Energy Efficiency & Expansion

CHATHAM COUNTY

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EXECUTIVE SUMMARY

The purpose of this report is to outline increasing efficiencies of new and existing buildings and renewable energy initiatives for Chatham County, North Carolina. Specifically, the initiatives address the goals of the Chatham County Climate Action Plan. This report used the Energy and Atmosphere Standards within the Leadership in Energy and Environmental Design (LEED) Certification for increasing building efficiency and several solar energy databases for renewable energy expansion. The LEED Certification component of this report is directed towards the Chatham County Schools' buildings, while the renewable energy expansion, specifically solar energy expansion, is directed towards the residents of Chatham County. This report presents the process to gain LEED Certification and recommendations for that process. Additionally, it presents the estimated calculations of potential solar photovoltaic generation and value economically and environmentally. The economic value is presented as energy savings, while the environmental value is presented as reductions in carbon dioxide emissions. Furthermore, this report describes the financial incentives available both on the state and federal level for the installation of solar photovoltaics, thereby increasing the economic value of solar photovoltaics.

INTRODUCTION

As of October 29, 2018, the governor of North Carolina, Roy Cooper, committed North Carolina "to address climate change and transition to a clean energy economy" through Executive Order No. 80 (EO80) (Executive Order No. 80, 2018). In accordance with this, the Chatham County Board of Commissioners adopted a resolution "Supporting a State and National Goal of 100% Clean Energy by 2050 and the Creation of Green Jobs" (Executive Order No. 80, 2018). Additionally, the Chatham County Climate Change Committee has developed a Climate Action Plan. This report focuses on the 'building energy efficiency' and 'expanding renewable energy production' initiatives outlined within the Climate Action Plan.

This report addresses the energy efficiency initiative using the Leadership in Energy and Environmental Design (LEED) standards established by the U.S. Green Building Council (USGBC, 2014). While there are several energy efficiency categories for LEED certification, this report focuses on the Energy and Atmosphere category (USGBC, 2014). The other efficiency categories, such as water efficiency, materials and resources, and indoor environmental quality are not addressed because this report seeks to provide reasonable recommendations both economically and environmentally, especially as this report focuses on the analysis of public school buildings. Additionally, the Energy and Atmosphere (EA) category incorporates both of the initiatives as it "approaches energy from a holistic perspective, addressing energy use reduction, energy-efficient strategies, and renewable energy sources" (USGBC, 2014). The goal of this report is to provide reasonable recommendations, but also provide a means for the public schools in Chatham County to educate its students on the significance of LEED standards and what they mean as the schools are pursuing certification.

Aside from the Energy and Atmosphere category discussing potential renewable energy expansion in various existing buildings, the expansion of renewable energy production initiative is discussed through the analysis of producing solar energy at

residential houses. According to Amanda Robertson, one of the founders of the Chatham County Climate Change Advisory Committee, county buildings and several other buildings within Chatham County are undergoing assessment for their capacity to produce solar energy using the program SolSmart, which is a national program that helps cities, counties, and regional organizations develop solar energy (SolSmart, 2019). Upon requesting a consultation, SolSmart provides technical assistance about solar capacity and installation (SolSmart, 2019). Amanda Robertson requested this assistance for Chatham County business and municipal buildings. So while these businesses and municipalities are looking to install these solar photovoltaic panels, there is still an educational gap between residents and the economic and environmental benefits and costs of personal solar energy. ArcGIS Desktop sampled residential houses within Chatham County to input those residential addresses within the PVWatts Calculator provided by National Renewable Energy Laboratory. This calculation estimates the energy production of a photovoltaic energy system based on latitudinal and longitudinal coordinates of the address. This data provides a sample of the efficiency of solar energy for residents in Chatham County to be better informed. Additionally, as stated, the economic benefits and costs are important to the residents, and therefore this study; the current tax incentives available for residents are assessed through the three electric energy providers of Chatham County: Central Electric Membership Corporation, Duke Energy Progress, and Randolph Electric Corporation.

Overall, this report produces feasible recommendations for increasing energy efficiency of new and existing buildings and expanding renewable energy production within Chatham County. The recommendations are geared towards making economically and environmentally sound decisions but also providing means to educate the public, specifically public school students and residents, on real practices that Chatham County can take to aid in the satisfaction of EO80 and the Chatham County Climate Change Action Plan.

LEED ENERGY & ATMOSPHERE

Chatham County has already made efforts to adopt LEED certification into the county-owned buildings. This report, based on the goals laid out in the Chatham County Climate Action Plan (Climate Change Advisory Committee, 2017), urges more buildings in Chatham County to develop sustainably, and make pre-existing buildings more efficient and sustainable. Following the lead of Chatham County, this report uses LEED certification as a guide.

The LEED initiative is a green building rating system that indicates the energy efficiency of a building. It was created by the United States Green Building Council (USGBC) to apply to a wide variety of buildings and budgets. The certification has different levels, including Certified, Silver, Gold, and Platinum. Each of these levels apply to different budgetary and building needs and achieved by obtaining a certain number of points. The points are earned by making changes or implementing energy-efficient measures in the building. For example, the Energy and Atmosphere prerequisite can give a building up to 33 points based on the internal environment produced for occupants and greenhouse gas output. Different point values can lead to different certification levels: 40 points for "certification," 50 points for a "silver" rating, 60 points for a "gold" rating, and 80+ points for a "platinum" rating. Regardless of certification level, the LEED standards are a helpful aid in increasing building efficiency and reducing costs.

Methods

To begin the process to increase building efficiency throughout Chatham County, this report emphasizes the significance of LEED certification for both new and existing buildings. LEED certification ensures that efficiency claims are accurate, expert technical support is available, and has a wider range of marketing benefits.

The Energy and Atmosphere prerequisite of the LEED Operation and Maintenance (O&M) Reference Guide (V4) lists recommendations to begin the process of becoming LEED certified that are applicable to Chatham County buildings. Chatham County already has projects underway to expand renewable energy production to public school buildings and such innovations are a great way to achieve LEED points. School buildings were also of interest because they are among the most heavily occupied buildings in the county and require a great deal of energy to function. This report analyzes some of the potential costs and savings across different levels of LEED certification by studying and comparing other school LEED projects similar to those in Chatham County. It was also important for this report to address the costs of associated projects with attaining LEED certification. Using the pricing data from USGBC and the LEED O&M Reference Guide (V4), the importance and need for these incurred costs becomes inherently clear.

In reference to *Green School Facts* by Ashley Katz, it is important to analyze real-world examples and their significance. Schools that prioritize energy efficiency and operate under "green" standards, on average, reduced energy use by 33 percent and water consumption by 32 percent over more traditional schools. Along with a significant decrease in consumption throughout the buildings, these green schools also saved on average $100,000 per year on operating costs. Currently, there are more than 3,000 LEED certified schools worldwide. Specifically, Adlai E. Stevenson High School in Lincolnshire, Illinois earned LEED Gold certification and achieved savings of $100,000 on energy costs by decreasing electricity use by 7 percent and natural gas consumption by 5 percent during their two year certification process (Katz, 2012). These statistics are quite impressive but beg the question: "how much does it cost?"

Results

From the LEED OM Reference Guide table, in **Table 1** below, the following recommendations were made:

- Insulation on the piping and windows to better retain heating/cooling;
- More efficient heating and cooling;
- Replacing lights with CFL or LED lights;
- Automated lighting, faucets, HVAC;
- "Green" landscaping/roofing to aid in natural heating/cooling of the school;
- Automated meters for accurate energy consumption data.

