years	193%	486%
Expected Payback w/ Rebates	$70,700	$221,900
Metric Tons of Carbon Avoided	25	7

Table VI. Solar Photovoltaic Benefits and Costs Summary

The Transit Village Development would pay approximately $434,500 for installing an 80kW which would supply approximately 100% of all proposed households electrical consumption over a year and offset the electricity purchased from FirstEnergy. The system may be owned by a Transit Village Homeowner Association or a separate solar developer. A tax credit of thirty percent of the total cost of the solar photovoltaic system and income from selling the Solar Renewable Energy Credits (SRECs), which cumulatively equal approximately $388,900, would be returned to the Owner when paying taxes and over the life of the system. The Owner would need to collect paperwork identifying the cost of the system and the energy performance of the solar photovoltaic equipment from the contractor for tax records and to complete the IRS tax forms. Tax regulations for non-residential credits should be reviewed by a tax consultant prior to installing the system.

To receive the SRECs, the Owner would need to sign an agreement with an SREC purchaser, such as FirstEnergy, or with an SREC broker. Information for completing an SREC agreement should be provided by the solar installation contractor and/or the FirstEnergy website. After deducting tax credits, incentives, SRECs and rebates from installation costs, the net cost would be approximately $45,700.

Electricity produced by the solar photovoltaic panels would be supplied the building electrical panels first. Any electricity produced that is not used by the residents would flow backwards through the meter into the grid. Estimated savings generated over the twenty-five year lifetime of the system is $221,900 which is 486% of the cost to install the system. This averages to a savings of approximately $740/month for the development. These energy savings translate into an estimated carbon emission reduction of 1,041 metric tons, which is the same as taking 10 cars off the road for ten years. The cost savings achieved by lowering the electric bill and receiving SREC payments would pay for the cost of installing solar photovoltaic system in approximately 7 years.

The payback may be lowered when the Owner combines it with accelerated depreciation and other available commercial tax incentives.

8.3.4 Permitting

Because it is an exterior improvement, the system would need to go through Plan Review with Shaker Heights. Once the Plan Review is completed, building and/or electrical permits would be required from the Building Department.

FirstEnergy approval is a two-step process that happens concurrently with the Architectural Review and Building Department Plan Review and Approval. Such an installation of a district, utility-side generation requires working with the wholesale division. FirstEnergy's wholesale division would first report back on the feasibility and potential upgrades that may have to be paid for by the applicant. If the applicant wishes to continue the process, FirstEnergy would perform a facility study to determine the equipment upgrades, identify upgrades and costs and then would negotiate a schedule of payments and activities to complete the improvements. If the applicant and FirstEnergy come to an agreement, FirstEnergy and the applicant would proceed with installing their systems. FirstEnergy would not finalize the agreement until the solar photovoltaic installation is inspected and witness-tested. The permitting process with FirstEnergy may require 6 months to a year or more to complete.

The future development at Transit Village application process could look much like the individual residential application because it would connect on the customer-side of the utility meter.

8.4 Funding and Ownership Mechanisms

Systems on individual households would be installed through private homeowners by obtaining their own financing through a bank or entering into a long term power purchase agreement with a third party. In all cases, the federal energy tax credit equal to 30% of the installed cost with no limit would be available to the owner to offset the cost. The tax credit is a dollar-for-dollar savings on the amount of tax owed. Tax credits can be applied for multiple years. Solar photovoltaic systems would receive income from selling the Renewable Energy Credits (SRECs) on the open market for a significant portion of the system life. Distribution of SREC income should be clearly identified in any financing agreement into which the owner enters.

District systems would require an owner that can negotiate the Solar PPA with FirstEnergy in order to obtain financing for the construction project. The wholesale rate for electricity that is received when the solar photovoltaic system is connected directly to the power grid instead of to a power consumer creates a significant disincentive unless the system is very large, utility scale that lowers the installation cost per unit. As a result, the district system is unlikely to be a viable option unless the net metering law is revised and/or the SREC value increases significantly.

9. CONDOMINIUMS

Residents of condominiums, cluster homes, or other homeowner type associations typically have bylaws regarding exterior improvements or use of common areas. Commonly, any time an individual resident of these areas wants to install geothermal, solar thermal or solar photovoltaic systems, a review and approval process with the homeowner association would be required prior to any governmental review.

Often homeowner associations prohibit solar systems because any exterior improvement that creates a visible area that is different from the rest of the development is prohibited. Geothermal boreholes may also be prohibited if bylaws prevent use of the ground beneath common areas. Geothermal may be allowable because it is not visible, but the specifics would need to be reviewed with the association. It may be beneficial to promote that the association install systems that serve a common area or that every building install a system to keep the uniform look of the development.

10. APARTMENT 14101 S. WOODLAND

The second study site was 14101 S. Woodland. The building is a twelve-unit, two-story brick structure that was built in the 1940s. It is located near light rail and shopping, and is a fairly typical Shaker Heights apartment building.

Figure 15 - 14101 S. Woodland Study Area

10.1 Geothermal

For building owners who pay the heating and cooling utility bills, a geothermal system would reduce their utility bills and improve the market value of their property. If the individual residents pay the heating and cooling bills, apartment owners would see the direct benefit from lower utility bills for the common areas and indirectly through the increased renter retention due to owners' lower utility bills and comfortable environment from a state-of-the-art heating and cooling system. Tax incentives regarding depreciation and property tax financing are available through the local, state and federal governments, which may provide additional reasons for commercial building owners to install geothermal when replacing an existing system.

10.1.1 Important Considerations

The borehole piping, outdoor equipment location and contractor selection items identified in the Single Family and Two-Family Geothermal section apply to the apartment building also.

<u>Qualifying for Rebates</u>

There is a federal tax credit available for commercial geothermal systems for 10% of the total cost of the geothermal system (borehole field + mechanical system upgrades). Obtaining the credit would significantly reduce the system cost and increase overall savings.

Important considerations for the tax credit, as of January 2011, include:

- It is a tax credit that reduces taxes owed dollar for dollar;
- System must be installed in a home owned by the taxpayer but primary residency is not required;
- System must be brought into service between 2008 and 2016;
- Heat pump must meet the Energy Star performance criteria;
- There is no limit to amount of the credit or the number of times the credit can be claimed;
- Tax credit can be combined with other tax credits;
- If the tax credit exceeds the value of taxes owed, the credit can be applied forward for a limitless number of years;
- The tax credit would not create a tax refund; and
- Credit is calculated as a percentage of total system cost including equipment, piping, and labor.

A rebate of up to $600 is available for an Energy Star rated geothermal heat pump for a small commercial purchase that is rate code GS. The rebate can be obtained from FirstEnergy if a FirstEnergy certified installer is used and the system is installed between March 23, 2011 and December 15, 2012. There currently is no rebate or incentive from local or state governments for geothermal. Tax laws and their interpretation change frequently. A homeowner should verify the most up to date tax rules with a tax advisor or internal revenue service prior to purchasing the system. Additionally, homeowners should ask their local government, utility, and contractor for available rebates and other incentives before purchasing a system, because the programs frequently change.

Existing Home Conditions

Older apartment buildings typical of Shaker Heights would require energy efficiency upgrades to make a geothermal system viable. Before installing alternative energy systems, homeowners and building owners should conduct an energy audit and implement the recommended maintenance and upgrades to reduce the amount of energy consumed for heating, cooling, and electricity to be equivalent to average modern construction.

A good time to consider installing geothermal is when the heating and cooling equipment needs to be replaced either because of age or poor efficiency or if air conditioning needs to be added to a home. Replacing a newer, high efficiency furnace, boiler or air conditioner would generate lower utility bills savings than older, inefficient units. Additionally, if the cost of natural gas is expected to increase, then heating with geothermal may become less expensive than even a new, highly efficient boiler or furnace.

The feasibility and cost of installing geothermal on an existing apartment building is directly dependent on the condition and type of heating and cooling equipment currently being used in the home. Existing equipment would determine if it should be completely replaced, or a geothermal heat pump should be added onto the existing. Ductwork, piping, cooling units and other items may need to be modified or added. Details on modification options are explained in the Modifications to Existing Homes section of this report.

10.1.2 Size and Costs

14101 S. Woodland is an apartment building having similar construction to many other apartment buildings in Shaker Heights. It is a 14,400 square feet, three-story, masonry structure built in the 1940s that has twelve apartments, four common stairwells, a basement common area, and a mechanical room. An attached single story parking garage is heated by a single hot water fan coil unit to prevent freezing of the fire protection piping.

Building and utility data collected from conducting a site visit, reviewing the building construction drawings, interviewing the building superintendent and obtaining the previous year's utility bills for the common spaces were utilized to create an energy model. The model results were compared to actual utility bills to create an existing conditions heating and cooling profile.

The energy model for 14101 S. Woodland generated an annual total heating demand of approximately 610,000 MBTU/yr and a cooling demand of 80,200 MBTU/yr which is approximately 7.6 times more heating than cooling. Peak heating demand was 355 MBTU/hr and peak cooling demand was 183 MBTU/hr.

The costs of geothermal either with installing ductwork throughout the building or with VRV does not pay for itself in 30 years or less as shown in the table below. On another apartment building, if the ductwork did not have to be installed the payback for a geothermal system could be reduced to about 15 – 20 years.

	Geothermal w/ductwork	Geothermal w/VRV
Est. # of wells /KW	*20-24 u-tube wells*	*20-24 u-tube wells*
Capital Cost excludes cost to make homes energy efficient	*$216,000 - $280,000*	*$387,000 - $450,000*
Estimated Rebates	*$65,000 - $84,000*	*$116,000 - $135,000*
Est. capital cost after rebates (excludes making homes energy efficient)	*$151,000 - $196,000*	*$271,000 - $315,000*
Extra Cost for Alternative Energy vs. Standard	*$183,000 - $247,000*	*$354,000 - 418,000*
Payback year w/incentives	*33 - 39*	*58 - 61*
First year energy cost reduction	*$2,700*	*$2,100*
Lifetime Savings	*N/A*	*N/A*
% Greenhouse gas emissions reduction	*29% - 32%*	*26% - 28%*

Table VI. 14101 S. Woodland Geothermal Summary

10.1.3 Modifications to Existing Apartment Building

The apartment building at 14101 South Woodland was built in the late 1940s and currently utilizes the original radiators and hot water distribution piping for space heating. The heating system is fed by three natural gas-fired boilers. Air conditioning is presently provided by through-wall air conditioners in individual apartments that serve just the living room and tenants can add window air conditioners. This study considered three potential geothermal retrofit configurations to the building: a variable refrigerant volume (VRV) heat pump system, a distributed water-to-air heat pump system, and a central water-to-water heat pump system.

A variable refrigerant volume (VRV) heat pump system coupled to a geothermal ground loop was considered to replace the through-wall air conditioners and reduce usage of the boilers.
A VRV heat pump system would consist of a central heat pump or bank of heat pumps connected by refrigerant lines to low-profile fan coil boxes distributed throughout individual rooms. A VRV system is able to adjust its heating or cooling output based on the amount of demand present at a given time, allowing for improved climate moderation and for control of

temperature by a thermostat in each individual apartment. The existing radiator heating system would remain in place to provide backup heat should heating demand exceed the capacity of the VRV system.

The study also investigated an alternative geothermal system configuration which would consist of water-to-air heat pumps individually located in each apartment connected by a distribution piping network to the ground heat exchanger. Heating, cooling, and ventilation would be delivered from the heat pumps to each apartment via ductwork installed in each apartment. As with a VRV system, the existing radiator heating system would remain in place to provide backup heating.

An additional alternative system that we considered would consist of a central bank of water-to-water heat pumps installed in the mechanical room alongside the existing boilers and connected to the existing radiator piping loop. The heat pumps would provide heated or chilled water as demanded to provide heating and cooling.

A VRV heat pump system has several advantages in terms of cost and capabilities over the alternative systems considered. We determined installing water-to-water heat pumps and utilizing the existing radiator system is not feasible compared to a VRV system because the high temperature water required for heating (180 degrees F) cannot be met by most heat pumps and because the radiators would not be effective at delivering cooling compared to alternatives. Installing water-to-air heat pumps with ductwork was not chosen because we determined that the costs of installing ductwork would be prohibitive given the construction of the building and the configuration of the apartments. A VRV system can deliver both heating and cooling, does not need to meet the high temperatures demanded by radiators, and does not require ductwork.

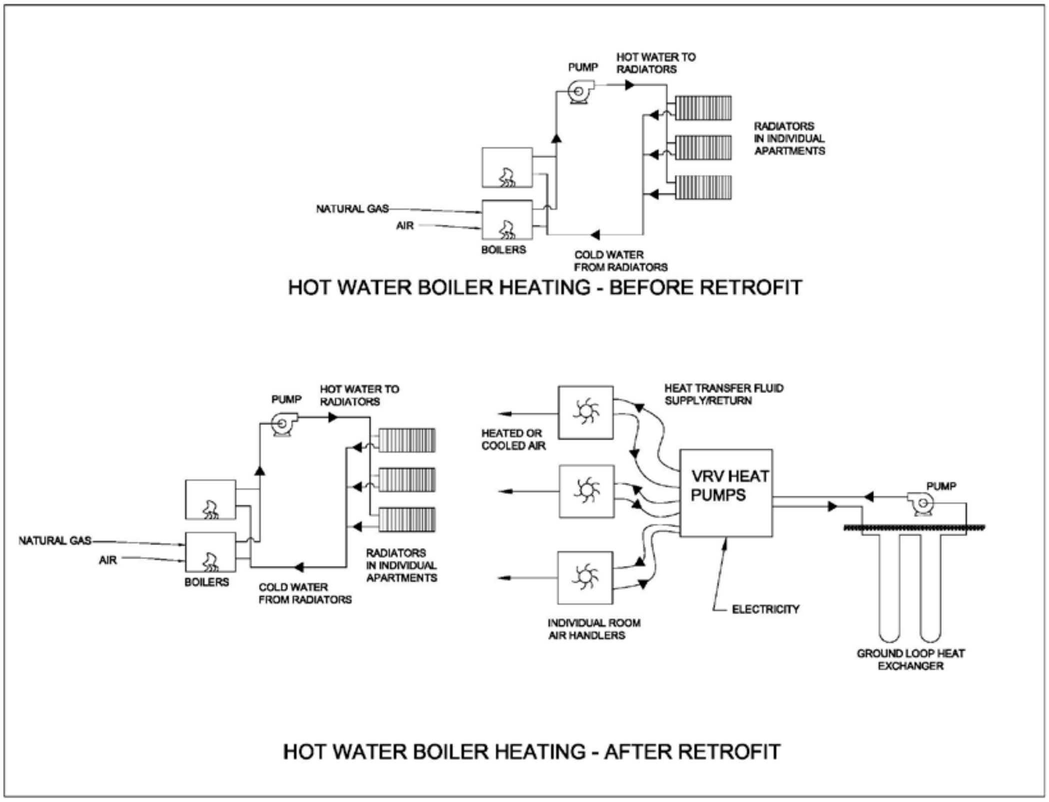


Figure 16 - Boiler Retrofit to Geothermal/VRV

.

A geothermal borehole field could be placed in the grass area and potentially the driveways with boreholes spaced at 20 feet from each other. We estimate that existing available space can accommodate 21 to 30 boreholes. Preliminary calculating indicates this field is sufficient to serve the size geothermal system necessary for 100% load at the apartment building. Each borehole needs approximately 3,415 square feet of area.

