A SOLAR FARM IN *MY* BACKYARD? RESIDENT PERSPECTIVES OF UTILITY-SCALE SOLAR IN EASTERN NORTH CAROLINA

by

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Solar farm development has taken hold in North Carolina, particularly in the eastern part of the state which is historically rural and maintains low land costs. While sparsely populated in comparison with the rest of the state, solar farm development in eastern North Carolina results in some facilities constructed adjacent to homes and neighborhoods. This mixed methods study addresses the factors affecting the perspectives of the people who live next to solar farms, encompassing the following questions, “Are there different aspects that affect resident satisfaction regarding solar farms? If so, to what extent can these different aspects explain variations in satisfaction?”, “Are there variations in satisfaction for residents among differing geographic settings, e.g. neighborhoods adjacent to the solar farms or distanced from the solar farms?” and “How can insight from both the utility and planning sectors, combined with knowledge gained from residents, fill gaps in communication and policy writing in regard to solar farms?”

Door-to-door surveys and stakeholder interview methods collected responses from 70 individuals in four study sites in Eastern North Carolina. Interviews with 12 stakeholders in both utility and planning sectors gave understanding to the planning, incorporation and operation

process in regard to the solar farms. These responses were analyzed: open-ended answer input, descriptive statistical analysis, factor analysis and linear regression analysis. Data analysis involved both qualitative and quantitative analysis. Results showed that overall, residents felt positively regarding the solar farms near their neighborhoods. The most consistent and significant factor affecting opinions on the solar farms was *Perceived benefits of the solar farm,* indicating that when residents highly value the benefits of solar farms, their satisfaction with living near a solar farm as a result would increase more than any other factors considered. For the neighborhoods that are farther away but still within a one-mile radius, *Appeal of the solar farm* turned out to be the most significant factor, followed by *Income, Perceived benefits of the solar farm,* and *Education*. For the neighborhoods that are adjacent to the solar farm, *Perceived benefits of the solar farm* was the only significant factor. Interestingly, *Concerns in regard to the solar farm* was not significant in any model, which indicates residents' satisfaction with the solar farm has no significant association with negative concerns.

Findings from this study lend insight into what shapes opinions of these solar facilities in residential areas in eastern North Carolina. While there were some serious concerns expressed, they did not diminish the general satisfactory opinions of the solar farms. This study also revealed background planning processes and showed where there are gaps between the local governments, solar development companies and residents. Given the most consistent concern about information dissemination, rural planning policies may be drawn for more transparent communication and more readily available information about the solar farms between the private companies, local governments, and the general populace. Overall, the perceived benefits of the solar farms being the most significant factor is a good indicator that they are generally well-received in this area.

“A SOLAR FARM IN *MY* BACKYARD?”: RESIDENT PERSPECTIVES OF UTILITY-SCALE SOLAR IN EASTERN NORTH CAROLINA

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CHAPTER 1: INTRODUCTION & RESEARCH QUESTIONS

The power of the sun is recognized throughout history as one of the significant natural resources we can use here on Earth. Only recently, however, have we as humans managed to convert this resource into usable electricity. The solar energy industry blossomed over the past half-century and continues to be a popular alternative to conventional energy sources in many parts of the world. Areas that receive abundant and consistent sunlight are most common for solar panel installation, and people who live in the regions that receive this sunlight can take advantage of rooftop solar panels. Larger companies invest in utility-scale solar energy production facilities, which often cover many acres and can produce many times the electricity that smaller, rooftop panels can. In this case, some companies may lease land in rural, sparsely populated areas to construct utility-scale solar facilities; these are known as solar farms.

These solar farms may be regarded as a benefit to U.S. energy infrastructure. The U.S., despite advances in innovation in many industries, is lacking in its utilization of renewable energy resources. Countries in Central America and Europe have far surpassed the U.S. in moving away from the existing fossil-fuel oriented global energy market by developing renewable energy resources such as hydroelectricity and solar farms (Jacobsson & Bergek, 2004; Krauter & Kissel, 2017). In the U.S., some urban areas made strides in incorporating solar panels into office buildings, while wind turbines dot the countryside. In a more suburban setting, individuals are investing their own money in connecting their house to a solar-based roof panel system, decreasing their reliance on state and local energy grids (Solar Energy Industries Association, 2017). However, the United States as a whole is still heavily reliant on the fossil-fuel industry.