Table 1. LEED OM Recommendations

Measure	Implementation Cost ($)	Total Annual Savings ($)	Simple Payback Period (Years)
Modify Fan Controls	$2,400	$7,797	0.3
Add Pipe Insulation	$650	$1,173	0.6
Install LEDs On All Exit Signs	$2,500	$1,175	2.1
Chiller Maintenance	$0	$5,528	0.0
Pump Balancing	$0	$1,848	0.0
Pump Maintenance	$7,400	$2,503	3.0
Install Light Occupancy Sensors in Mechanical Rooms and Lobby	$3,150	$5,649	0.6
AHU Sensor Calibration Issues	$600	$6,174	0.1
AHU Damper, Economizer Cycle Issues	$2,800	$3,638	0.8
Adjust Tenant Lighting Controls	$7,200	$10,471	0.7
Total	**$26,700**	**$45,956**	**0.6**

Table 1. This table makes specific suggestions for improvements to be made in existing school and business buildings to work towards LEED standards for energy and atmosphere. Such suggestions and prices may vary depending on the age, location, building purpose, etc. The changes are listed under the “measures” column, while the “implementation costs” provide a rough estimate of how much it would cost to implement. The “total annual savings” column gives the estimated annual savings each change would give to the school or business, while the “simple payback years” column gives estimates of how long it would take to get a return on the money spent implementing those changes. Here, all recommendations made are beneficial for gaining points and investing in efficiency to save money. The totals at the bottom show overall estimates for the “total to implement,” “total annual savings,” and how many years it would take to get a return on the implementation costs.

The recommendations for more energy efficient buildings were developed from the LEED Energy and Atmosphere Reference Guide (USGBC, 2014). There is a list of “No-Cost or Low-Cost” measures, which include recommendations estimated at $7,500 or less; those measures were of main interest here.

The recommendations include adding pipe insulation, using LED lights, performing maintenance on chillers and pumps, and installing better controls or automatic controls for lighting. The recommendation for push-down faucets came from this as well, to make the public schools more efficient in water usage. These recommendations are rather small, as they do not require major renovations of the facility, making them more accessible and easier for the pre-existing school buildings to follow. There are some considerations for each building, including age and accessibility, in addition to the funding each school has to spend on making the building more efficient. Depending on how many changes the schools are able to make, they may be eligible for additional LEED points and certifications. These recommendations are beneficial to the buildings in different ways, each of which are explained below.

Insulation

Most people can add at least some kind of insulation to pipes and walls in their own homes. The suggestion for better insulation on the piping helps the air or water inside retain its temperature. For heating purposes, the pipes will retain more of the heat if insulated. This would demand less energy production, thereby making the HVAC system more energy efficient. The same is true for cool air or water in the pipes; the cooler temperatures would be better preserved if insulated. Insulating the windows will cause the building to maintain its internal temperature better, thereby reducing the need to run the air or heat. Window insulation will aid the heating and cooling to run more efficiently and require less energy but having a more energy efficient HVAC system would also need less energy to run.

Lighting

Switching to more efficient light bulbs is highly accessible. When one lightbulb burns out, switching the bulbs to light emitting diode (LED) and compact fluorescent light (CFL) is a great way to work toward being more energy efficient. Though these light bulbs are initially more expensive, they use far less energy than incandescent or other light bulbs, and last much longer, making them cost efficient in the long run.

Automation

Motion-sensor lighting is useful in places where turning lights on and off is not something occupants of a building can be trusted to do on their own. Therefore, this technology is extra helpful in public buildings such as schools or businesses. Automated lighting ensures that the lights are off when the room is not in use; the sensor detects when there is movement in the room and turns the lights on and keeps them on for a predetermined period of time. Additionally, automated faucets will preserve water, and therefore, the heating or cooling required for the water as well. This makes the faucets more efficient and reduces wasting energy and water. Automated HVAC systems cause the system to be in use when necessary, stopping it from running constantly, and decreasing the amount of energy used to maintain temperatures.

Green Landscaping

Green landscaping is another option for buildings to implement. This may be a more time-consuming energy saving measure, but it is quite effective. Green landscaping includes green roofs, which help to absorb the radiation from the sun, thereby aiding the HVAC system and decreasing the amount of energy needed to cool the building. Additionally, planting trees and shrubs next to windows can provide shade and cooler temperatures naturally in the spring and summer. This also allows the sun to come in during the fall and winter to keep the building warmer. Green landscaping causes the HVAC system to need to run less, making it more efficient, and keeping energy costs down. Additionally, green roofs can be used to provide insulation from the roof, helping keep sun rays in especially hot or sun-prone areas. Overall, green landscaping is aesthetically pleasing and creates a more peaceful environment to live, work, or learn in.

Metering

Metering is a great option for many different types of buildings and is a useful tool to track energy consumption and identify areas for reduction in energy consumption. Accurate and timely metering is essential in any construction installation. Meters can track every aspect of building consumption from energy and water consumption to combined cycle steam production, CO_2 levels, and the time the HVAC has run each day. Some meters are still using outdated technology meaning they will not provide readings with decimal precision and must be checked manually, therefore they do not provide an accurate picture of building consumption and efficiency levels. The greatest importance is placed on replacing old meters with modern technology that can perform with much greater precision and provides automatic data readings at the same time each day. The best meters for modern buildings are not provided by utility companies; instead, private installations downstream of the utility company meter provide the best building-level use data. Ultimately, to best understand how a building uses energy on a day-to-day basis, an automated meter taking readings every hour may be the ideal solution.

Along with the costs associated with the recommended modifications is the cost of becoming certified. Using the USGBC Certification Guide, existing buildings that aren't LEED members, incur a registration fee of $1,500. Every building wishing to become certified under these criteria is charged a flat fee of $5,000 for non-LEED members and $4,000 for previously LEED certified buildings. It is reasonable to assume that all public school buildings in Chatham County are less than 250,000 square feet, as the Biltmore Estate is merely 175,000 square feet. Any building less than 250,000 square feet must also pay certification review fees, which are valid for three years, of $0.0274/square foot for a minimum of $1,350 (USGBC, 2019). For reference, a 100,000 square foot building would have to pay roughly $9,240 for certification fees. It is important to note the costs of the previously mentioned recommendations are not included in the $9,240 figure.

Discussion

In reference to LEED certification, prerequisites can hold different weighted values for assessing buildings and projects, with Energy and Atmosphere weighted the most at 33 possible points. A focus on the Energy and Atmosphere prerequisite gives each public school building the best opportunity to achieve general LEED certification (40+ points)--the lowest tier. Along with the points from the prerequisite, every building has the opportunity to earn up to 10 base points for currently efficient operations. The suggestions outlined earlier could result in 43 possible points and eligibility to receive LEED recognition. While these recommendations are a framework for gaining the general LEED certification level, it is possible to pursue further building renovations and additional points for higher certification levels.

Each of these suggestions can help earn points toward LEED certification, and together can contribute in large part to a more energy efficient Chatham County. Each building that implements these recommendations helps decrease the fossil fuel-dependency and carbon footprint common of older installations. In this case, the buildings and operators have to pay for the certification, but the third-party verification provided by USGBC and their LEED standards are sure to show the public that taxpayer money is being wisely spent on sustainable and efficient buildings that save money and energy.

RENEWABLE ENERGY PRODUCTION

The Chatham County Action Plan discusses taking steps to expand renewable energy production through solar and wind power generation and use in the County. However, for the purposes of this report, wind power is not considered. While it is a highly regarded renewable energy, urban wind energy has yet to be widely adopted due to concerns with aesthetics, installation space, low and turbulent wind-speed characteristics, safety, and so forth (Kammen & Sunter, 2016, p. 922-928). Therefore, instead the feasibility and viability of solar power in the County is discussed with a specific focus on the installation of residential solar photovoltaics. The installation of solar photovoltaics on the rooftops of other buildings are not the focus of this report because the program SolSmart is already providing technical assistance for such buildings through the request submitted by Amanda Robertson, a co-founder and former member of the Chatham County Climate Advisory Committee.