10.1.4 Funding Mechanisms

Systems on individual buildings would be installed through private homeowners by obtaining their own financing through a bank, or entering into a long term thermal power purchase agreement with a third party, such as a geothermal utility or a broker of thermal power purchase agreements. In all cases, the federal energy tax credit equal to 30% of the installed cost with no limit would be available to the owner to offset the cost. The tax credit is a dollar for dollar savings on the amount of tax owed. Tax credits can be applied for multiple years.

Northeast Ohio Advanced Energy District

Commercial projects may be eligible for financing through the Northeast Ohio Advanced Energy District (NEOAED). NEOAED is a Special Improvement District (SID) as defined in Ohio Revised Code 1710. It is a not-for-profit entity created by Shaker Heights of Cleveland and some members of the First Suburbs Development Council to facilitate Property Assessed Clean Energy (PACE) financing within their region. Using PACE, property owners or a group of property owners may obtain financing to pay for special clean energy projects or services involving solar photovoltaic, solar thermal, geothermal, wind, biomass, gasification and energy efficiency. Owner(s) receive upfront capital to cover project costs and pay back the capital over a long period through their property tax bill. Payments are secured by a lien placed on the subject property. Two major benefits to this type of financing are that the cost of the Clean Energy investment is reflected in the property tax value and the financing funds the high upfront project costs. Typically the financing is not available unless the savings are proven to exceed the cost of the system.

Currently, residential properties that have mortgages underwritten by Fannie Mae and Freddie MAC cannot use PACE financing because the Federal Housing Finance Agency (FHFA) has directed Fannie Mae and Freddie MAC to not underwrite mortgages with a PACE assessment. FHFA is concerned because PACE assessments in arrears have a senior lien to mortgage payments in the event of a default. There are lawsuits in progress to overturn this FHFA directive.

NEOAED has not fully developed their project criteria and financing at this time. Smaller projects, such as 14101 S. Woodland may need to be aggregated by NEOAED to facilitate their financing requirements.

10.2 Solar Photovoltaic

In an apartment building where each tenant receives an electric bill from the utility, the property owner usually maintains some common areas (stairwells, parking, lobbies) that require lighting and other appliances (laundry, elevators). Therefore, the property owner controls these spaces, maintains them and receives a bill for these electrical uses. Targeting common area electricity offset for a solar photovoltaic project achieves the best cost per unit. A separate inverter would be required for each utility customer if it were to be split to multiple users.

10.2.1 Size and Energy Usage

The system was designed to supply the common areas of the building such as the stairwells, outside lighting and laundry room. System size was estimated, based on past utility bills, to be approximately 18,000 kWh/yr.

10.2.2 Important Considerations

<u>Location</u>

The rooftop space at 14101 S. Woodland provides decent solar exposure. The trees to the east create some shade on the roof. This area should be avoided.

Figure 17 - 14101 S. Woodland Bird's eye view of three sunny areas of the roof.

The apartment building faces within 10 degrees of south – good orientation toward the sun. The pitched roof looks to be in good condition and not in need of replacement at this time.

Figure 18 - South face of 14101 S. Woodland

The electrical service for the common area loads is a fuse-based panel that would likely require an upgrade to breakers and a possible increase in feeder size. The existing panel is supplied with 70A service which is significantly undersized compared to modern construction. If the same facility were being built now, it would likely be installed with a minimum 200A service for the common areas as dictated by current load analysis requirements in the National Electrical Code.

Figure 19 - Fuse Panel serving the Common Areas

The sunny area of the roof could easily hold 90 modules totaling 17kW of generating capacity. This system may generate as much as 19,090 kilowatt-hours annually to cover 18,000+ consumed by the facility's common areas.

There are three sunny areas of the roof of 14101 S. Woodland. The middle two sections (numbers 2 and 3 in Figure 17 above) are targeted for solar photovoltaic modules. These two areas are approximately equal and modules could easily be installed in a symmetrical fashion. At locations with more real estate, a sheltered parking structure would be a useful consideration as a ground-mounted option.

10.2.3 Size and Cost

Results of the financial analysis are summarized below:

APPLICATION	APARTMENT
SIZE	17kW
Installation Costs	$101,000
Utility Tie-in Costs	$67
Annual Operating Costs	$1,000
Life Cycle Costs	$24,000
Energy Savings, 25 years	$47,000
Percentage Offset of Usage	100%
30% Federal Tax Credit (year 0)	$31,000
SRECs (over 5 years)	$20,000
Depreciation	$36,000
Net Cost/kilowatt-hours, 25 years	$0.17
Expected Payback (w/Incentives)	10
CO2 Avoided, 25 years (Metric Tons)	194

Table VII. Summary Financial Analysis S. Woodland Apt. Bldg., Photovoltaic Solar

<u>Installation Costs</u>

The installation is relatively straightforward and the cost is approximately $101,000.

<u>Utility Tie-in Cost</u>

The interconnection costs are not prohibitive when operating on the customer side of the meter. Since this proposed system would be offsetting such a large portion of the typical usage, scaling it back slightly may be appropriate. Reducing the size and quantity of backfed kilowatt-hours can help reduce the FirstEnergy interconnection costs that could increase the costs by 10 or 20%.

Annual Operating Cost

Typically, solar photovoltaic does not require a great deal of maintenance. Some small percentage of 0.5-2% should be set aside on an annual basis in the event of needing some equipment repair after warranties expire or repairing some part of the mechanical installation.

Life Cycle Cost

Over the life of the installation, the largest maintenance expense would be in a potential inverter replacement or upgrade in year 15. Most inverter warranties are 10 years and inverters may in fact last more than 15 years, but some repairs or upgrades are likely over the life of the system.

Energy Savings Over 25 Years

Conservatively estimating a 3% annual increase in utility rates, the facility would realize over $46,000 in electricity savings over 25 years.

Net Cost Per Kilowatt-Hour Over 25 Years

With an expected life of 25 or more years, solar photovoltaic can contribute to long-term energy cost planning. Assuming the available incentives can be used, the lifetime costs per kilowatt-hour range would be approximately $0.166/kilowatt-hours. Based on a conservative 3% annual utility rate increase, the utility would be charging $0.166/kilowatt-hours ten years from now.

Expected Payback

Because solar photovoltaic generates much more than kilowatt-hour savings, an expected payback accounts for the value accumulated through a 30% federal tax credit, accelerated depreciation of equipment for commercial entities, and solar renewable energy credits (SRECs). If a state-level incentive program returns, this would be an additional value. Any additional carbon-offset value is also not addressed.

The value created through these mechanisms is greater than the electricity offset. The expected payback accounts for all possible sources of revenue to the bottom line of a solar project. Reasonable increases in utility costs and expected output are also included.

Metric Tons of Carbon Dioxide Avoided

Based on reduction of electricity consumed from fossil fuel sources, the amount of carbon dioxide is avoided at the utility generation facility.

10.2.4 Permitting and Schedule

Installation of the modules is an exterior improvement which would have to be submitted to the Shaker Heights Planning and Development Department for consideration by the Architectural Board of Review (ABR). After plan review is completed, permits would need to be obtained from Shaker Heights Building Department for the mechanical and electrical work.

FirstEnergy currently requires a two-step process to obtain interconnection approval. There is an application during which technical specifications are provided. If necessary, FirstEnergy may conduct a feasibility and facility study to verify and make recommendations. Upon obtaining an authorization to proceed, the system can be constructed. Final documentation of proper installation is submitted upon completion and a final agreement is executed between the utility and the customer generator; Owner.

After completion from the architectural review process, the local building department would typically evaluate electrical and structural drawings for code compliance. As the project is expected to offset all of the electrical consumption of the facility, FirstEnergy should be engaged early to allow the utility to best choose equipment with the expectation of significant onsite offset and export of generation. This can take 3 or more months depending on FirstEnergy's studies. If the system were to target only 25 or 50% of the usage, the utility would be able to provide approvals within days for both the preliminary and final approvals.

10.2.5 Funding and Ownership Mechanisms

10.2.5.1 Individual Ownership

Depending on the needs and interests of the building owner, a small commercial system like this 17kW may qualify for an equipment lease or an energy improvement loan.

10.2.5.2 Third-Party Ownership

A newer method of developing solar projects is beginning to take root. An investor group organizes for a project or group of projects to take advantage of the incentives while the end-user experiences a fixed electricity cost for a 20 year period. This power purchase agreement (PPA) structure generally targets large projects. This 17kW is not large enough to attract outside investors. For example, in our past experience, a large bank such as PNC is not interested in solar installations that cost less than millions of dollars.

10.2.5.3 Northeast Ohio Advanced Energy District

Commercial projects may be eligible for financing through the Northeast Ohio Advanced Energy District (NEOAED). NEOAED is a Special Improvement District (SID) as defined in Ohio Revised Code 1710. It is a not-for-profit entity created by the City of Cleveland and some members of the First Suburbs Development Council to facilitate Property Assessed Clean Energy (PACE) financing within their region. Using PACE, property owners or a group of property owners may obtain financing to pay for special clean energy projects or services involving solar photovoltaic, solar thermal, geothermal, wind, biomass, gasification and energy efficiency. Owner(s) receive upfront capital to cover project costs and pay back the capital over a long period through their property tax bill. Payments are secured by a lien placed on the subject property. Two major benefits to this type of financing are that the cost of the Clean Energy investment is reflected in the property tax value and the financing funds the high upfront project costs. Typically the financing is not available unless the savings are proven to exceed the cost of the system.

Currently, residential properties that have mortgages underwritten by Fannie Mae and Freddie MAC cannot use PACE financing because the Federal Housing Finance Agency (FHFA) has directed Fannie Mae and Freddie MAC to not underwrite mortgages with a PACE assessment. FHFA is concerned because PACE assessments in arrears have a senior lien to mortgage payments in the event of a default. There are lawsuits in progress to overturn this FHFA directive.

NEOAED has not fully developed their project criteria and financing at this time. Smaller projects, such as 14101 S. Woodland may need to be aggregated by NEOAED to facilitate their financing requirements.

10.3 Solar Thermal

10.3.1 Benefits

Solar thermal is installed at an apartment building to create hot water. The major components of a solar thermal system are a bank of solar collectors, a pump, and hot water storage tank which transfers the heat collected from the sun to a hot water heater. When there is enough sunlight, the pump circulates water through the solar collectors to capture the sun's heat.

The benefits to an apartment building owner could be:

- Creates hot water;
- Lower utility bills;
- Low maintenance;
- Supplement hot water boilers;
- Turn off boilers in summertime;
- Pool or hot tub heating;
- Can be used for space heating;
- Lowers greenhouse gases emissions; and
- Environmentally friendly

The solar collectors themselves, known commonly as "flat-plate" collectors, are clear plates with tubes running through them. Other types of solar collectors include unglazed collectors, which are tanks painted black to absorb sunlight, and evacuated tube collectors, which consist of a double layer of tubes with a vacuum between them. The flat-plate type collectors were chosen over other styles because they are the ones most commonly used for hot water-heating applications in this region and offer the best tradeoff between cost and performance. Evacuated tube technology is changing rapidly and apartment owners should consider evacuated tubes and flat-plate collectors when evaluating their project. Unglazed collectors may be suitable for pool or hot tub heating.

As the water passes through the tubes in the collectors, it absorbs the sun's energy and heats up. After passing through the collector, the warm water is piped into the building and through a heat exchanger, where it gives up its heat and cools down. Once cold, the water is pumped back into the solar collectors and the cycle starts over again. If the solar thermal system is used to heat water, then the heat exchanger is a storage tank similar to a conventional water heater. The heat added from the solar thermal system significantly reduces the amount of natural gas or electricity required to heat hot water.

10.3.2 Important Considerations

Location and Orientation

Solar thermal collectors require an unshaded area that faces south for maximum gain. A roof surface that faces east or west can be utilized if the collector can be tilted to face south. Areas where they are unlikely to be damaged are best. Areas that would remain unshaded through all seasons and into the future are ideal. Roof-mounted systems are typical for Shaker Heights because they are less intrusive from an aesthetic standpoint, yard space is not lost, and damage from incidental contact is less likely. The roof and structure must be examined to verify they are in good repair and be able to support the collectors. The site description identified in the solar photovoltaic section gives further details.

Water Storage and Backup System

In the Shaker Heights climate, solar thermal does not produce hot water at all times when it is demanded. A backup system for creating hot water and a storage tank should be installed to make hot water available any time. If space is available, a well-insulated storage tank designed for solar hot water use that has at least 1.5 gallons of storage for each square foot of collector should be installed. In the Shaker Heights climate, antifreeze protection by either using antifreeze solution or by having the system drain to a tank inside whenever not in use is required. Larger tanks may be required for drain back designs.

Number of People in the Apartment Building

Evaluation herein focuses on providing solar thermal to supply the apartment domestic hot water storage. The size of the system for other locations would be dependent on the number of residents and the size of the hot water storage system. The given example is not for hot water created for space heating. If a system is dedicated to creating water strictly for hot water, hydronic heating systems, the sizing and economics would need to be examined. The greater the number of people who are in the household, then a larger collection area and larger storage tanks would be needed to deliver the same percentage of savings and usage.

Pool and Hot Tub Heating

Solar thermal is a very cost effective means of heating a pool in the summer. If the solar thermal would be used for heating a pool or a hot tub, then a larger area of panels is required than stated herein for domestic hot water production only. The area of solar collectors required would range from 50% to 100% of the pool area, depending on the exact collector selected. It should be noted that the federal tax credit, as well as many other rebates and incentives, do not apply to solar thermal systems used for heating a pool or a hot tub.

Qualifying for Rebates and Incentives

There is a federal tax credit available to homeowners and commercial businesses for 30% of the total cost of the solar thermal system. The requirements for this credit are explained in the previous Geothermal section. Requirements specific to solar thermal are that the solar water heater must provide at least half the energy used to heat the dwelling's water and be certified by the Solar Rating Certification Corporation (SRCC), a non-profit organization that administers a certification, rating and labeling program for certain solar-thermal systems sold in the United States or an equivalent state rebate certification.

Contractor Selection

Even though solar thermal has been in residential applications for many years, many HVAC contractors do not have significant experience installing it. It is important to select a contractor(s) with:

- References for multiple residential installations;
- Experience installing solar thermal systems for at least three years;
- Contractor licenses and/or registrations with the State of Ohio and the City of Shaker Heights;
- Solar Thermal Installer Certification from National American of Board Certified Energy Practitioners (NABCEP); and a
- Distribution agreement with a Solar Thermal Manufacturer.