Through the analysis of the average downward thermal infrared (longwave) radiation throughout the year, the potential for solar energy generation in Chatham County can be generalized. Data collected was collected from the NASA Prediction of Worldwide Energy Resources (POWER Project Data Sets, n.d.). NASA has a tool on their website called POWER Access Data Viewer, which allows users to acquire solar data from any past time period. Using the most recent data from this past year, January 1, 2018 to January 1, 2019, gave relevant information of what to expect in the following years. The geographic location of Chatham County was imputed into the Access Data Viewer. Solar irradiance and related parameters were selected along with the downward thermal infrared (longwave) radiative flux. The downward thermal infrared radiative flux was chosen as the parameter of focus because it shows “the monthly average longwave radiative flux values represent a multiyear averaged for month j of the longwave radiative flux incident on a horizontal surface at the

surface of the earth for all sky conditions" (POWER Project Data Sets, n.d.). The result was plotted using plotly.com as displayed in **Figure 1**.

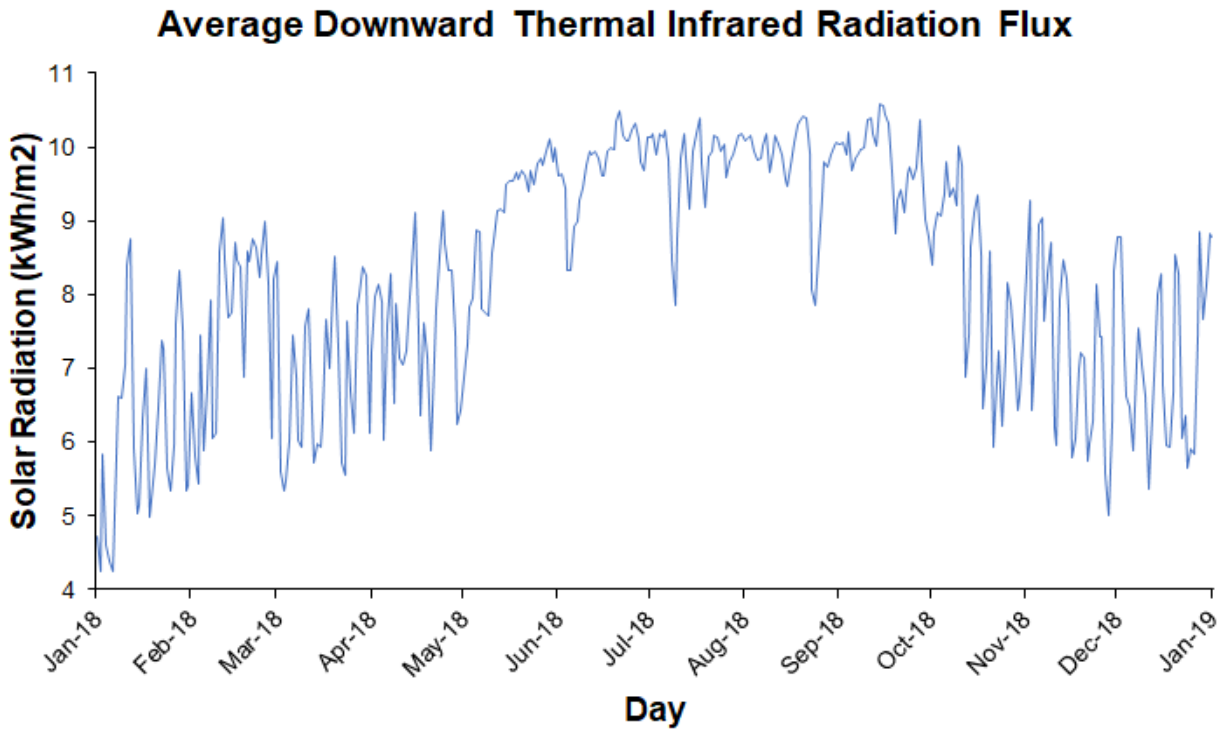


Figure 1. The plot displays the average downward thermal infrared (longwave) radiation flux in kWh/m^2/day in Chatham County from January 1, 2018 to January 1, 2019 with the exclusion of February 5, 2018.

The downward thermal infrared (longwave) radiation displayed in **Figure 1** is the solar energy that directly encounters Earth's surface per day. It is affected by aerosols, carbon dioxide, ozone, water vapor, and other molecules; therefore, based on the concentration of these in a geographic location, the solar energy directly encountering the Earth's surface will fluctuate (Cheng & Nnadi, 2014). Additionally, the sun strikes the Earth's surface at different angles ranging from 0° to 90° with the maximum amount of solar energy encountering the Earth's surface at an angle of 90°, or when the sun's rays are vertical. The incoming radiation at lesser angles, or slanted angles, take longer to travel through the atmosphere causing the incoming radiation to be less intense.

Chatham County, lying in the middle latitudes, receives more solar energy in the summer not only because the days are longer but because the sun is nearly overhead, as seen from the data displayed for June through September in **Figure 1**, where the average kWh/m^2/day fluctuated between 7.8 and 10 kWh/m^2/day compared to fluctuating between 4 and 9 kWh/m^2/day from January to May.

Therefore, the radiation flux given by the NASA Prediction of Worldwide Energy Resources reveals that Chatham County receives a significant quantity of solar radiation throughout the entire year.

Residential Solar Energy

With a focus on residential solar energy, this section focuses on the viability of installations of residential solar photovoltaics with the residents as the target audience. Therefore, this section provides the statistics on the average benefits from the average output of solar photovoltaics.

To provide an estimate of what a typical resident of Chatham County would experience with the installation of solar photovoltaics on their rooftop, the PVWatt Calculator was used. With 44,853 residential houses in Chatham County, a random number generator was used with a formula in Excel to select 100 houses. The purpose of a random number generator was to ensure that several different types of houses all across Chatham County were analyzed for their solar photovoltaic capacity

To visually display what residential house were used, a map displaying the locations was created using ArcGIS Desktop. All of the Chatham County data was acquired through NC OneMap Geospatial Portal and the National Map and displayed using ArcGIS Desktop 10.5 Software. Chatham County parcel data was downloaded from the NC OneMap database, imported into ArcGIS Desktop to display the location of all 44,853 residential houses on top of the National Map, and incorporated as a shapefile. This displayed the exact location of the residential houses geographically and numerically throughout the county. Of the 100 houses selected, 26 of the addresses provided were P.O. boxes, and therefore, were not used in the study. With the original parcel data, a 'select by attribute' formula,"FID" = # OR "FID" =# OR etc..., selection was used to display the remaining 74 residential houses. After applying this to the map, the data was exported into a new layer, displaying the desired 74 homes over the Chatham County boundary lines. The map was then exported as a JPEG as seen in **Figure 2.**

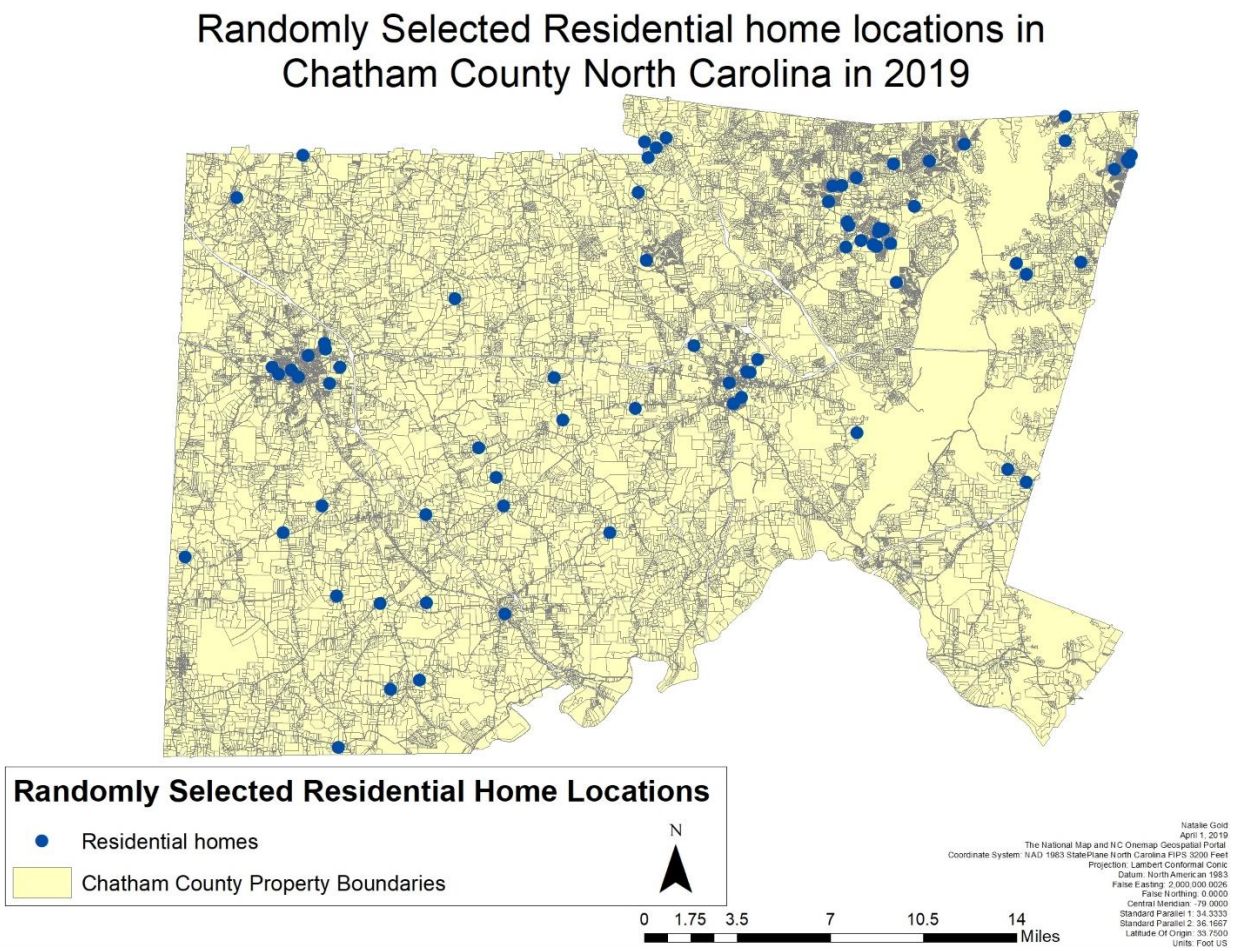


Figure 2. ArcGIS Desktop provided the shape file of Chatham County, North Carolina; the blue dots scattered throughout the shape file are the 74 houses randomly selected for analysis.

Upon selecting those houses, they were analyzed using the PVWatt Calculator available through the National Renewable Energy Laboratory (NREL). This calculator provided an output of annual solar radiation (kWh/m^2/day), AC energy (kWh), and value ($) based on the input of a business or home address; the calculator uses the latitudinal and longitudinal coordinates of those addresses for the output. The summary statistics for the output of the 74 houses are displayed in **Table 2**.

Table 2. PVWatt Calculator Output Summary Statistics

Statistic	Annual Solar Radiation (kWh/m^2/day)	AC Energy (kWh/Year)	Value ($)
Average	5.21	5,512	594
Standard Deviation	± 0.04	± 650	± 28

The PVWatt Calculator outputs AC energy because space cooling and heating is the largest single use of energy within a residential house (U.S. Energy Information

Administration, n.d.). The U.S. Energy Information Administration cites it to constitute 29% of electricity consumption with 421 billion kWh used for space cooling and heating by the U.S. residential sector in 2018. With approximately 128 million households in the U.S., this averages to be 3,289 kWh electricity per household used for space cooling and heating. From **Table 2**, the potential generation of AC energy in kWh per year exceeds this average.

In addition to the PV Watt Calculator, Project Sunroof was also utilized for summary statistics. Project Sunroof is a free service by Google that uses Google Earth imagery to analyze the local weather and roof shape of the specified house. Project Sunroof does not yet extend into Chatham County; however, it does include estimated rooftop solar potential for Apex, Cary, and Chapel Hill, which partially constitute Chatham County as seen in **Figure 3**. Therefore, with only three towns (Goldston, Pittsoro, and Siler City) not included in these estimations, all of which experience alike solar radiation, the estimations for these three towns give a fairly accurate depiction of the rooftop solar potential for all residents within Chatham County.