10.3.3 Size and Costs

System size was based on providing the annual heat required to produce 30 gallons/person for 24 people residing in the apartment building. The 20 panel system would require about 550 square feet of roof, which is about a third of the roof area available for solar equipment. The capacity is sufficient to provide all the domestic hot water required, but the actual percentage would depend on usage and weather. Savings vary whether the system would replace the use of natural gas water heater or an electric water heater. A summary of the cost and savings can be viewed in the following table:

	Replacing Natural Gas Water Heater	Replacing Electric Water Heater
System Size	20 Panel – 146 MMBTU/yr	20 Panel – 146 MMBTU/yr
Capital Cost	$38,800 - $50,000	$38,800 - $50,000
Estimated Rebates	$11,600 - $15,000	$11,600 - $15,000
Capital Cost After Rebates/Credits	$27,200 - $35,000	$27,200 - $35,000
Payback Year w/Incentives	11 to 14	5 - 7
Annual Cost Savings ($/yr)	$2,540 (>75%)	$5,400(>75%)
Lifetime Savings	$63,500	$135,000
Annual Energy Savings	240 MMBTU/yr	41,700 kilowatt-hours/yr
Life Cycle Energy Savings (30 year)	729 MMBTU	128,730 kilowatt-hours
Carbon Savings MTCE/yr	13	30

Table VIII. 14101 S. Woodland Solar Thermal Summary

The apartment owner would pay between $38,800 and $50,000 for installing a twenty-collector, 550 square feet system, to replace the use of a natural gas hot water heater. A tax credit of thirty percent of the total cost of the solar thermal system, which is approximately $11,600 - $15,000, would be returned to the apartment owner at tax filing time. The apartment owner would need to collect paperwork identifying the cost of the system and the energy performance of the solar thermal equipment from the contractor for tax records and to complete the IRS tax forms. Once the apartment owner receives the tax credits and rebates, the net cost would be approximately $27,200 - $35,000.

A single system would offset an estimated 240 MMBTU of natural gas annually. These energy savings translate into an estimated carbon emission reduction of 13 metric tons per year and an annual cost savings of $2,540 or $212/month. This carbon savings is slightly more than the carbon produced by a single family residence in a year for all their heating, cooling and electrical consumption. The cost savings achieved by offsetting natural gas consumption would pay for the cost of installing solar thermal in 11 to 14 years.

Installation of the recommended twenty panel system for an individual household can be completed in one to weeks.

10.3.4 Permitting

The installation of the collector is an exterior improvement which would have to be submitted to the City of Shaker Heights Planning and Development Department for consideration by the Architectural Board of Review (ABR). After a plan review is completed, permits would need to be obtained from the City of Shaker Heights Building Department for the mechanical and electrical work.

11. NEXT STEPS

Going forward, Shaker Heights should consider promoting alternative energy and energy efficiency by taking the following actions:

Action 1 – Educate stakeholders on study findings

- Disseminate the study findings to Shaker Heights residents, businesses, construction firms, real estate developers, housing rehabilitation companies, public services, and government agencies.
- Promote available energy tax credits, financing mechanisms, and other incentives.
- Assess if the existing permitting and Architectural Board of Review processes need to be revised or how they should be applied to alternative energies considering the study information.
- Encourage energy efficiency through the Shaker Heights' website, magazine and other publications.

Action 2 – Make Residences More Energy Efficient

- Partner with Dominion East Ohio Home Performance with Energy Star program to offer low cost energy audits to eligible residents and promote weatherization assistance from Dominion East Ohio and Ohio Department of Development to eligible residents.
- Assess if existing permitting and Architectural Board of Review processes need to be revised and how they can be applied to Alternative Energy given study information.
- Create contract terms or an ordinance requiring that City sponsored home rehabilitations include energy efficiency upgrades.

Action 3 – Promote use of Alternative Energy for Shaker Heights Projects

- Require all new projects to evaluate the energy efficiency of the building and to be designed to use less energy than an established baseline.
- Require design and construction teams to evaluate alternative energy for every Shaker Heights project.
- Determine specific energy efficiency baseline, such as Energy Star label or ASHRAE 90.1-2010, on which to evaluate design and construction projects.

Action 4 – Research Geothermal Utility

- Investigate establishing a city-wide geothermal utility that is available to any building owner.
- Discuss potential of NEO alternative energy district creating a geothermal utility.

Action 5 – Continue Transit Village Alternative Energy Project

- Use NOPEC funds to offset costs of energy efficiency upgrades to existing residences in Transit Village and pilot geothermal project at Sutton Condominiums.
- Strengthen community outreach component of project to ensure success.

Action 6 – Create Alternative Energy Gateway at Transit Village

- Work with RTA to evaluate opportunities at Onaway Station.
- Investigate solar PV covered parking or lighting along RTA and/or Sutton Crescent.
- Seek out opportunities to incorporate alternative energy as public art.

APPENDIX A

Solar Photovoltaic Proposals

Summary

Customer	Site Address	Company Contact
Sutton Road	OH 44120	Erika Weliczko REpower SOLUTIONS 2434 Hamilton Ave Cleveland, OH 44114

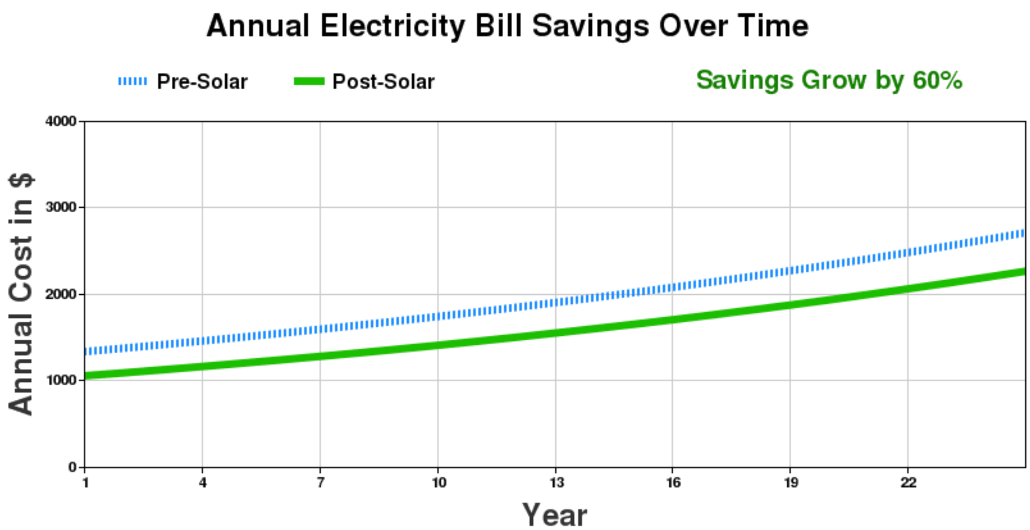
25 Year Financial Analysis			
Utility Savings Over System Life	$8,902 $30 / mo (avg)	Payback Period	> 20 years
Total Life-Cycle Payback (Cash Flow compared to Net Cost)	100%	System Resale Value	$5,580
Levelized Cost of Solar Energy	$0.173 / kWh		

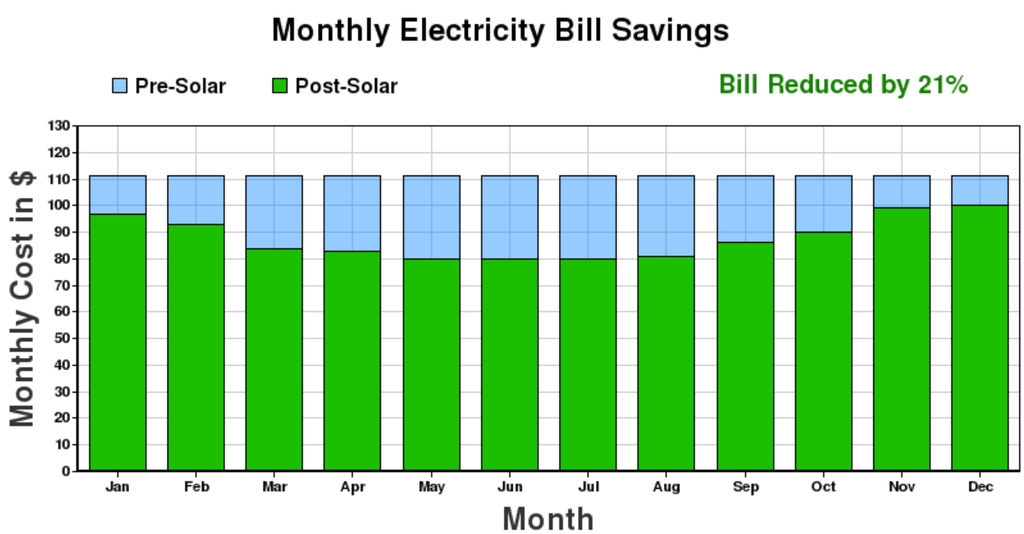
Cost Breakdown		
Installer Contract Cost	$11,696	($6.16/watt DC, $7.63/watt AC)
Federal Tax Credit/Tax Impact	($3,509)	
Net Cost (year of installation)	$8,187	($4.31/watt DC, $5.34/watt AC)
S-REC	($2,350)	
Net Cost (all years)	$5,837	($3.07/watt DC, $3.81/watt AC)

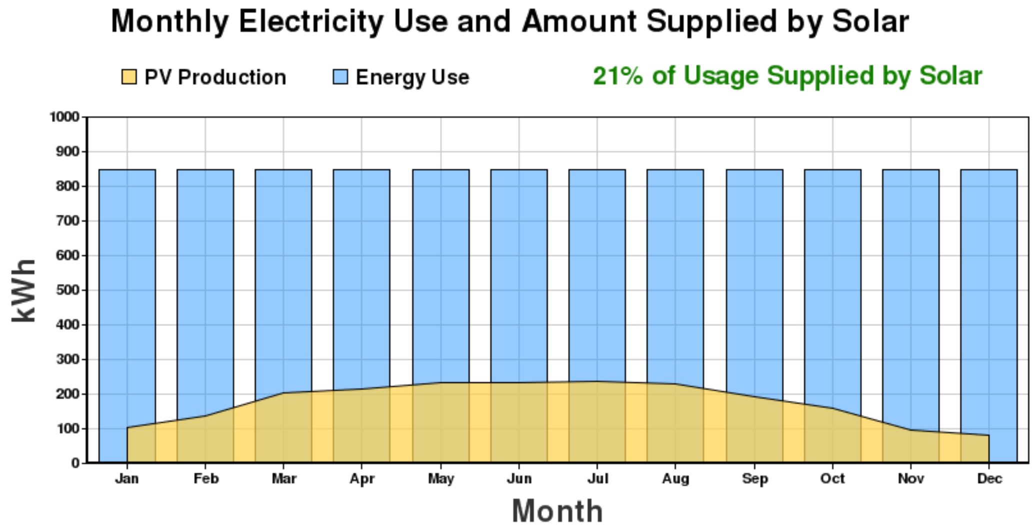
System Description	
Total System Size	1.900 kW DC Power (STC) / 1.532 kW AC Power (CEC)
Estimated Annual Production	2,128 kWh
PV Panel Description	10 x MAGE Solar Model: Powertec Plus 190/5MI
Inverters	Qty. 1 - Fronius USA LLC Model: IG 2000 NEG

Energy Analysis

We have summarized your historical energy usage. Based upon the suggested system size, the expected energy bill s avings over a 25 year period are provided. In addition, the first-year predicted performance is compared to estimated electricity needs of the building.







Assumptions: Post-Solar Electric Rate Schedule for Cleveland Electric Illum Co is 0.127/kwh CEI residential Annual utility inflation: 3.00% (assumed). Energy Bill Savings are actual, without any tax effects applied.

Energy Bill Estimate

The following energy bill estimate is without any tax effects applied.

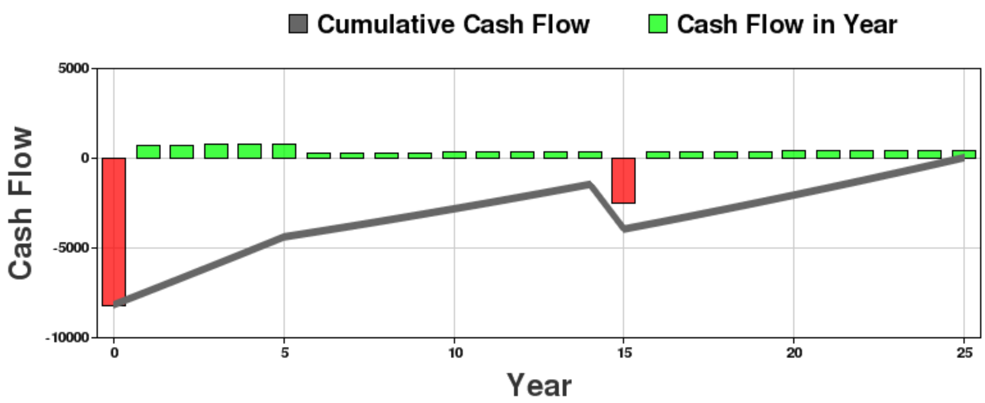
(kWh)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Total Usage	850	850	850	850	850	850	850	850	850	850	850	850	10.2k
Solar Production	105	138	205	214	236	235	236	228	194	160	95	83	2,128
Energy to Purchase	745	712	645	636	614	615	614	622	656	690	755	767	8,072

(Cost)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Pre-solar*	$111	$111	$111	$111	$111	$111	$111	$111	$111	$111	$111	$111	$1,332
Post-solar*	$97	$93	$84	$83	$80	$80	$80	$81	$86	$90	$99	$100	$1,053
Energy Bill Savings	$14	$18	$27	$28	$31	$31	$31	$30	$25	$21	$12	$11	$279

*Includes rate inflation

Financial Analysis

The chart summarizes the cash flow over the life of the solar electric system we are suggesting. The table provides a summary of some key measures.



Financial Summary	
Utility Savings Over System Life	$8,902
Average Monthly Utility Savings	$30 (over system life)
Net Cost (In year of installation)	$8,187
Payback Period	> 20 years
Total Life-Cycle Payback (Cash flow compared to Net Cost)	100%
Levelized Cost of Solar Energy (Net Cost / lifetime energy production)	$0.173 / kWh

Environmental Impact Analysis

A solar electric system will generate significant environmental benefits. These come primarily from avoided coal-fired power plant emissions. Below is a summary of some of the environmental benefits your solar system will provide.

Your New, Lower Carbon Footprint	
Your solar system will reduce Green House Gas emissions by **36 tons of CO2** (Over 25 years)	
Equivalent CO2 Reductions	
Small Car:	123,390 miles
Medium Car:	66,182 miles
SUV:	46,369 miles
Air Miles:	75,052 miles
Trees Planted:	1,456 trees planted
CO2 from Trash & Waste:	66 persons

Cash Flow by Year

The following table of estimated cash flows includes any tax effects, rate and cost inflation and other time-related cash flow factors. Refer to the Disclaimers & Assumptions section (below) for further clarification.