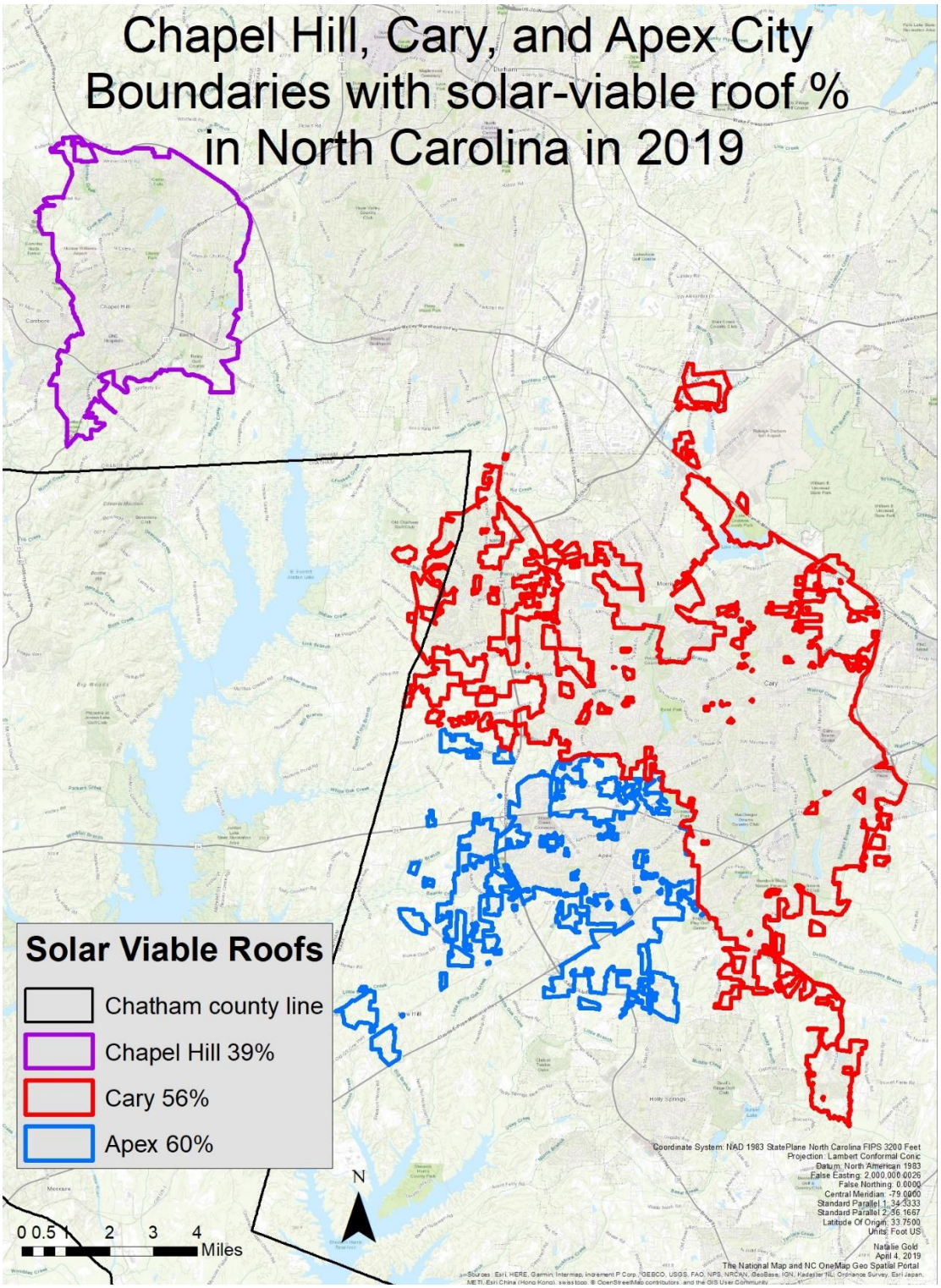


Figure 3. ArcMap image of the city boundaries of Chapel Hill, Cary, and Apex, which constitute part of Chatham County.

The analysis presented by Project Sunroof included several parameters; however, with the residents as the audience, the focus was on the estimated solar installation potential and their potential impact. These estimates are based on what Project Sunroof has defined as a "viable solar roof," which are roofs that are sizeable enough for four adjacent solar panels with the consideration of chimneys. The estimated solar installation potentials are presented in **Table 3**.

Table 3. Project Sunroof Output

City	Solar-Viable Roofs (%)	Median Roof Space (sq. ft.)	Median Capacity per Roof (kW DC)	Median Electricity (kWh AC/yr)
Apex	80 ± 20	529 ± 132	7.5 ± 1.9	9,500 ± 2,400
Cary	74 ± 19	617 ± 154	8.8 ± 2.2	10,900 ± 2,700
Chapel Hill	52 ± 13	599 ± 150	8.5 ± 2.1	10,400 ± 2,600

In **Table 3**, the city's estimation of the percent of solar-viable roofs are given with the average between Apex, Cary, and Chapel Hill as 69%. With not all roofs estimated as 'solar-viable,' the estimations per roof are only based on the median estimated solar photovoltaic system size and solar electricity production per viable roof in each city. With that, between the included cities, the average median roof space was 582 square feet, the average median capacity per roof was 8.3 kW DC, and the average median electricity production was 10,267 kWh AC per year.

Project Sunroof also estimates the potential impact through avoided carbon dioxide emissions from the electricity sector equated to passenger cars taken off the road for one year and tree seedlings grown for ten years. **With all viable buildings installing solar photovoltaics, Apex, Cary, and Chapel Hill could each average avoiding 217,333 metric tons of carbon dioxide emissions.** To further understand the potential impact of avoided the estimated carbon dioxide emissions, Project Sunroof equates the carbon dioxide emissions to passenger cars taken off the road for one year and to tree seedlings grown for 10 years, which would sequester carbon dioxide. With that, 217,333 metric tons of carbon dioxide emissions equates to an average of 45,967 passenger cars taken off the road for one year or to 5.6 million tree seedlings grown for 10 years.

However, it should be noted that estimated technical solar potential varies; therefore, Project Sunroof notes that based on their definition, the results could vary by at least 25% which is displayed by the variance in **Table 3**.

This data analysis of solar energy, specifically residential solar energy installed in Chatham County, had the main goal of presenting the feasibility and viability of solar energy in a way that was clear and understandable for the actual homeowners and general public. Additionally, it was desired for this information to be easily assessed, therefore, the information pertaining to solar energy and its potential impacts are outlined in the infographics seen in **Figure 4**, **Figure 5**, and **Figure 6**. Specifically:

- Figure 4 outlines the solar potential of Chatham County noting the solar radiation that reaches Chatham County throughout the year and what that would mean for a house with a 250-watt solar panel.
- Figure 5 outlines the solar-viability in each of the areas of Apex, Cary, and Chapel Hill, in addition to what it would mean for the environment if all solar-viable roofs installed solar photovoltaic panels. This environmental impact is given through carbon dioxide emissions avoided and then equated to passenger cars taken off the road for one year and tree saplings growing for ten years.
- Figure 6 gives a brief outline of how Chatham County residents would install the solar photovoltaic panels that are described as feasible and viable. Each of these steps are taken from the website, ChathamCleanPath.org. It is the goal of this infographic to present quick, digestible information from the website that catches the interest of the residents.

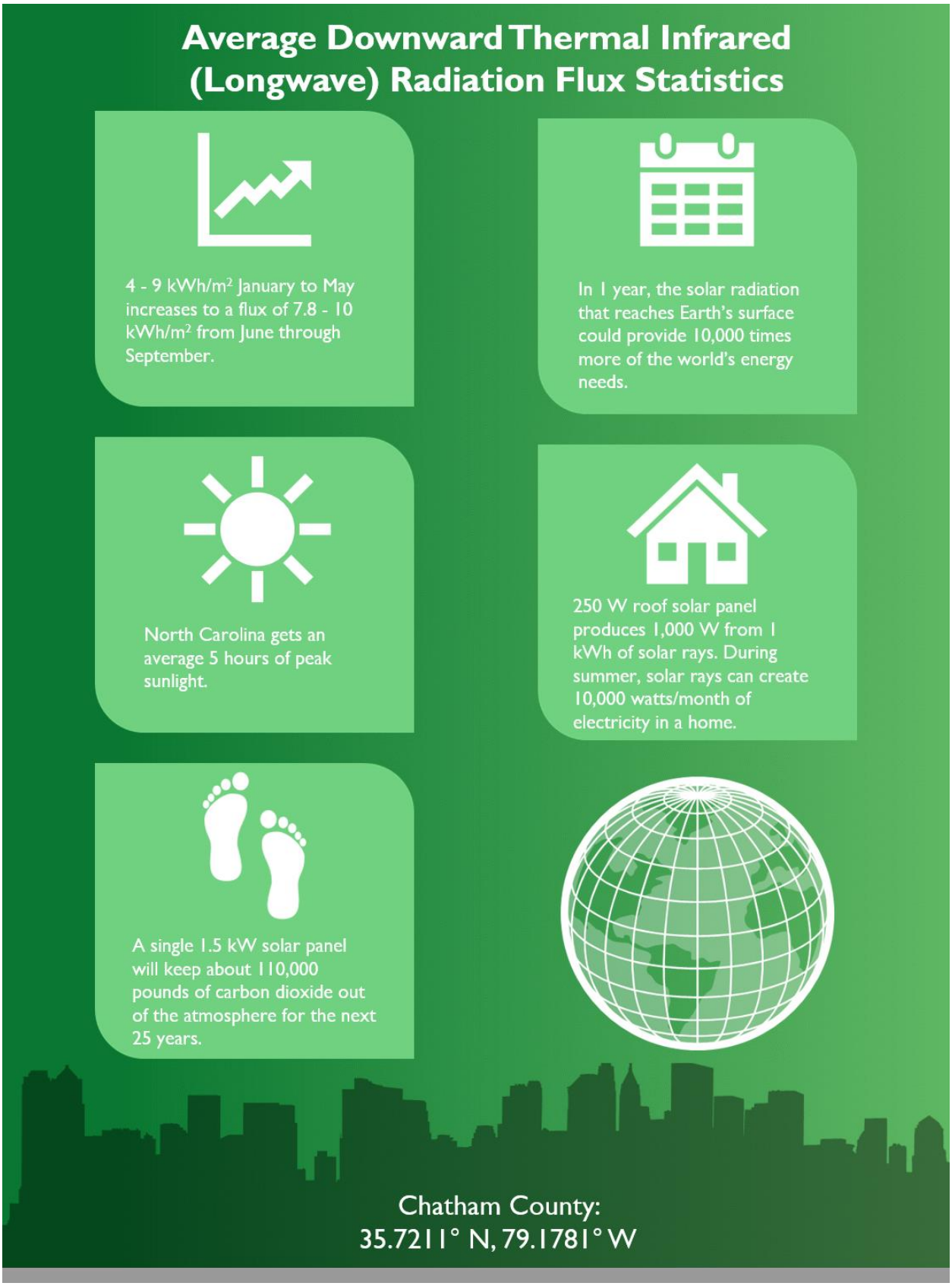


Figure 4. Infographic of NASA data regarding the solar radiation in Chatham County.

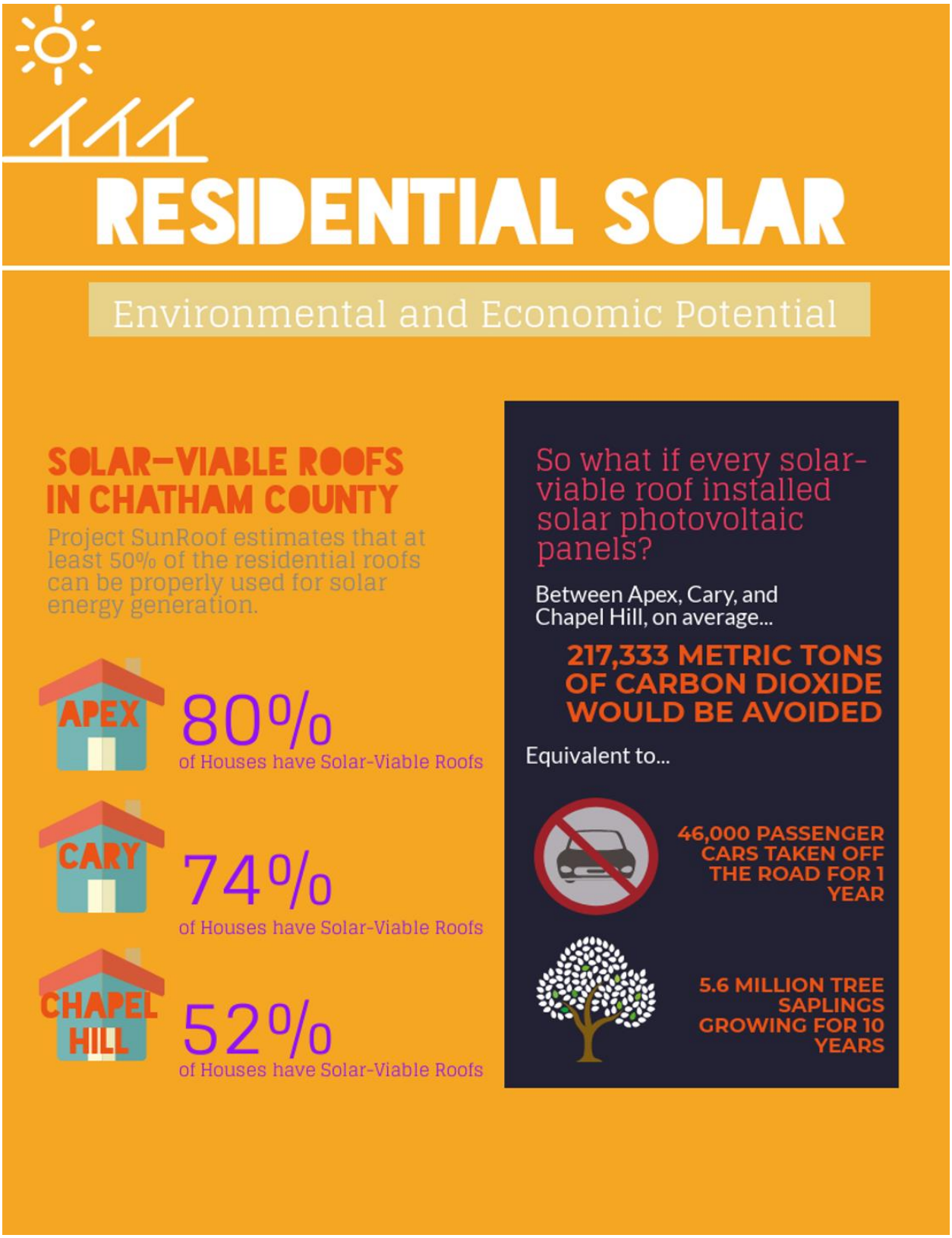


Figure 5. Infographic of the environmental and economic potential of residential solar energy installed in Chatham County.

Figure 6. Infographic of steps to take to install residential solar energy as provided by ChathamCleanPath.org

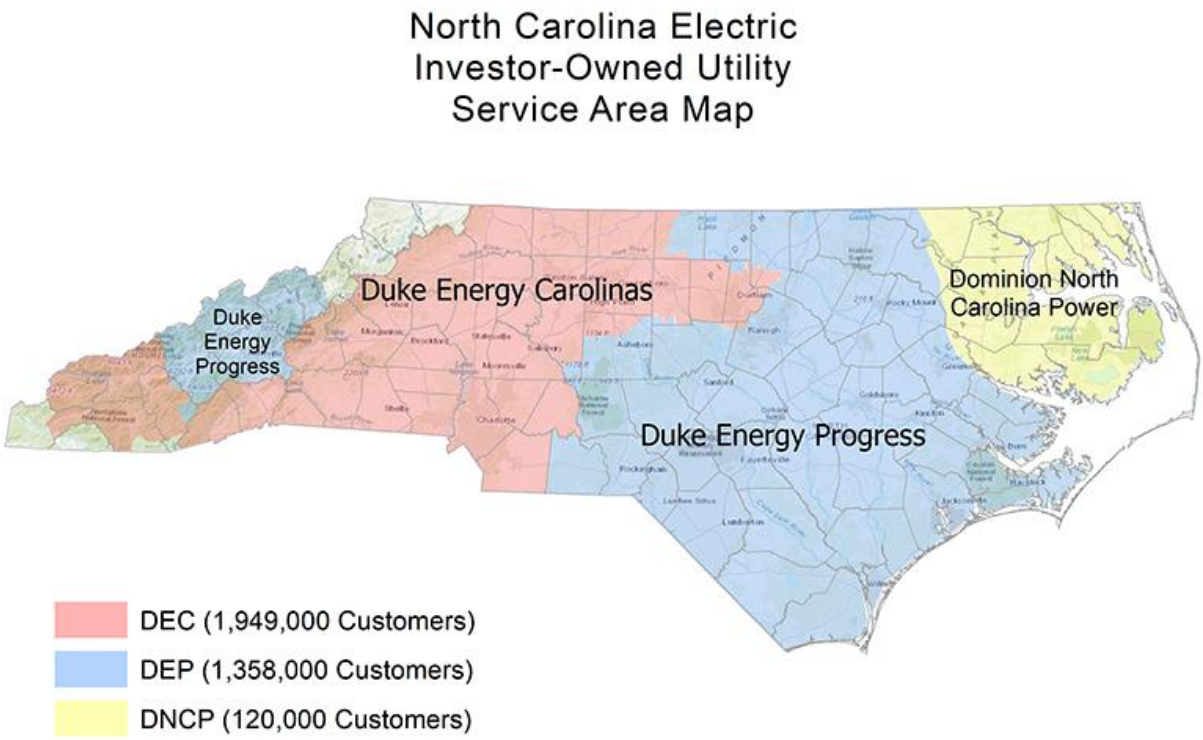
The choice to use produce these infographics was based on reports regarding communication of scientific information to the public. It was reported that information visualization is more effective than text-only materials (Li, Brossard, et. al., 2018).