Year:	0	1	2	3	4
Installation, Operation & Maintenance Costs	($11,696)	($6)	($6)	($6)	($6)
S-REC	$0	$470	$470	$470	$470
Federal Individual Tax Credit (30%)	$3,509	$0	$0	$0	$0
Energy Bill Savings	$0	$279	$285	$290	$296
Total Annual Cash Flow	**($8,187)**	**$743**	**$749**	**$754**	**$760**
Cumulative Cash Flow	($8,187)	($7,444)	($6,695)	($5,941)	($5,181)

Year:	5	6	7	8	9
Installation, Operation & Maintenance Costs	($6)	($7)	($7)	($7)	($7)
S-REC	$470	$0	$0	$0	$0
Federal Individual Tax Credit (30%)	$0	$0	$0	$0	$0
Energy Bill Savings	$301	$307	$313	$320	$326
Total Annual Cash Flow	**$765**	**$300**	**$306**	**$313**	**$319**
Cumulative Cash Flow	($4,416)	($4,116)	($3,810)	($3,497)	($3,178)

Year:	10	11	12	13	14
Installation, Operation & Maintenance Costs	($8)	($8)	($8)	($9)	($9)
S-REC	$0	$0	$0	$0	$0
Federal Individual Tax Credit (30%)	$0	$0	$0	$0	$0
Energy Bill Savings	$333	$339	$346	$352	$359
Total Annual Cash Flow	**$325**	**$331**	**$338**	**$343**	**$350**
Cumulative Cash Flow	($2,853)	($2,522)	($2,184)	($1,841)	($1,491)

Year:	15	16	17	18	19
Installation, Operation & Maintenance Costs	($2,857)	($10)	($10)	($10)	($11)
S-REC	$0	$0	$0	$0	$0
Federal Individual Tax Credit (30%)	$0	$0	$0	$0	$0
Energy Bill Savings	$367	$374	$381	$389	$397
Total Annual Cash Flow	**($2,490)**	**$364**	**$371**	**$379**	**$386**
Cumulative Cash Flow	($3,981)	($3,617)	($3,246)	($2,867)	($2,481)

Year:	20	21	22	23	24	25
Installation, Operation & Maintenance Costs	($11)	($12)	($12)	($12)	($13)	($13)
S-REC	$0	$0	$0	$0	$0	$0
Federal Individual Tax Credit (30%)	$0	$0	$0	$0	$0	$0
Energy Bill Savings	$405	$412	$420	$428	$437	$446
Total Annual Cash Flow	**$394**	**$400**	**$408**	**$416**	**$424**	**$433**
Cumulative Cash Flow	($2,087)	($1,687)	($1,279)	($863)	($439)	($6)

Disclaimers & Assumptions

Operation, Maintenance, and Inflation Rates

This estimate assumes the following system operation, maintenance and inflation rates:

System Life:	25 years
Operation & Maintenance:	0.05% of system cost per annum
PV Degradation:	1.00% per annum
Estimated Inverter Life:	15 years
O&M and Inverter Replacement Inflation:	3.5% per annum

System Size Ratings & Performance

There are three methods commonly used to rate PV system size: STC, PTC and CEC. The Standard Test Condition rating ("STC" also called "DC" or "nameplate") assumes a standard set of optimal operating conditions. The STC rating is most often used by manufacturers to classify the power output of PV modules. The PV-USA Test Condition ("PTC") and California Energy Commission ("CEC") ratings were designed to approximate system performance in more realistic operating conditions.

The Energy production for the first year is based on PVWatts Version 2. To calculate the system's energy production for any future year, the expected degradation in system performance is included (See "PV Degradation", in table above).

Tax Credits & Deductions

Income tax rate assumed: 42.00% (Federal 33.00% - State: 9.00%)

To calculate the estimated cash flow in this proposal, our analysis used these tax rates. We should stress that we cannot provide tax or investment guidance. You should consult your tax preparer or investment adviser for these services. This analysis calculates the cash flows based only on the assumptions entered into the proposal.

This analysis assumes Federal income Tax is <u>not</u> applied to any rebates. Therefore, the basis for the Federal ITC is the installation cost <u>less</u> 100% of any and all rebates.

<u>Residential:</u>

In calculating the cash flow for an individual, our analysis assumes that the homeowner can deduct the interest from financing the system. This will be true if the financing is secured by the real estate, such as with a second mortgage, home equity loan, or home equity line of credit.

(Net) Energy Bill Savings

For an individual, electric bills are not usually deductible against income taxes.

For a business, electric bills are usually deductible against income taxes. If an income tax rate is defined, the cash flow displays a "Net" Energy Bill Savings line item which is the Energy Bill Savings less the loss in tax deduction due to the PV system's lowering of the electric bill. Cost inflation for the utility rate and degradation of system performance are also taken into account.

Average Monthly Utility Savings

"Average Monthly Utility Savings" is the average monthly (Net) Energy Bill Savings expected over the system life. This takes into account utility rate inflation and any expected degradation in system performance. This estimate has not assumed any changes in the amount or timing in your building's energy use.

Rate of Return (IRR) on Cash Invested

"Rate of Return on Cash Invested" (also called "Internal Rate of Return" or "IRR") is the annual compounded rate of return that the cash flows (savings, incentives, tax benefits, etc.) bring based upon the net cash invested in the year of installation ("Year 0"). In financial math terms, IRR is the discount rate required to make the sum of the present values of each annual cash flow equal zero. If you financed your system 100%, IRR does not apply since you did not actually invest cash.

System Resale Value

"System Resale Value" is based upon research published in the Appraisal Journal which concluded that "The increase in appraisal value for a home is about twenty (20) times the annual reduction in operating costs due to energy efficiency measures." To calculate System Resale Value the first year annual utility savings is multiplied by twenty (20). Source: Evidence of Rational Market Valuations for Home Energy Efficiency, Appraisal Journal, Nevin/Watson, October 1998

Total Life-Cycle Payback

"Total Life-Cycle Payback" is the total cash flows (savings, incentives, tax benefits, etc.) for all years after installation as a percentage of the net cash invested in the year of installation ("Year 0"). This ROI calculation is not adjusted for inflation or the time-value of money.

Levelized Cost of Energy

"Levelized Cost of Energy" (or LCOE) is an approximation of the average cost of energy from your solar system ($/kWh). To determine LCOE, the system Net Cost ($ in the installation year) is divided by the amount of energy produced (kWh) over the system life (years). For this calculation, energy produced over system life is limited to the annual energy consumption of the building times the system life in years. The Net Cost does not include incentives which may materialize in later years, such as tax credits or deductions or production rebates. This calculation is not adjusted for the time-value of money.

Environmental Analysis

CO_2 gas emissions avoided per passenger via various travel methods:

Travel Method	Emissions / mile
Small Car	.59 pounds
Medium Car	1.10 pounds
SUV/4 Wheel Drive	1.57 pounds
Airplane (Boeing 747)	0.97 pounds

Air travel average USA capacity.

Tree offset calculation is based on a tree planted in the humid tropics absorbing on average 50 pounds (22 kg) of carbon dioxide annually over 40 years - each tree will absorb 1 ton of CO2 over its lifetime; but as trees grow, they compete for resources and some may die or be destroyed - not all will achieve their full carbon sequestration potential. This calculator assumes that 5 trees should be planted to ensure that at least one lives to 40 years or that their combined sequestration equals 1 ton.

General waste is based on the USA average carbon dioxide emission equivalent of 1,010 pounds per person per year.

Sources: Sightline Institute, Trees for the Future and USA Environmental Protection Agency

Electric Utility Rates & Assumptions

Utility:	Cleveland Electric Illum Co
Rate Name (Post Installation):	0.127/kwh CEI residential
Annual Inflation:	3.0% (assumed)

Utility Electric Rate Inflation: Historical References

National Averages: In 2009, the average retail electricity price for all customers across the United States rose to 9.83 cents per kWh, a small increase over 2008. Over the two year period though, from 2007 to 2009, the average retail price rose 7.7 percent.

In 2009, residential retail prices nationally increased from 11.26 cents per kWh in 2008 to 11.51 cents per kWh.

See the following Dept of Energy source for more detail on regional and state inflation patterns.

Source: http://www.eia.doe.gov/cneaf/electricity/esr/esr_sum.html

Summary

Customer
Sutton Road District

Site Address
OH 44120

Company Contact
Erika Weliczko
REpower SOLUTIONS
2434 Hamilton Ave
Cleveland, OH 44114

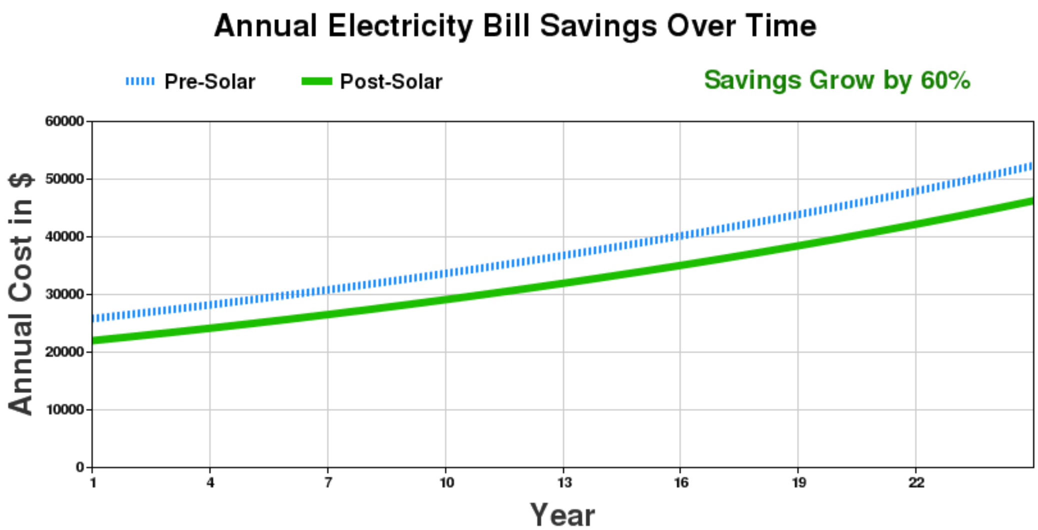
25 Year Financial Analysis			
Utility Savings Over System Life	$70,658 $236 / mo (avg)	Payback Period	> 20 years
Total Life-Cycle Payback (Cash Flow compared to Net Cost)	82%	Levelized Cost of Solar Energy	$0.165 / kWh

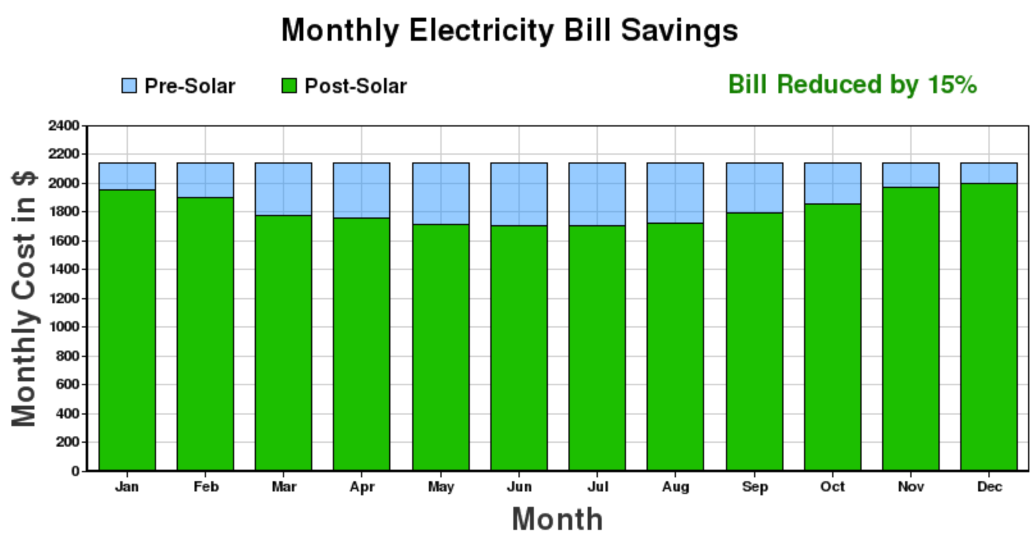
Cost Breakdown		
Installer Contract Cost	$243,675	($6.11/watt DC, $7.41/watt AC)
Federal Tax Credit/Tax Impact	($73,103)	
Net Cost (year of installation)	$170,572	($4.27/watt DC, $5.19/watt AC)
MACRS Depreciation	($86,992)	
S-REC	($47,000)	
Net Cost (all years)	$36,580	($0.92/watt DC, $1.11/watt AC)

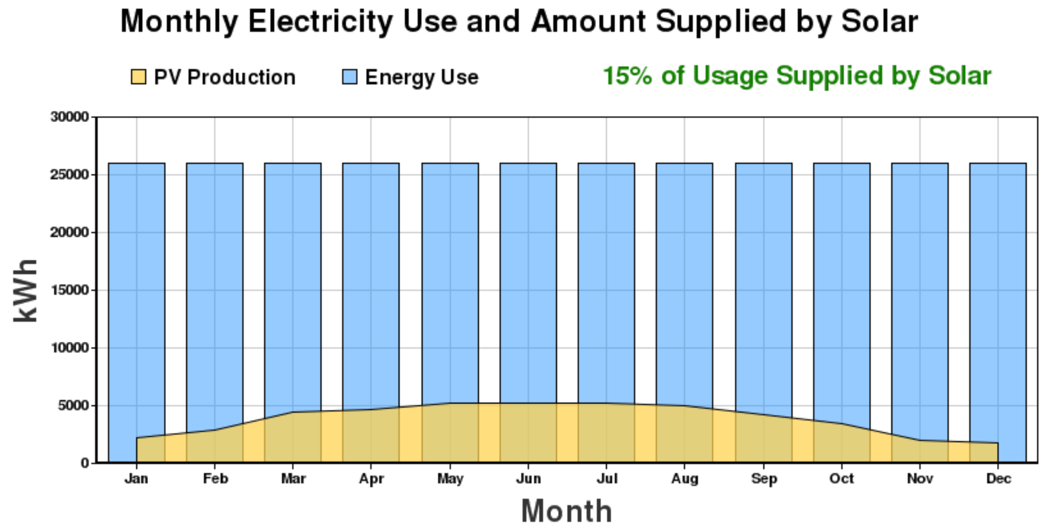
System Description	
Total System Size	39.900 kW DC Power (STC) / 32.870 kW AC Power (CEC)
Estimated Annual Production	46,394 kWh
PV Panel Description	210 x MAGE Solar Model: Powertec Plus 190/5MI
Inverters	Qty. 1 - Solectria Renewables LLC Model: PVI60kW-480

Energy Analysis

We have summarized your historical energy usage. Based upon the suggested system size, the expected energy bill s avings over a 25 year period are provided. In addition, the first-year predicted performance is compared to estimated electricity needs of the building.







Assumptions: Post-Solar Electric Rate Schedule for OTHER is 0.08/kwh general Annual utility inflation: 3.00% (assumed). Energy Bill Savings are actual, without any tax effects applied.

Energy Bill Estimate

The following energy bill estimate is without any tax effects applied. The **Energy Bill Savings** line does not include the opportunity cost of no longer being able to take energy bill expense deductions on corporate income taxes. See the Energy Bill Savings line in the cash flow for this tax impact.

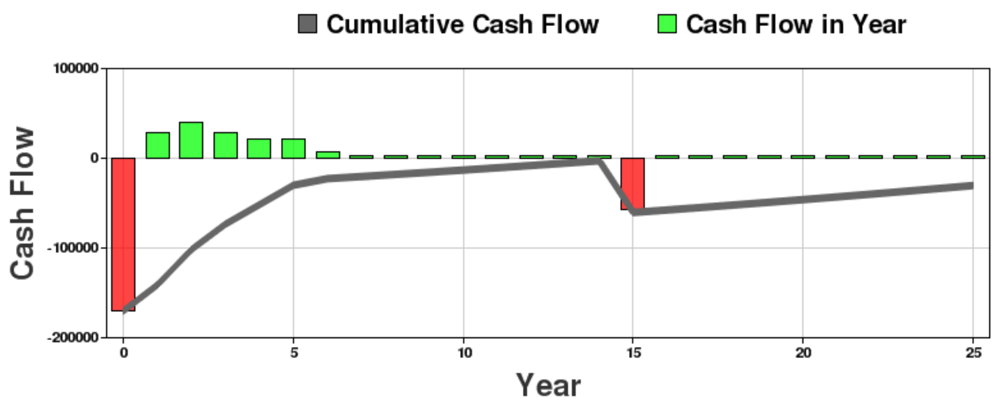
(kWh)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Total Usage	26.0k	26.0k	26.0k	26.0k	26.0k	26.0k	26.0k	26.0k	26.0k	26.0k	26.0k	26.0k	312k
Solar Production	2,224	2,943	4,429	4,678	5,217	5,237	5,247	5,027	4,209	3,421	2,015	1,746	46.4k
Energy to Purchase	23.8k	23.1k	21.6k	21.3k	20.8k	20.8k	20.8k	21.0k	21.8k	22.6k	24.0k	24.3k	266k

(Cost)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Pre-solar*	$2,142	$2,142	$2,142	$2,142	$2,142	$2,142	$2,142	$2,142	$2,142	$2,142	$2,142	$2,142	$25.7k
Post-solar*	$1,959	$1,900	$1,777	$1,757	$1,713	$1,711	$1,710	$1,728	$1,796	$1,860	$1,976	$1,999	$21.9k
Energy Bill Savings	$183	$242	$365	$385	$429	$431	$432	$414	$346	$282	$166	$143	$3,818

*Includes rate inflation

Financial Analysis

The chart summarizes the cash flow over the life of the solar electric system we are suggesting. The table provides a summary of some key measures.



Financial Summary	
Utility Savings Over System Life	$70,658
Average Monthly Utility Savings	$236 (over system life)
Net Cost (In year of installation)	$170,572
Payback Period	> 20 years
Total Life-Cycle Payback (Cash flow compared to Net Cost)	82%
Levelized Cost of Solar Energy (Net Cost / lifetime energy production)	$0.165 / kWh

Environmental Impact Analysis

A solar electric system will generate significant environmental benefits. These come primarily from avoided coal-fired power plant emissions. Below is a summary of some of the environmental benefits your solar system will provide.

Your New, Lower Carbon Footprint

Your solar system will reduce Green House Gas emissions by **899 tons of CO2**
(Over 25 years)

Equivalent CO2 Reductions

Small Car:	3,047,119 miles
Medium Car:	1,634,364 miles
SUV:	1,145,096 miles
Air Miles:	1,853,402 miles
Trees Planted:	35,956 trees planted
CO2 from Trash & Waste:	1,634 persons

Cash Flow by Year

The following table of estimated cash flows includes any tax effects, rate and cost inflation and other time-related cash flow factors. Refer to the Disclaimers & Assumptions section (below) for further clarification.

Year:	0	1	2	3	4
Installation, Operation & Maintenance Costs	($243,675)	($126)	($130)	($135)	($139)
S-REC	$0	$9,400	$9,400	$9,400	$9,400
Federal Investment Tax Credit (30%)	$73,103	$0	$0	$0	$0
MACRS 5-year Accelerated Depreciation (Fed & State Tax Avoided)	$0	$17,398	$27,837	$16,702	$10,021
Net Energy Bill Savings (Reduced by lower income tax deduction)	$0	$2,214	$2,258	$2,303	$2,348
Total Annual Cash Flow	**($170,572)**	**$28,886**	**$39,365**	**$28,270**	**$21,630**
Cumulative Cash Flow	($170,572)	($141,686)	($102,321)	($74,051)	($52,421)

Year:	5	6	7	8	9
Installation, Operation & Maintenance Costs	($144)	($149)	($155)	($160)	($166)
S-REC	$9,400	$0	$0	$0	$0
Federal Investment Tax Credit (30%)	$0	$0	$0	$0	$0
MACRS 5-year Accelerated Depreciation (Fed & State Tax Avoided)	$10,021	$5,011	$0	$0	$0
Net Energy Bill Savings (Reduced by lower income tax deduction)	$2,394	$2,441	$2,489	$2,538	$2,589
Total Annual Cash Flow	**$21,671**	**$7,303**	**$2,334**	**$2,378**	**$2,423**
Cumulative Cash Flow	($30,750)	($23,447)	($21,113)	($18,735)	($16,312)

Year:	10	11	12	13	14
Installation, Operation & Maintenance Costs	($171)	($177)	($184)	($190)	($197)
S-REC	$0	$0	$0	$0	$0
Federal Investment Tax Credit (30%)	$0	$0	$0	$0	$0
MACRS 5-year Accelerated Depreciation (Fed & State Tax Avoided)	$0	$0	$0	$0	$0
Net Energy Bill Savings (Reduced by lower income tax deduction)	$2,640	$2,691	$2,745	$2,798	$2,854
Total Annual Cash Flow	**$2,469**	**$2,514**	**$2,561**	**$2,608**	**$2,657**
Cumulative Cash Flow	($13,843)	($11,329)	($8,768)	($6,160)	($3,503)

Year:	15	16	17	18	19
Installation, Operation & Maintenance Costs	($60,516)	($211)	($218)	($226)	($234)
S-REC	$0	$0	$0	$0	$0
Federal Investment Tax Credit (30%)	$0	$0	$0	$0	$0
MACRS 5-year Accelerated Depreciation (Fed & State Tax Avoided)	$0	$0	$0	$0	$0
Net Energy Bill Savings (Reduced by lower income tax deduction)	$2,910	$2,967	$3,025	$3,085	$3,146
Total Annual Cash Flow	**($57,606)**	**$2,756**	**$2,807**	**$2,859**	**$2,912**
Cumulative Cash Flow	($61,109)	($58,353)	($55,546)	($52,687)	($49,775)

Year:	20	21	22	23	24	25
Installation, Operation & Maintenance Costs	($242)	($250)	($259)	($268)	($278)	($287)
S-REC	$0	$0	$0	$0	$0	$0
Federal Investment Tax Credit (30%)	$0	$0	$0	$0	$0	$0
MACRS 5-year Accelerated Depreciation (Fed & State Tax Avoided)	$0	$0	$0	$0	$0	$0
Net Energy Bill Savings (Reduced by lower income tax deduction)	$3,208	$3,271	$3,336	$3,401	$3,468	$3,537
Total Annual Cash Flow	**$2,966**	**$3,021**	**$3,077**	**$3,133**	**$3,190**	**$3,250**
Cumulative Cash Flow	($46,809)	($43,788)	($40,711)	($37,578)	($34,388)	($31,138)

Disclaimers & Assumptions

Operation, Maintenance, and Inflation Rates

This estimate assumes the following system operation, maintenance and inflation rates:

System Life:	25 years
Operation & Maintenance:	0.05% of system cost per annum
PV Degradation:	1.00% per annum
Estimated Inverter Life:	15 years
O&M and Inverter Replacement Inflation:	3.5% per annum

System Size Ratings & Performance

There are three methods commonly used to rate PV system size: STC, PTC and CEC. The Standard Test Condition rating ("STC" also called "DC" or "nameplate") assumes a standard set of optimal operating conditions. The STC rating is most often used by manufacturers to classify the power output of PV modules. The PV-USA Test Condition ("PTC") and California Energy Commission ("CEC") ratings were designed to approximate system performance in more realistic operating conditions.

The Energy production for the first year is based on PVWatts Version 2. To calculate the system's energy production for any future year, the expected degradation in system performance is included (See "PV Degradation", in table above).

Tax Credits & Deductions

Income tax rate assumed: 42.00% (Federal 33.00% - State: 9.00%)

To calculate the estimated cash flow in this proposal, our analysis used these tax rates. We should stress that we cannot provide tax or investment guidance. You should consult your tax preparer or investment adviser for these services. This analysis calculates the cash flows based only on the assumptions entered into the proposal.

This analysis assumes Federal income Tax is not applied to any rebates. Therefore, the basis for the Federal ITC is the installation cost less 100% of any and all rebates.

Commercial:

In calculating the cash flow for a business, our analysis assumes that your beginning utility expense is a tax deductible business expense. Since your beginning utility bill will be reduced by installing the solar energy system,

our analysis takes this into account.

It also assumes that when you install your solar energy system, you will be able to receive tax benefits from the investment tax credit, depreciation of the equipment, annual maintenance expense, and interest used in financing. Unlike a residential system, the financing does not have to be secured by real estate in order for the interest to qualify as a tax deduction. Clean Power Finance can arrange this financing for you.

MACRS Depreciation: Any commercial entity that invests in or purchases qualified solar energy property may use the Modified Accelerated Cost Recovery System (MACRS) accelerated depreciation schedule: Year 1=20.00%, Year 2=32.00%, Year 3=19.20%, Year 4=11.52%, Year 5=11.52%, Year 6=5.76%. This analysis assumes Federal income Tax is not applied to any state or local incentives. Therefore, the basis for depreciation is the installation cost less 50% of any Federal energy tax credits less 100% of any and all state or local incentives received in year 0. See IRS Publications 946 and 587.

In this analysis, year 0 is the year in which the solar energy system is installed. Our analysis assumes that you will benefit from the Investment Tax Credit in year 0 (by knowing you won't have to pay as much tax), though you apply for it in year 1.

For all following years, tax deductions are applied to the year in which they occurred. The tax effect of deductions in year 1 are applied to year 1, and so forth.

(Net) Energy Bill Savings

For an individual, electric bills are not usually deductible against income taxes.

For a business, electric bills are usually deductible against income taxes. If an income tax rate is defined, the cash flow displays a "Net" Energy Bill Savings line item which is the Energy Bill Savings less the loss in tax deduction due to the PV system's lowering of the electric bill. Cost inflation for the utility rate and degradation of system performance are also taken into account.

Average Monthly Utility Savings

"Average Monthly Utility Savings" is the average monthly (Net) Energy Bill Savings expected over the system life. This takes into account utility rate inflation and any expected degradation in system performance. This estimate has not assumed any changes in the amount or timing in your building's energy use.

Rate of Return (IRR) on Cash Invested

"Rate of Return on Cash Invested" (also called "Internal Rate of Return" or "IRR") is the annual compounded rate of

return that the cash flows (savings, incentives, tax benefits, etc.) bring based upon the net cash invested in the year of installation ("Year 0"). In financial math terms, IRR is the discount rate required to make the sum of the present values of each annual cash flow equal zero. If you financed your system 100%, IRR does not apply since you did not actually invest cash.

Total Life-Cycle Payback

"Total Life-Cycle Payback" is the total cash flows (savings, incentives, tax benefits, etc.) for all years after installation as a percentage of the net cash invested in the year of installation ("Year 0"). This ROI calculation is not adjusted for inflation or the time-value of money.

Levelized Cost of Energy

"Levelized Cost of Energy" (or LCOE) is an approximation of the average cost of energy from your solar system ($/kWh). To determine LCOE, the system Net Cost ($ in the installation year) is divided by the amount of energy produced (kWh) over the system life (years). For this calculation, energy produced over system life is limited to the annual energy consumption of the building times the system life in years. The Net Cost does not include incentives which may materialize in later years, such as tax credits or deductions or production rebates. This calculation is not adjusted for the time-value of money.

Environmental Analysis

CO_2 gas emissions avoided per passenger via various travel methods:

Travel Method	Emissions / mile
Small Car	.59 pounds
Medium Car	1.10 pounds
SUV/4 Wheel Drive	1.57 pounds
Airplane (Boeing 747)	0.97 pounds

Air travel average USA capacity.

Tree offset calculation is based on a tree planted in the humid tropics absorbing on average 50 pounds (22 kg) of carbon dioxide annually over 40 years - each tree will absorb 1 ton of CO2 over its lifetime; but as trees grow, they compete for resources and some may die or be destroyed - not all will achieve their full carbon sequestration potential. This calculator assumes that 5 trees should be planted to ensure that at least one lives to 40 years or that their combined sequestration equals 1 ton.

General waste is based on the USA average carbon dioxide emission equivalent of 1,010 pounds per person per year.

Sources: Sightline Institute, Trees for the Future and USA Environmental Protection Agency

Electric Utility Rates & Assumptions

Utility:	OTHER
Rate Name (Post Installation):	0.08/kwh general
Annual Inflation:	3.0% (assumed)

Utility Electric Rate Inflation: Historical References

National Averages: In 2009, the average retail electricity price for all customers across the United States rose to 9.83 cents per kWh, a small increase over 2008. Over the two year period though, from 2007 to 2009, the average retail price rose 7.7 percent.

Average commercial prices decreased one tenth of a cent per kWh from 10.36 to 10.26 cents per kWh. Average industrial prices decreased 0.02 percent from 6.83 cents per kWh in 2008 to 6.70 cents per kWh in 2009.

See the following Dept of Energy source for more detail on regional and state inflation patterns.

Source: http://www.eia.doe.gov/cneaf/electricity/esr/esr_sum.html

Summary

Customer
Sutton Road

Site Address
OH 44120

Company Contact
Erika Weliczko
REpower SOLUTIONS
2434 Hamilton Ave
Cleveland, OH 44114

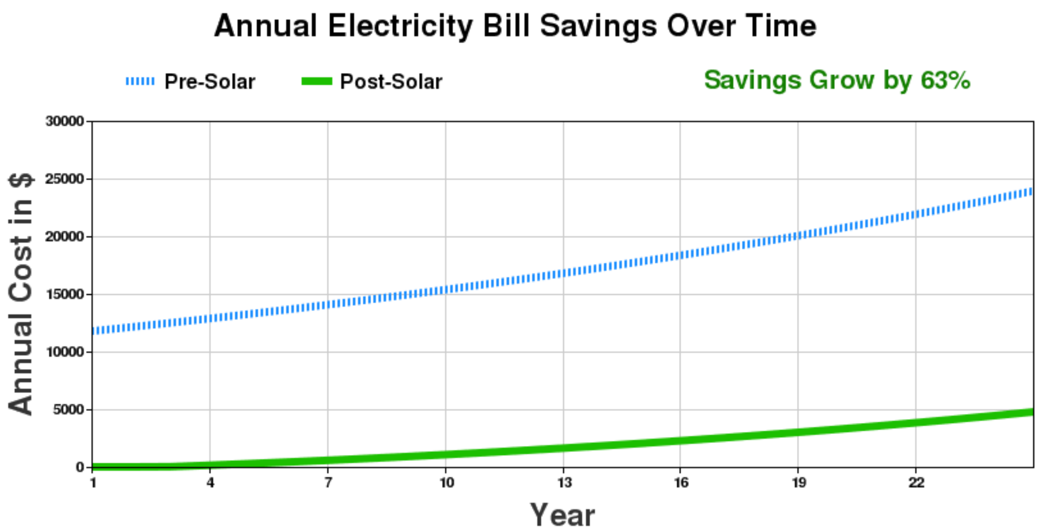
25 Year Financial Analysis			
Utility Savings Over System Life	$221,823 $739 / mo (avg)	Payback Period	6-7 years
Total Life-Cycle Payback (Cash Flow compared to Net Cost)	133%	Rate of Return on Cash Invested	5.3%
Levelized Cost of Solar Energy	$0.149 / kWh		