FINANCIAL INCENTIVES

A multitude of state and Federal tax incentives exist for private investments in renewable energy systems. This report examines the financial incentives that apply to photovoltaic (PV) energy system that are eligible for Chatham County residents. The incentives that this report examines are the NC Solar Rebate program offered by Duke Energy, property tax exemptions for renewable system investments, and Federal Investment Tax Credits for renewable system investments.

Duke Energy Rebate

The state General Assembly and Governor Cooper authorized Duke Energy to create the NC Solar Rebate Program in the summer of 2017 with the passing of the H.B. 587 (Competitive Energy Solutions for N.C., 2017). Public enthusiasm for the rebate program was high, resulting in Duke Energy hitting its 2019 limit for residential rebate payments within the first few weeks of January 2019 (Robertson, Personal Communication, 2019). The bill hands Duke Energy the mandate to expand statewide PV capacity by 100,000 kW within a five year period, and it authorizes the reimbursement of Duke Energy by the State of NC for the cost of running the program up until 2022. Duke Energy distributes electricity service in North Carolina through two of its subsidiaries, Duke Energy Progress and Duke Energy Carolinas, as presented in **Figure 7**.



Source: North Carolina's Public Utility Infrastructure & Regulatory Climate Presented by North Carolina Utilities Commision (October 2017)

Figure 7. Map of North Carolina serviced by Duke Energy Progress (DEP), Duke Energy Carolinas (DEC), and Dominion Energy (DNCP). Each of the Duke Energy subsidiaries is given 50,000 kW of the 100,000 kW total capacity target along with the mandate to foster PV investments in each of their respective service areas. Chatham County is primarily served by Duke Energy Progress, and so it will have to compete with residents living in the cities of Asheville, Wilmington, Fayetteville and Raleigh for rebates from the limited pool of 50,000 kW.

Duke Energy Progress manages the Solar Rebate program in Chatham County and offers rebates on a yearly basis with an annual cap of 10,000 kW for PV systems as presented in **Table 4**.

Table 4. Duke Energy Progress Solar Rebates

Duke Energy Progress	2018	2019	2020	2021	2022
Residential Installations	5960 kW	7500 kW	5000 kW	5000 kW	5000 kW
Non-residential Installations	2579 kW	0 kW	2500 kW	2500 kW	2500 kW
Nonprofit Installations	54 kW	2500 kW	2500 kW	2500 kW	2500 kW
Total Per Year	8953 kW	10000 kW	10000 kW	10000 kW	10000 kW

Duke Energy Progress is required to provide a minimum of 5,000 kW of its 10,000 kW annual capacity for residential installations and to provide 2,500 kW for use by nonprofit organizations. The remaining 2,500 kW is specified as non-residential capacity in which either residential or nonprofit customers may draw upon after their respective capacity limit is met. The solar rebate offered in the fiscal year of 2019 prioritized 7,500 kW of its 10,000 kW yearly limit for residential installations with 2,500 kW set aside for non-profit installations. 50 kW of the 2,500 kW allocated for nonprofits is reserved for use by the NC Greenpower Solar Schools Pilot program, while any nonprofit organizations are free to use the remainder for their own PV systems. Any solar capacity left unsubscribed by the end of the fiscal year may roll over to the next fiscal year's limits. Any solar capacity left unmet by January 1, 2023 will be available to any customers who meet the program requirements regardless of any prior allocation requirements.

The Solar Rebate program by Duke Energy starts on January 1st of every fiscal year until 2022. Customers who have installed a PV system during the year of 2019 must complete and submit a Solar Rebate Rider (SRR) application no later than 90 days after the completion of installation. Customers who had installed a residential PV system prior to January 1, 2020 and filed the application within 90 days of installation have to reapply within 90 days after January 1, 2020 to be eligible for the 2020 rebates. Customers may apply prior to the installation of a PV system to receive a guarantee on a rebate reservation. Customers who have received a rebate reservation for a given year must complete the installation of their PV system by December 31st of that year or their rebate is nulled.

However, customers must fulfill certain conditions with their PV installation before they may apply for the Solar Rebate program. Customers must qualify for the Net Metering Rider offered by Duke Energy and must complete the Interconnection Request application with Duke Energy. The Net Metering Rider is required if Chatham customers want to offset their electricity bill with energy generated from their personal systems. Duke Energy verifies the safety of its customers' PV systems by comparing their PV system to state and local regulation standards under the Interconnection Request process. Customers will be able to complete the Solar Rebate Rider application after their interconnection request has been processed and the customer receives their interconnection project identification number.

Net Metering (NM) Rider

The Net Metering (NM) Rider outlines the key terms and conditions that customers must accept to have a net meter installed on their property. The important clauses of the NM Rider are its qualification provisions, the energy credit schedule terms, metering equipment provisions, and safety and inspection requirements. Customers are qualified for net metering under the Rider if they are operating a PV system on their property and are receiving electricity service from Duke Energy. Customers will receive energy credits from Duke Energy when their PV property generates more electricity than they consume. The energy credits may only be used to discount energy consumption from Duke Energy. The energy credits will carry over from month to month, but any accrued credit will reset from zero starting on the first of June of each year. If a customer wants to operate under a time of use schedule, then they are subjected to a separate rating schedule and may keep their renewable energy credits for trading in a solar renewable energy credit market. The retail rate of electric service will vary under the time of use schedule based on peak demand conditions and seasonal generation capacity. Chatham County customers will need to provide Duke Energy, as stated in the NM Rider, a designated space on their property that is readily accessible. Duke Energy will furnish, install, own and maintain metering equipment on the designated location.

Customers will receive their one time rebate payment on a "first come, first serve" basis after their application has been processed. Customers will receive a rebate at a rate of $0.60 per watt for the first 10 kW of their installed residential PV systems. Customers can install PV systems larger than 10 kW, but any installed capacity more than 10 kW is not eligible for rebate. Rebates for residential installations will be given out by Duke Energy Progress until the company has met the residential capacity it has set for that fiscal year. Duke Energy Progress met their 2019 residential capacity limit of 7,500 kW within the first two weeks of January 2019. A majority of the rebate payments were distributed towards PV systems that had been placed on the 2018 waiting list and had been installed prior to January 2019. The speed at which Duke Energy Progress hit their allocated rebate limit for 2019 suggests that customers looking to apply for the 2020 allocation of rebates will have to complete their applications in the year 2019 so that they may apply immediately after the start date of January 1, 2020.

Customers are automatically enrolled in a ten year contract period with Duke Energy Progress once they receive their solar rebate. The contract requires the customer to maintain their PV system in operating condition during the contract period. If the PV system is removed or shut down, then an early termination fee will apply unless the termination is for good cause. A good cause involves any circumstances where termination is beyond the control of the PV system owner.

Chatham County residents who have made the county their final home or who are staying longer than 10 years are best suited to apply for the rebates. Chatham residents who are uncertain about their residency in the County will need to be mindful of the termination clauses if they plan to invest in a home PV system. If a Chatham County resident who is benefiting from the solar rebates were to sell their property, then they would be liable for the termination fees. If the resident was able to secure a buyer who would agree to carry out the terms and conditions of the solar rebate agreement, then the original investor of the PV investment may keep their rebate payment.