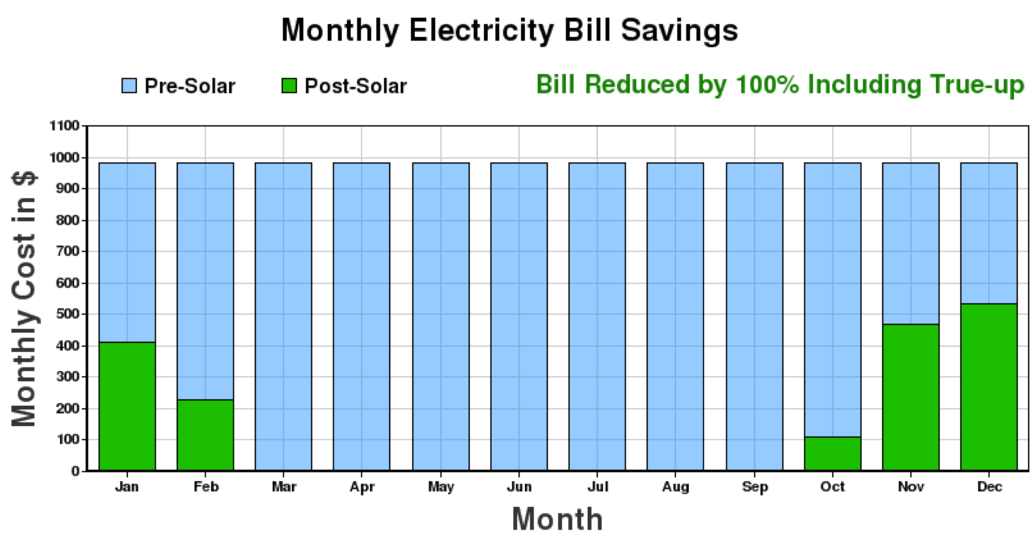
Cost Breakdown		
Installer Contract Cost	$434,481	($5.44/watt DC, $6.61/watt AC)
Federal Tax Credit/Tax Impact	($130,344)	
Net Cost (year of installation)	$304,137	($3.81/watt DC, $4.63/watt AC)
MACRS Depreciation	($155,110)	
S-REC	($103,400)	
Net Cost (all years)	$45,627	($0.57/watt DC, $0.69/watt AC)

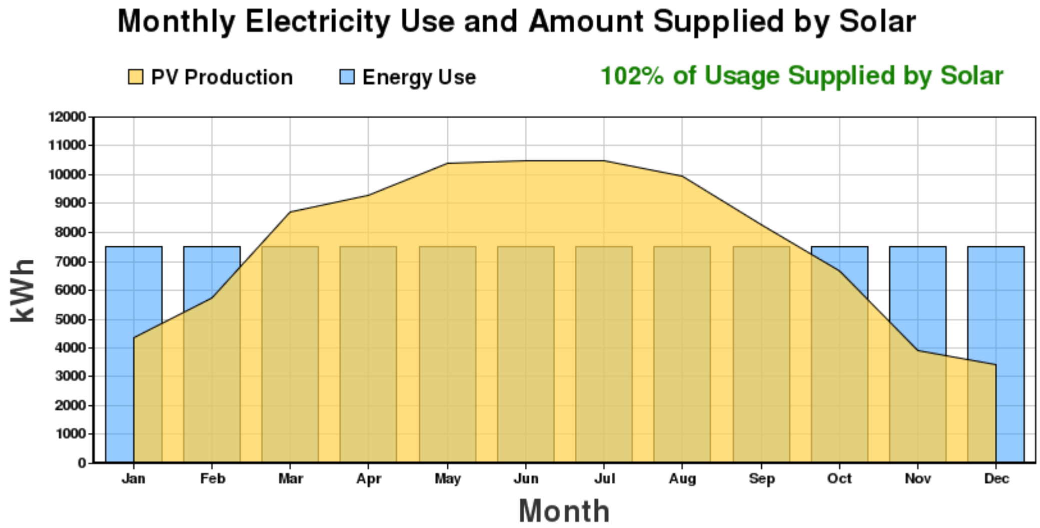
System Description	
Total System Size	79.800 kW DC Power (STC) / 65.740 kW AC Power (CEC)
Estimated Annual Production	91,710 kWh
PV Panel Description	420 x MAGE Solar Model: Powertec Plus 190/5MI
Inverters	Qty. 1 - Solectria Renewables LLC Model: PVI82kW-480

Energy Analysis

We have summarized your historical energy usage. Based upon the suggested system size, the expected energy bill s avings over a 25 year period are provided. In addition, the first-year predicted performance is compared to estimated electricity needs of the building.







Assumptions: Post-Solar Electric Rate Schedule for Cleveland Electric Illum Co is 0.127/kwh CEI Annual utility inflation: 3.00% (assumed). Energy Bill Savings are actual, without any tax effects applied.

Energy Bill Estimate

The following energy bill estimate is without any tax effects applied. The **Energy Bill Savings** line does not include the opportunity cost of no longer being able to take energy bill expense deductions on corporate income taxes. See the Energy Bill Savings line in the cash flow for this tax impact.

(kWh)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Total Usage	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	90.0k
Solar Production	4,349	5,746	8,698	9,297	10.4k	10.5k	10.5k	9,955	8,279	6,663	3,930	3,411	91.7k
Energy to Purchase	3,151	1,754	-1,198	-1,797	-2,914	-2,994	-2,974	-2,455	-779	837	3,570	4,089	-1,710

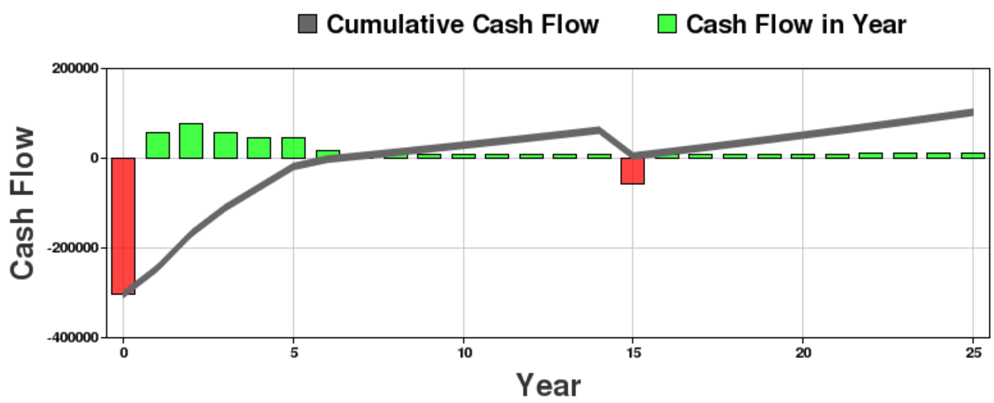
(Cost)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Pre-solar*	$981	$981	$981	$981	$981	$981	$981	$981	$981	$981	$981	$981	$11.8k
Post-solar*	$412	$229	$0	$0	$0	$0	$0	$0	$0	$109	$467	$535	$1,752
Annual Bill "True-up"	Credit for excess electricity generated (month of credit depends on interconnect date)											$1,752	$1,752
Energy Bill Savings	$569	$752	$981	$981	$981	$981	$981	$981	$981	$872	$514	$2,198	$11.8k

*Includes rate inflation

NOTES ON **Annual True-up**AND **Energy Bill Savings**:
The Energy Bill Savings is your Pre-solar Bill minus the Post-solar Bill, plus the True-up. The energy "Credit for excess electricity generated" cannot be greater than the energy charges incurred during the year.

Financial Analysis

The chart summarizes the cash flow over the life of the solar electric system we are suggesting. The table provides a summary of some key measures.



Financial Summary	
Utility Savings Over System Life	$221,823
Average Monthly Utility Savings	$739 (over system life)
Net Cost (In year of installation)	$304,137
Payback Period	6-7 years
Rate of Return on Cash Invested	5.3%
Total Life-Cycle Payback (Cash flow compared to Net Cost)	133%
Levelized Cost of Solar Energy (Net Cost / lifetime energy production)	$0.149 / kWh

Environmental Impact Analysis

A solar electric system will generate significant environmental benefits. These come primarily from avoided coal-fired power plant emissions. Below is a summary of some of the environmental benefits your solar system will provide.

Your New, Lower Carbon Footprint	
Your solar system will reduce Green House Gas emissions by **1,777 tons of CO2** (Over 25 years)	
Equivalent CO2 Reductions	
Small Car:	6,023,390 miles
Medium Car:	3,230,727 miles
SUV:	2,263,567 miles
Air Miles:	3,663,711 miles
Trees Planted:	71,076 trees planted
CO2 from Trash & Waste:	3,231 persons

Cash Flow by Year

The following table of estimated cash flows includes any tax effects, rate and cost inflation and other time-related cash flow factors. Refer to the Disclaimers & Assumptions section (below) for further clarification.

Year:	**0**	**1**	**2**	**3**	**4**
Installation, Operation & Maintenance Costs	($434,481)	($224)	($232)	($240)	($249)
S-REC	$0	$20,680	$20,680	$20,680	$20,680
Federal Investment Tax Credit (30%)	$130,344	$0	$0	$0	$0
MACRS 5-year Accelerated Depreciation (Fed & State Tax Avoided)	$0	$31,022	$49,635	$29,781	$17,869
Net Energy Bill Savings (Reduced by lower income tax deduction)	$0	$6,828	$7,033	$7,235	$7,377
Total Annual Cash Flow	**($304,137)**	**$58,306**	**$77,116**	**$57,456**	**$45,677**
Cumulative Cash Flow	($304,137)	($245,831)	($168,715)	($111,259)	($65,582)

Year:	**5**	**6**	**7**	**8**	**9**
Installation, Operation & Maintenance Costs	($258)	($267)	($276)	($286)	($296)
S-REC	$20,680	$0	$0	$0	$0
Federal Investment Tax Credit (30%)	$0	$0	$0	$0	$0
MACRS 5-year Accelerated Depreciation (Fed & State Tax Avoided)	$17,869	$8,934	$0	$0	$0
Net Energy Bill Savings (Reduced by lower income tax deduction)	$7,523	$7,671	$7,822	$7,976	$8,133
Total Annual Cash Flow	**$45,814**	**$16,338**	**$7,546**	**$7,690**	**$7,837**
Cumulative Cash Flow	($19,768)	($3,430)	$4,116	$11,806	$19,643

Year:	10	11	12	13	14
Installation, Operation & Maintenance Costs	($306)	($317)	($328)	($339)	($351)
S-REC	$0	$0	$0	$0	$0
Federal Investment Tax Credit (30%)	$0	$0	$0	$0	$0
MACRS 5-year Accelerated Depreciation (Fed & State Tax Avoided)	$0	$0	$0	$0	$0
Net Energy Bill Savings (Reduced by lower income tax deduction)	$8,293	$8,457	$8,624	$8,793	$8,967
Total Annual Cash Flow	**$7,987**	**$8,140**	**$8,296**	**$8,454**	**$8,616**
Cumulative Cash Flow	$27,630	$35,770	$44,066	$52,520	$61,136

Year:	15	16	17	18	19
Installation, Operation & Maintenance Costs	($66,707)	($376)	($389)	($403)	($417)
S-REC	$0	$0	$0	$0	$0
Federal Investment Tax Credit (30%)	$0	$0	$0	$0	$0
MACRS 5-year Accelerated Depreciation (Fed & State Tax Avoided)	$0	$0	$0	$0	$0
Net Energy Bill Savings (Reduced by lower income tax deduction)	$9,143	$9,323	$9,507	$9,694	$9,886
Total Annual Cash Flow	**($57,564)**	**$8,947**	**$9,118**	**$9,291**	**$9,469**
Cumulative Cash Flow	$3,572	$12,519	$21,637	$30,928	$40,397

Year:	20	21	22	23	24	25
Installation, Operation & Maintenance Costs	($432)	($447)	($463)	($479)	($496)	($513)
S-REC	$0	$0	$0	$0	$0	$0
Federal Investment Tax Credit (30%)	$0	$0	$0	$0	$0	$0
MACRS 5-year Accelerated Depreciation (Fed & State Tax Avoided)	$0	$0	$0	$0	$0	$0
Net Energy Bill Savings (Reduced by lower income tax deduction)	$10,080	$10,278	$10,481	$10,688	$10,898	$11,113
Total Annual Cash Flow	**$9,648**	**$9,831**	**$10,018**	**$10,209**	**$10,402**	**$10,600**
Cumulative Cash Flow	$50,045	$59,876	$69,894	$80,103	$90,505	$101,105

Disclaimers & Assumptions

Operation, Maintenance, and Inflation Rates

This estimate assumes the following system operation, maintenance and inflation rates:

System Life:	25 years
Operation & Maintenance:	0.05% of system cost per annum
PV Degradation:	1.00% per annum
Estimated Inverter Life:	15 years
O&M and Inverter Replacement Inflation:	3.5% per annum

System Size Ratings & Performance

There are three methods commonly used to rate PV system size: STC, PTC and CEC. The Standard Test Condition rating ("STC" also called "DC" or "nameplate") assumes a standard set of optimal operating conditions. The STC rating is most often used by manufacturers to classify the power output of PV modules. The PV-USA Test Condition ("PTC") and California Energy Commission ("CEC") ratings were designed to approximate system performance in more realistic operating conditions.

The Energy production for the first year is based on PVWatts Version 2. To calculate the system's energy production for any future year, the expected degradation in system performance is included (See "PV Degradation", in table above).

Tax Credits & Deductions

Income tax rate assumed: 42.00% (Federal 33.00% - State: 9.00%)

To calculate the estimated cash flow in this proposal, our analysis used these tax rates. We should stress that we cannot provide tax or investment guidance. You should consult your tax preparer or investment adviser for these services. This analysis calculates the cash flows based only on the assumptions entered into the proposal.

This analysis assumes Federal income Tax is not applied to any rebates. Therefore, the basis for the Federal ITC is the installation cost less 100% of any and all rebates.

Commercial:

In calculating the cash flow for a business, our analysis assumes that your beginning utility expense is a tax deductible business expense. Since your beginning utility bill will be reduced by installing the solar energy system,

our analysis takes this into account.

It also assumes that when you install your solar energy system, you will be able to receive tax benefits from the investment tax credit, depreciation of the equipment, annual maintenance expense, and interest used in financing. Unlike a residential system, the financing does not have to be secured by real estate in order for the interest to qualify as a tax deduction. Clean Power Finance can arrange this financing for you.

MACRS Depreciation: Any commercial entity that invests in or purchases qualified solar energy property may use the Modified Accelerated Cost Recovery System (MACRS) accelerated depreciation schedule: Year 1=20.00%, Year 2=32.00%, Year 3=19.20%, Year 4=11.52%, Year 5=11.52%, Year 6=5.76%. This analysis assumes Federal income Tax is not applied to any state or local incentives. Therefore, the basis for depreciation is the installation cost less 50% of any Federal energy tax credits less 100% of any and all state or local incentives received in year 0. See IRS Publications 946 and 587.

In this analysis, year 0 is the year in which the solar energy system is installed. Our analysis assumes that you will benefit from the Investment Tax Credit in year 0 (by knowing you won't have to pay as much tax), though you apply for it in year 1.

For all following years, tax deductions are applied to the year in which they occurred. The tax effect of deductions in year 1 are applied to year 1, and so forth.

(Net) Energy Bill Savings

For an individual, electric bills are not usually deductible against income taxes.

For a business, electric bills are usually deductible against income taxes. If an income tax rate is defined, the cash flow displays a "Net" Energy Bill Savings line item which is the Energy Bill Savings less the loss in tax deduction due to the PV system's lowering of the electric bill. Cost inflation for the utility rate and degradation of system performance are also taken into account.

Average Monthly Utility Savings

"Average Monthly Utility Savings" is the average monthly (Net) Energy Bill Savings expected over the system life. This takes into account utility rate inflation and any expected degradation in system performance. This estimate has not assumed any changes in the amount or timing in your building's energy use.

Rate of Return (IRR) on Cash Invested

"Rate of Return on Cash Invested" (also called "Internal Rate of Return" or "IRR") is the annual compounded rate of

return that the cash flows (savings, incentives, tax benefits, etc.) bring based upon the net cash invested in the year of installation ("Year 0"). In financial math terms, IRR is the discount rate required to make the sum of the present values of each annual cash flow equal zero. If you financed your system 100%, IRR does not apply since you did not actually invest cash.

Total Life-Cycle Payback

"Total Life-Cycle Payback" is the total cash flows (savings, incentives, tax benefits, etc.) for all years after installation as a percentage of the net cash invested in the year of installation ("Year 0"). This ROI calculation is not adjusted for inflation or the time-value of money.

Levelized Cost of Energy

"Levelized Cost of Energy" (or LCOE) is an approximation of the average cost of energy from your solar system ($/kWh). To determine LCOE, the system Net Cost ($ in the installation year) is divided by the amount of energy produced (kWh) over the system life (years). For this calculation, energy produced over system life is limited to the annual energy consumption of the building times the system life in years. The Net Cost does not include incentives which may materialize in later years, such as tax credits or deductions or production rebates. This calculation is not adjusted for the time-value of money.

Environmental Analysis

CO_2 gas emissions avoided per passenger via various travel methods:

Travel Method	Emissions / mile
Small Car	.59 pounds
Medium Car	1.10 pounds
SUV/4 Wheel Drive	1.57 pounds
Airplane (Boeing 747)	0.97 pounds

Air travel average USA capacity.

Tree offset calculation is based on a tree planted in the humid tropics absorbing on average 50 pounds (22 kg) of carbon dioxide annually over 40 years - each tree will absorb 1 ton of CO2 over its lifetime; but as trees grow, they compete for resources and some may die or be destroyed - not all will achieve their full carbon sequestration potential. This calculator assumes that 5 trees should be planted to ensure that at least one lives to 40 years or that their combined sequestration equals 1 ton.

General waste is based on the USA average carbon dioxide emission equivalent of 1,010 pounds per person per year.

Sources: Sightline Institute, Trees for the Future and USA Environmental Protection Agency

Electric Utility Rates & Assumptions

Utility:	Cleveland Electric Illum Co
Rate Name (Post Installation):	0.127/kwh CEI
Annual Inflation:	3.0% (assumed)

Utility Electric Rate Inflation: Historical References

National Averages: In 2009, the average retail electricity price for all customers across the United States rose to 9.83 cents per kWh, a small increase over 2008. Over the two year period though, from 2007 to 2009, the average retail price rose 7.7 percent.

Average commercial prices decreased one tenth of a cent per kWh from 10.36 to 10.26 cents per kWh. Average industrial prices decreased 0.02 percent from 6.83 cents per kWh in 2008 to 6.70 cents per kWh in 2009.

See the following Dept of Energy source for more detail on regional and state inflation patterns.

Source: http://www.eia.doe.gov/cneaf/electricity/esr/esr_sum.html

Summary

Customer
Sutton Road

Site Address
OH 44120

Company Contact
Erika Weliczko
REpower SOLUTIONS
2434 Hamilton Ave
Cleveland, OH 44114

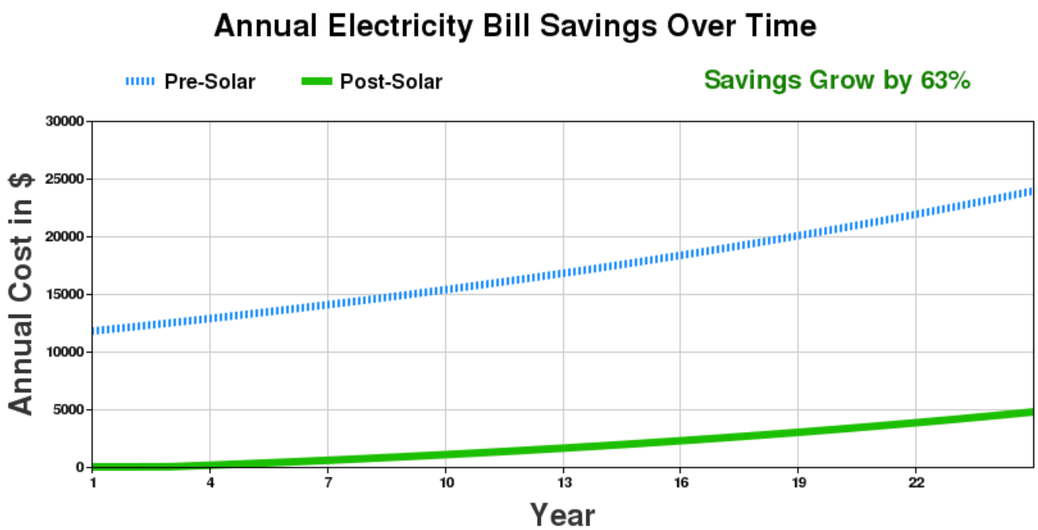
25 Year Financial Analysis			
Utility Savings Over System Life	$221,823 $739 / mo (avg)	Payback Period	6-7 years
Total Life-Cycle Payback (Cash Flow compared to Net Cost)	133%	Rate of Return on Cash Invested	5.3%
Levelized Cost of Solar Energy	$0.149 / kWh		

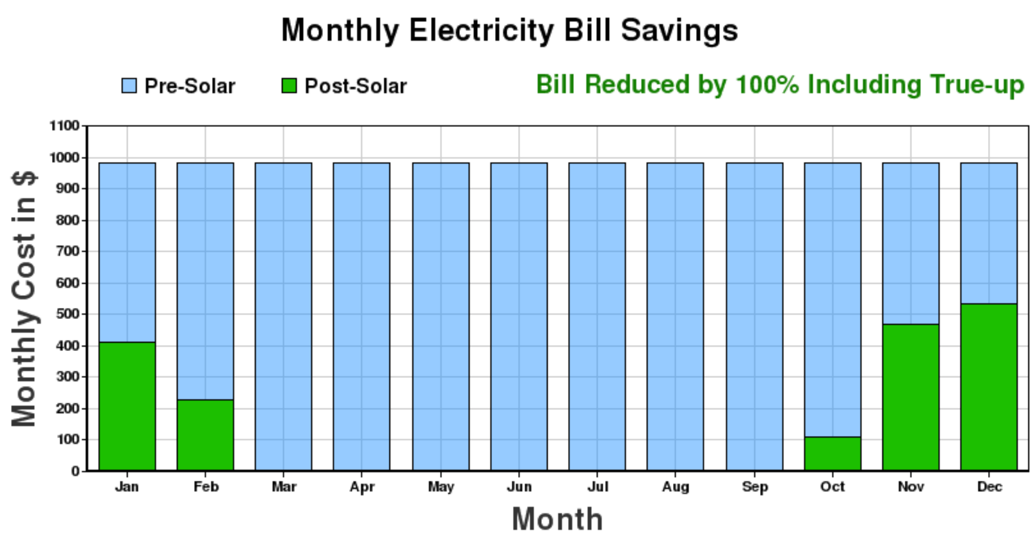
Cost Breakdown		
Installer Contract Cost	$434,481	($5.44/watt DC, $6.61/watt AC)
Federal Tax Credit/Tax Impact	($130,344)	
Net Cost (year of installation)	$304,137	($3.81/watt DC, $4.63/watt AC)
MACRS Depreciation	($155,110)	
S-REC	($103,400)	
Net Cost (all years)	$45,627	($0.57/watt DC, $0.69/watt AC)

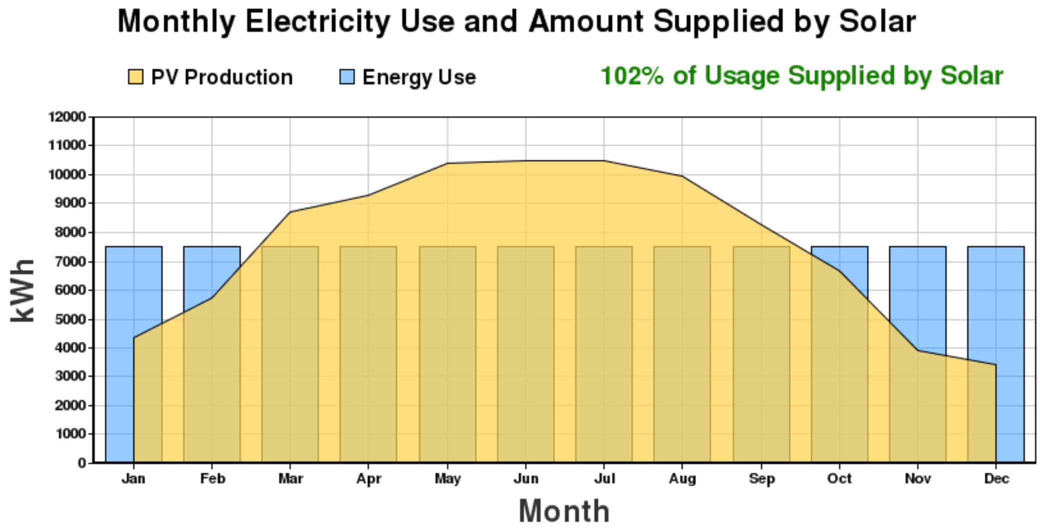
System Description	
Total System Size	79.800 kW DC Power (STC) / 65.740 kW AC Power (CEC)
Estimated Annual Production	91,710 kWh
PV Panel Description	420 x MAGE Solar Model: Powertec Plus 190/5MI
Inverters	Qty. 1 - Solectria Renewables LLC Model: PVI82kW-480

Energy Analysis

We have summarized your historical energy usage. Based upon the suggested system size, the expected energy bill s avings over a 25 year period are provided. In addition, the first-year predicted performance is compared to estimated electricity needs of the building.







Assumptions: Post-Solar Electric Rate Schedule for Cleveland Electric Illum Co is 0.127/kwh CEI Annual utility inflation: 3.00% (assumed). Energy Bill Savings are actual, without any tax effects applied.

Energy Bill Estimate

The following energy bill estimate is without any tax effects applied. The **Energy Bill Savings** line does not include the opportunity cost of no longer being able to take energy bill expense deductions on corporate income taxes. See the Energy Bill Savings line in the cash flow for this tax impact.

(kWh)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Total Usage	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	90.0k
Solar Production	4,349	5,746	8,698	9,297	10.4k	10.5k	10.5k	9,955	8,279	6,663	3,930	3,411	91.7k
Energy to Purchase	3,151	1,754	-1,198	-1,797	-2,914	-2,994	-2,974	-2,455	-779	837	3,570	4,089	-1,710

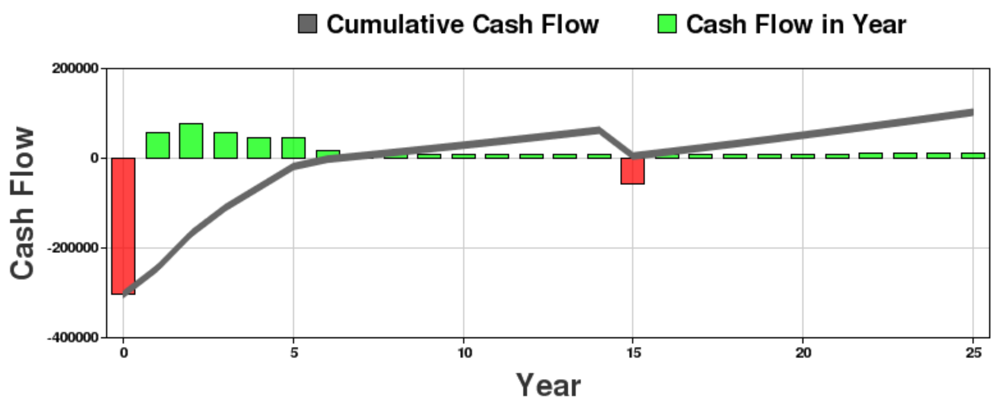
(Cost)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Pre-solar*	$981	$981	$981	$981	$981	$981	$981	$981	$981	$981	$981	$981	$11.8k
Post-solar*	$412	$229	$0	$0	$0	$0	$0	$0	$0	$109	$467	$535	$1,752
Annual Bill "True-up"	Credit for excess electricity generated (month of credit depends on interconnect date)											$1,752	$1,752
Energy Bill Savings	$569	$752	$981	$981	$981	$981	$981	$981	$981	$872	$514	$2,198	$11.8k

*Includes rate inflation

NOTES ON **Annual True-up**AND **Energy Bill Savings**:
The Energy Bill Savings is your Pre-solar Bill minus the Post-solar Bill, plus the True-up. The energy "Credit for excess electricity generated" cannot be greater than the energy charges incurred during the year.

Financial Analysis

The chart summarizes the cash flow over the life of the solar electric system we are suggesting. The table provides a summary of some key measures.



Financial Summary	
Utility Savings Over System Life	$221,823
Average Monthly Utility Savings	$739 (over system life)
Net Cost (In year of installation)	$304,137
Payback Period	6-7 years
Rate of Return on Cash Invested	5.3%
Total Life-Cycle Payback (Cash flow compared to Net Cost)	133%
Levelized Cost of Solar Energy (Net Cost / lifetime energy production)	$0.149 / kWh

Environmental Impact Analysis

A solar electric system will generate significant environmental benefits. These come primarily from avoided coal-fired power plant emissions. Below is a summary of some of the environmental benefits your solar system will provide.

Your New, Lower Carbon Footprint

Your solar system will reduce Green House Gas emissions by **1,777 tons of CO_2** (Over 25 years)

Equivalent CO_2 Reductions

Small Car:	6,023,390 miles
Medium Car:	3,230,727 miles
SUV:	2,263,567 miles
Air Miles:	3,663,711 miles
Trees Planted:	71,076 trees planted
CO_2 from Trash & Waste:	3,231 persons

Cash Flow by Year

The following table of estimated cash flows includes any tax effects, rate and cost inflation and other time-related cash flow factors. Refer to the Disclaimers & Assumptions section (below) for further clarification.