Property Tax Exemptions

Property taxes normally levied upon NC citizens by Counties have been starkly diminished for investments in PV systems. The North Carolina General Assembly enacted legislation in August 2008 that exempted 80% of the appraised value of Solar Systems from property tax liability. A memorandum sent to County Commissioners in February 2011 further clarified that residential PV systems that are used for personal power generation and are not used for commerce may be entirely exempted from property taxes (Baker, 2011). Chatham County residents will be able to claim a minimum 80% property tax deduction for their investments in a PV system. Chatham residents may claim full exemption if they can prove that their PV system is a non-business private property. Residential PV systems that are receiving credits from a utility company through a net metering agreement would be classified as a non-business private property and would thus be exempted from property tax. PV systems used in connection with a business are still liable for the 20% reduced property tax. This includes residential PV systems that are generating income from producing and selling electric power to private energy utilities.

Solar Tax Credits

The 109th United States Congress established the renewable energy investment tax credits (ITC) with the passage of the Energy Policy Act of 2005. The tax provisions were extended by the Energy Improvement and Extension Act of 2008 to December 31, 2016 where it was further extended with the Consolidated Appropriation Act of 2016 through December 31, 2021. This consistent pattern of solar-friendly policy extension is important for building a public confidence in solar energy as a substantive investment instead of fad. Public confidence grows exponentially with increased societal support and such public confidence is the best means to reach Chatham Counties carbon goals. The federal investment tax credits allows a taxpayer to claim a percent of the qualified expenditures of their photovoltaic system investment as nonrefundable credits against their taxes. This means that taxpayers should pay zero taxes if their initial tax obligations are less than the solar tax credits. Taxpayers will still have to pay taxes if their initial tax obligations is greater than their solar tax credits, but they get to deduct the tax credits from their amount owed. There is no maximum credit allowance for eligible systems placed in service after 2008. A PV system needs to be installed on a private property located in the United States that is owned by a taxpayer to be eligible for the solar tax credits. The renewable energy investment tax credits are only applicable to systems bought outright in a single payment or through a solar loan agreement.

The incentive rates offered by the investment tax credits decline in steps through December 31, 2021. The Internal Revenue Service will allow taxpayers to claim 30% of their solar systems value placed in service by December 31, 2019 as credit against their taxes. This rate declines to 26% for systems beginning operation after December 31, 2019 and 22% after December 31, 2020 and before December 31, 2022.

Application Process for Incentives

The high cost of photovoltaic systems are a major deterrent for residential PV investments. Both the state and federal government offer incentives for PV investments, but the language written in the programs makes it difficult for customers to determine their eligibility for the programs. A hired professional, such as a local solar panel dealer, is recommended to help customers walkthrough the process of applying for solar incentives. The following sections highlight the key steps of the processes that Chatham County residents will need to pay attention while applying for solar incentives for their PV systems.

Applying for Duke Energy Solar Rebate

Customers need to be mindful of certain dates when applying for the 2020 allocation of solar rebates. Duke Energy must receive a completed Interconnection Request application by October 31, 2019. This guarantees the eligibility of the customer to apply for rebates by the start date of January 1, 2020. The customer, in addition, must receive an inspection approval of their photovoltaic system by December 1, 2019 so that a net meter can be installed before the January 1st deadline. Customers should apply for the 2019 rebate waiting list within 90 days of installation. This maintains the eligibility of the photovoltaic system for the 2020 share of the Solar Rebate.

Customers must complete and submit an Interconnection Request before starting any installation of their photovoltaic system. This process is required to connect a photovoltaic system to the power grid regardless of the solar rebates. The first step of the process requires customers to submit an Interconnection Request Online Application with Duke Energy. This form needs the basic information of the customer, the customer's photovoltaic system, and details about the customer's property. Customers will need to pay a nonrefundable processing fee of $100 after submitting an interconnection request.

Customers will need to attach an electrical one-line schematic diagram depicting the photovoltaic system and its ancillary equipment with the Interconnection Request. The diagram will need to include basic information of the customer, equipment specification manuals for solar panels and inverters, and the metering arrangement specified for the system. The diagram attached to the Interconnection Request will need to include the model numbers and the nameplate electrical sizes of each electrical equipment of the PV system.

Additionally, customers need to attach documents demonstrating liability insurance coverage of their properties with the Interconnection Request. A standard homeowners' insurance policy with liability coverage in the amount of at least $100,000 per occurrence without any aggregate limits is adequate for customers according to the Interconnection Request. Customers may have an insurance policy with aggregate limits, but the aggregate limits must be in amounts of at least $900,000. Insurance coverage is mandatory if the customer wishes to operate their photovoltaic system while interconnected with Duke Energy's electric grid system.

Residential customers must file a Report of Proposed Construction with the North Carolina Utilities Commission (NCUC) separate from the Interconnection Request form. NCUC is the governing body regulating electricity service in North Carolina and they require notification of any new installation of renewable generation systems in the state. Customers will need to provide information in the Report of Proposed Construction concerning the owner of the photovoltaic system, a photo or aerial map of the system and its surroundings,

technical specifics of the PV system, and the estimated costs of the system. Duke Energy requires its customers to attach a copy of the Report of Proposed Construction to their Interconnection Request applications. Customers will be assigned a docket number once they have filed their report with NCUC. Customers will need to retrieve their docket number from the official website of the NCUC.

Duke Energy will return a copy of the Interconnection Request to customers granting contingent approval to install photovoltaic systems. PV systems must be inspected by a certified professional who will provide an electrical inspection approval form certifying the integrity of the system. Customers will need to complete the Certification of Completion attached to the Interconnection Request, and they will have to resubmit the form back to Duke Energy attached with the local electrical inspection approval document. This then makes customers eligible to apply for the solar rebates on the Duke Energy's Solar Rebate website.

Applying for Property Tax Exemption

Property tax exemptions for photovoltaic systems are administered by County governments. Chatham County residents are required to report any improvements to their property such as the addition of a PV system. Chatham residents will need to file an AV-10 application form with the Assessor's Office during the listing month of January of each year. Residents will receive their updated property tax bill in August and are expected to make the payment by December 31st. Residents should expect to see a full tax exemption for their non-business photovoltaic systems on their tax invoice. If residents do not see an exemption for their PV system, then they should file a property tax appeal with the County's Appraisal Department within a month of receiving their tax bill.

Applying for Federal Solar Tax Credits

Taxpayers interested in claiming investment tax credits for their photovoltaic systems will need to file a Form 5695 with the Internal Revenue Service. Taxpayers are entitled to record all their solar expenditures on Form 5695 to receive a receive a 30% nonrefundable credit against their tax obligations. Form 5695 will need to be filed alongside other tax forms like Form 1040 by April 15th each year. Taxpayers should expect a refund within 21 days of filing online or within 6 weeks if filed by mail.

RECOMMENDATIONS

- Chatham County Climate Advisory Committee should conduct tours of a LEED certified building, educating citizens about LEED and how they could implement LEED standards into residential homes.

- Residents, businesses, and schools in Chatham County should make changes to comply with LEED standards of energy efficiency through the following changes:
    - Insulation on the piping and windows to better retain heating/cooling
    - More efficient heating and cooling
    - Replacing lights with CFL or LED lights
    - Automated lighting, faucets, HVAC
    - "Green" landscaping/roofing to aid in natural heating/cooling of the school
    - Automated meters for accurate energy consumption data

- Chatham County municipalities should disseminate information regarding solar energy capacity and installation to residents, including the infographics of this report.

- The Chatham County Climate Advisory Committee should partner with Chatham CleanPath to hold information sessions/workshops about the growing affordability of residential solar energy.
    - If residential solar is not an option for a Chatham County resident, they can request for a "retail choice" from an energy supplier, allowing them to support wind or solar without ever installing them personally.

- Chatham County municipalities should hold information sessions about the Duke Energy Solar Rebate and how to apply for rebates.

- Provide a community classes educating Chatham County residents about the tax forms, how to properly file them, and when to expect the refunds.

- Establish a website or sign-up email where Chatham County residents can be easily access the solar forms.

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