Year:	**0**	**1**	**2**	**3**	**4**
Installation, Operation & Maintenance Costs	($434,481)	($224)	($232)	($240)	($249)
S-REC	$0	$20,680	$20,680	$20,680	$20,680
Federal Investment Tax Credit (30%)	$130,344	$0	$0	$0	$0
MACRS 5-year Accelerated Depreciation (Fed & State Tax Avoided)	$0	$31,022	$49,635	$29,781	$17,869
Net Energy Bill Savings (Reduced by lower income tax deduction)	$0	$6,828	$7,033	$7,235	$7,377
Total Annual Cash Flow	**($304,137)**	**$58,306**	**$77,116**	**$57,456**	**$45,677**
Cumulative Cash Flow	($304,137)	($245,831)	($168,715)	($111,259)	($65,582)

Year:	**5**	**6**	**7**	**8**	**9**
Installation, Operation & Maintenance Costs	($258)	($267)	($276)	($286)	($296)
S-REC	$20,680	$0	$0	$0	$0
Federal Investment Tax Credit (30%)	$0	$0	$0	$0	$0
MACRS 5-year Accelerated Depreciation (Fed & State Tax Avoided)	$17,869	$8,934	$0	$0	$0
Net Energy Bill Savings (Reduced by lower income tax deduction)	$7,523	$7,671	$7,822	$7,976	$8,133
Total Annual Cash Flow	**$45,814**	**$16,338**	**$7,546**	**$7,690**	**$7,837**
Cumulative Cash Flow	($19,768)	($3,430)	$4,116	$11,806	$19,643

Year:	10	11	12	13	14
Installation, Operation & Maintenance Costs	($306)	($317)	($328)	($339)	($351)
S-REC	$0	$0	$0	$0	$0
Federal Investment Tax Credit (30%)	$0	$0	$0	$0	$0
MACRS 5-year Accelerated Depreciation (Fed & State Tax Avoided)	$0	$0	$0	$0	$0
Net Energy Bill Savings (Reduced by lower income tax deduction)	$8,293	$8,457	$8,624	$8,793	$8,967
Total Annual Cash Flow	**$7,987**	**$8,140**	**$8,296**	**$8,454**	**$8,616**
Cumulative Cash Flow	$27,630	$35,770	$44,066	$52,520	$61,136

Year:	15	16	17	18	19
Installation, Operation & Maintenance Costs	($66,707)	($376)	($389)	($403)	($417)
S-REC	$0	$0	$0	$0	$0
Federal Investment Tax Credit (30%)	$0	$0	$0	$0	$0
MACRS 5-year Accelerated Depreciation (Fed & State Tax Avoided)	$0	$0	$0	$0	$0
Net Energy Bill Savings (Reduced by lower income tax deduction)	$9,143	$9,323	$9,507	$9,694	$9,886
Total Annual Cash Flow	**($57,564)**	**$8,947**	**$9,118**	**$9,291**	**$9,469**
Cumulative Cash Flow	$3,572	$12,519	$21,637	$30,928	$40,397

Year:	20	21	22	23	24	25
Installation, Operation & Maintenance Costs	($432)	($447)	($463)	($479)	($496)	($513)
S-REC	$0	$0	$0	$0	$0	$0
Federal Investment Tax Credit (30%)	$0	$0	$0	$0	$0	$0
MACRS 5-year Accelerated Depreciation (Fed & State Tax Avoided)	$0	$0	$0	$0	$0	$0
Net Energy Bill Savings (Reduced by lower income tax deduction)	$10,080	$10,278	$10,481	$10,688	$10,898	$11,113
Total Annual Cash Flow	**$9,648**	**$9,831**	**$10,018**	**$10,209**	**$10,402**	**$10,600**
Cumulative Cash Flow	$50,045	$59,876	$69,894	$80,103	$90,505	$101,105

Disclaimers & Assumptions

Operation, Maintenance, and Inflation Rates

This estimate assumes the following system operation, maintenance and inflation rates:

System Life:	25 years
Operation & Maintenance:	0.05% of system cost per annum
PV Degradation:	1.00% per annum
Estimated Inverter Life:	15 years
O&M and Inverter Replacement Inflation:	3.5% per annum

System Size Ratings & Performance

There are three methods commonly used to rate PV system size: STC, PTC and CEC. The Standard Test Condition rating ("STC" also called "DC" or "nameplate") assumes a standard set of optimal operating conditions. The STC rating is most often used by manufacturers to classify the power output of PV modules. The PV-USA Test Condition ("PTC") and California Energy Commission ("CEC") ratings were designed to approximate system performance in more realistic operating conditions.

The Energy production for the first year is based on PVWatts Version 2. To calculate the system's energy production for any future year, the expected degradation in system performance is included (See "PV Degradation", in table above).

Tax Credits & Deductions

Income tax rate assumed: 42.00% (Federal 33.00% - State: 9.00%)

To calculate the estimated cash flow in this proposal, our analysis used these tax rates. We should stress that we cannot provide tax or investment guidance. You should consult your tax preparer or investment adviser for these services. This analysis calculates the cash flows based only on the assumptions entered into the proposal.

This analysis assumes Federal income Tax is not applied to any rebates. Therefore, the basis for the Federal ITC is the installation cost less 100% of any and all rebates.

Commercial:

In calculating the cash flow for a business, our analysis assumes that your beginning utility expense is a tax deductible business expense. Since your beginning utility bill will be reduced by installing the solar energy system,

our analysis takes this into account.

It also assumes that when you install your solar energy system, you will be able to receive tax benefits from the investment tax credit, depreciation of the equipment, annual maintenance expense, and interest used in financing. Unlike a residential system, the financing does not have to be secured by real estate in order for the interest to qualify as a tax deduction. Clean Power Finance can arrange this financing for you.

MACRS Depreciation: Any commercial entity that invests in or purchases qualified solar energy property may use the Modified Accelerated Cost Recovery System (MACRS) accelerated depreciation schedule: Year 1=20.00%, Year 2=32.00%, Year 3=19.20%, Year 4=11.52%, Year 5=11.52%, Year 6=5.76%. This analysis assumes Federal income Tax is not applied to any state or local incentives. Therefore, the basis for depreciation is the installation cost less 50% of any Federal energy tax credits less 100% of any and all state or local incentives received in year 0. See IRS Publications 946 and 587.

In this analysis, year 0 is the year in which the solar energy system is installed. Our analysis assumes that you will benefit from the Investment Tax Credit in year 0 (by knowing you won't have to pay as much tax), though you apply for it in year 1.

For all following years, tax deductions are applied to the year in which they occurred. The tax effect of deductions in year 1 are applied to year 1, and so forth.

(Net) Energy Bill Savings

For an individual, electric bills are not usually deductible against income taxes.

For a business, electric bills are usually deductible against income taxes. If an income tax rate is defined, the cash flow displays a "Net" Energy Bill Savings line item which is the Energy Bill Savings less the loss in tax deduction due to the PV system's lowering of the electric bill. Cost inflation for the utility rate and degradation of system performance are also taken into account.

Average Monthly Utility Savings

"Average Monthly Utility Savings" is the average monthly (Net) Energy Bill Savings expected over the system life. This takes into account utility rate inflation and any expected degradation in system performance. This estimate has not assumed any changes in the amount or timing in your building's energy use.

Rate of Return (IRR) on Cash Invested

"Rate of Return on Cash Invested" (also called "Internal Rate of Return" or "IRR") is the annual compounded rate of

return that the cash flows (savings, incentives, tax benefits, etc.) bring based upon the net cash invested in the year of installation ("Year 0"). In financial math terms, IRR is the discount rate required to make the sum of the present values of each annual cash flow equal zero. If you financed your system 100%, IRR does not apply since you did not actually invest cash.

Total Life-Cycle Payback

"Total Life-Cycle Payback" is the total cash flows (savings, incentives, tax benefits, etc.) for all years after installation as a percentage of the net cash invested in the year of installation ("Year 0"). This ROI calculation is not adjusted for inflation or the time-value of money.

Levelized Cost of Energy

"Levelized Cost of Energy" (or LCOE) is an approximation of the average cost of energy from your solar system ($/kWh). To determine LCOE, the system Net Cost ($ in the installation year) is divided by the amount of energy produced (kWh) over the system life (years). For this calculation, energy produced over system life is limited to the annual energy consumption of the building times the system life in years. The Net Cost does not include incentives which may materialize in later years, such as tax credits or deductions or production rebates. This calculation is not adjusted for the time-value of money.

Environmental Analysis

CO_2 gas emissions avoided per passenger via various travel methods:

Travel Method	Emissions / mile
Small Car	.59 pounds
Medium Car	1.10 pounds
SUV/4 Wheel Drive	1.57 pounds
Airplane (Boeing 747)	0.97 pounds

Air travel average USA capacity.

Tree offset calculation is based on a tree planted in the humid tropics absorbing on average 50 pounds (22 kg) of carbon dioxide annually over 40 years - each tree will absorb 1 ton of CO2 over its lifetime; but as trees grow, they compete for resources and some may die or be destroyed - not all will achieve their full carbon sequestration potential. This calculator assumes that 5 trees should be planted to ensure that at least one lives to 40 years or that their combined sequestration equals 1 ton.

General waste is based on the USA average carbon dioxide emission equivalent of 1,010 pounds per person per year.

Sources: Sightline Institute, Trees for the Future and USA Environmental Protection Agency

Electric Utility Rates & Assumptions

Utility:	Cleveland Electric Illum Co
Rate Name (Post Installation):	0.127/kwh CEI
Annual Inflation:	3.0% (assumed)

Utility Electric Rate Inflation: Historical References

National Averages: In 2009, the average retail electricity price for all customers across the United States rose to 9.83 cents per kWh, a small increase over 2008. Over the two year period though, from 2007 to 2009, the average retail price rose 7.7 percent.

Average commercial prices decreased one tenth of a cent per kWh from 10.36 to 10.26 cents per kWh. Average industrial prices decreased 0.02 percent from 6.83 cents per kWh in 2008 to 6.70 cents per kWh in 2009.

See the following Dept of Energy source for more detail on regional and state inflation patterns.

Source: http://www.eia.doe.gov/cneaf/electricity/esr/esr_sum.html

APPENDIX B

Geothermal Methodology

Geothermal Methodology

For the Shaker Heights Alternative Energy Study, we are providing this summary of the key factors in our method and assumption in evaluating the geothermal systems.

To estimate the size of a geothermal district system, we summed the heating and cooling demand for the Sutton Road house with the Sutton Place condominiums and the future Transit Village development. We collected building and utility data from conducting an energy audit, interviewing the homeowner and obtaining the previous year's utility bills for a typical two-family house on Sutton Road and one condominium in Sutton Place. We imported this data into energy modeling programs: EQuest or ESim and created energy models for each building. The model results were compared to actual utility bills to create existing conditions heating and cooling profile. The existing conditions models were adjusted to create an improved house model that reflected adding air conditioning and/or sealing and insulating the home.

A heating and cooling load profile was created for each typical building and for each district. Load profiles were modeled using a custom Excel spreadsheet model and a ground source geothermal modeling program. It was quickly determined that the heating demand for the un-insulated, unimproved homes required a geothermal borehole field larger than area was available. The size of the geothermal heat pump and number of boreholes required to deliver these high peak heating loads made using geothermal for the unimproved houses not viable.

Individual habits and home conditions would cause the mode results to vary from actual conditions. Each residence must be examined on an individual basis before purchasing or installation of any of the studied technologies

Older homes in Shaker Heights require significantly more heating than cooling because of the climate and because the homes tend to have air leakage and require more heat to maintain a comfortable level. In addition there are high peaks for heating and cooling due to a wide spread of temperatures and humidity. For the Sutton Road Neighborhood, annual total heating demand, after typical energy efficiency improvements have been made, is approximately 4,950,000 MBTU/yr and the cooling demand is 750,000 MBTU/yr which is approximately 6.6 times more heating than cooling. Our financial analysis determined that using geothermal to serve 100% of these imbalanced loads resulted in a larger than average geothermal system with a longer payback than average.

The improved house model results were then extrapolated to create a heating and cooling profile for the entire neighborhood by multiplying the total square footage and a weighting for the type of construction (i.e. wood frame, brick). Another energy model was created of expected future development in Transit Village. Because this development is only at a conceptual stage, the model was based on information received in a meeting with City officials. We assumed two buildings with five units each ranging from 1,500 to 2,000 sq ft/unit and built with modern, energy-efficient construction.

We used a home load profile that reflected an improved building shell and found that the cost of building improvements to reduce the heating and cooling demand pays for itself in the cost reduction of the geothermal system. We ran a geothermal model and a financial analysis on the following scenarios:

- 100% of heating and cooling served by geothermal
- Partial geothermal with supplemental heating provided by solar thermal
- Partial geothermal with supplemental heating provided by natural gas furnace

To reduce the borehole field size and improve the case for installing geothermal, more heat should be added to the borehole field or the peak heating should be served by another source, making the geothermal serve only part of the heating load. We modeled both these scenarios. Installing solar thermal panels to collect heat from the sun and then transfer it into the ground was modeled. To avoid increasing the borehole supply temperature in the summer season, the solar thermal panels can add heat to the ground but only during times outside the summer season. Because the amount of daylight reduces significantly outside the summer season the number of panels required to collect the same amount of heat was large and the solar thermal supplemental heating did reduce the geothermal system cost enough to pay for itself.

The houses in the Sutton Road neighborhood used natural gas-fired forced air furnaces. The majority had either no air conditioning or window air conditioning units. A few houses had central air conditioning with an outdoor condenser unit. It is possible to add geothermal to these houses and maintain a natural gas furnace or an electric resistance strip heat that is full capacity back-up for heating. A model of a geothermal with supplemental heating whereby 100% of the cooling would be served by geothermal but heating would be served by geothermal until the borehole field was exhausted when an automatic switchover to the backup furnace would occur. The borehole field was reduced by over a third and the payback became 8 to 12 years.

Creating a district system on a residential street does not reduce the number of boreholes from number required if each house was constructed individually because their pattern of demand for heating and cooling does not vary significantly between residences. District systems provide a means to recycle and reuse thermal energy from one building to another. For example, excess heat from a building with significant refrigeration, such as a grocery store could be stored in the ground instead of being released into the air, to provide heating for a residence in the winter. To take advantage of this benefit, buildings with a diverse set of uses and occupancies that have different heating and cooling demand profiles need to be connected to the district. In the case of the Sutton Road Neighborhood, all the buildings are residences which have similar occupancy patterns and require maximum heating and cooling at the same time. The effect of this common peaking is that the district geothermal system size is not reduced by any diversity and can in fact be larger if not designed thoughtfully. Modeling shows that consolidating the district boreholes in a single grid at standard spacing in one location creates a heat island in the middle of the borehole field that reduces the overall capacity over time. A better, more cost effective practice is to create boreholes in fewer long lines instead of a single block. The affect becomes worse when the boreholes are further apart and grouped into one larger area due to long term thermal interference between the boreholes.

We estimated the capital costs by taking the system sizes estimated in the energy models and estimating unit prices using engineering judgment and information from previous projects. The utility prices were derived from homeowners' actual utility bills from the previous 12 months. Electricity price is $0.127/kilowatt-hours and the natural gas price is $1.00/therm and annual escalation rate of 3% was used for both utilities. Drilling costs can vary greatly based on whether the project is prevailing wage, volume of work, and number of bidders. For this analysis, we estimated the drilling costs to be from $8/lf to$14/lf. The cost of standard air conditioning is $500/ton and the cost of a standard natural gas furnace is $650/ton. The geothermal heat pump and other mechanical equipment inside the building were estimated at $1300/ton. Costs for supporting work, such as new ductwork, range from $0 to $10,000 per average-sized house and household. RS Means was utilized to estimate the district underground piping installed along the right of way. Estimates of retrofit costs were determined form local HVAC contractors.

Tax incentives and rebates are based on information available at this time and are likely to vary in the future.

Our results show that a district system does not provide any capital costs savings. The choice between completing a district and doing individual houses would probably be based on the actual financing mechanism. There is a federal tax credit available to homeowners for 30% of the total cost of the geothermal system (borehole field + mechanical system upgrades). To qualify for the credit, the system must be brought into service between 2008 and 2016 and the heat pump must meet the Energy Star performance criteria. We have included the analysis. If the district system is installed by Shaker Heights, utility, non-profit or another that does not pay taxes then the credit would not apply.

REPORT ON
ALTERNATIVE ENERGY FEASIBILITY STUDY
SUTTON NEIGHBORHOOD
SHAKER HEIGHTS, OHIO

by

Haley & Aldrich, Inc.
Cleveland, Ohio

for

City of Shaker Heights
Shaker Heights, Ohio

File No. 37569-000
29 July 2011

HALEY& ALDRICH