North Carolina has made progress over the past few decades in the implementation of solar power and has become one of the nation's leading states in renewable energy (Solar Energy Industries Association, 2017). A report from Duke University states, "the state had 150 operating solar facilities with 1 megawatt or more in capacity as of mid-December 2014. The facilities total 573 megawatts (MW) in nameplate capacity and $2 billion in total investment" (Brun, Hamrick, & Daly, 2015, p.12). The projects associated with the increase in solar power development have manifested in commercial, residential and government areas. Many planned and current utility-scale solar ("solar farms") in the state are set in rural, open areas, concentrated mainly in the central and eastern parts of the state. Each project presents unique challenges and successes, but a remaining challenge for the industry is local residents embracing the changes brought to their communities by renewable energy.

A growing trend in North Carolina is the allocation of open stretches of land to use for solar farm facilities. Much of the central and eastern regions of North Carolina are sparsely populated and agricultural. Many developers and investors are looking to rural areas for solar farm development. Some cash crops (e.g. tobacco) do not commonly produce the same profit margins today as they did in years past, and there is an increasing interest in using farmland as a site in which renewable energy sources can be planted (Odom, 2016). There is concern that this will disenfranchise farmers and rural landowners, some of whom are unfamiliar with the technology and may be overlooked by policymakers and investors who want to use the land. It is unknown, in many cases, to what degree the residents' inputs are valued in the planning, installation and incorporation process.

Figure 1: Chocowinity Solar Center.

The solar panels are behind the fence and tree line in the center of the image.

There is significant research in the renewable energy industry, and much on rural life, but not as much where the two intersect, especially in the United States. In a case such as Eastern North Carolina, where the industry is developing rapidly, it is pertinent to have a thorough understanding of how this industry affects both residents and government stakeholders. Through better comprehension of what aspects of solar farms shape resident opinions, supplemented by knowledge of the planning and incorporation process from a governmental perspective, we may be able to better write planning policy and develop more thorough communication about solar farms.

The study aims to understand residents' attitudes and levels of satisfaction with the solar farms near their community as well as their understanding of the renewable energy situation in North Carolina. The model of residents' perception towards solar farms will consider various aspects—including environmental, economic, socio-political, aesthetic and demographic elements. Interviews with stakeholders from both the energy/utility industry and the planning sector also give comprehension to what can be done from a government perspective, reveal where gaps are and how we can use the information from this study to fill them. There are three specific questions this research aims to address:

1. Are there different aspects that affect resident satisfaction regarding solar farms? If so, to what extent can these different aspects explain variations in satisfaction?
2. Are there variations in satisfaction for residents among differing geographic settings, e.g. neighborhoods adjacent to the solar farms or distanced from the solar farms?
3. How can insight from both the utility and planning sectors, combined with knowledge gained from residents, fill gaps in communication and policy writing in regard to solar farms?

There are two research methods: questionnaire survey and interview. The questionnaire survey asks residents' perception towards solar farms, which includes environmental, economic, socio-political, aesthetic and demographic considerations. Interviews with stakeholders from both the energy/utility industry and the planning sector also give comprehension to what can be done from a government perspective, reveal where gaps are and how the information gained from this study can be used to fill them. Results sections include word frequency analysis using Wordle, descriptive statistical analysis, factor and regression analysis, and stakeholder interviews.

CHAPTER 2: LITERATURE REVIEW

Solar Farms: Environmental Impact

Essential to understanding perceptions of renewables in an area is the acknowledgment that they while they have environmental benefits, there are negative impacts which go unnoticed. Several factors go into deciding whether an area of land is suitable for a solar farm, including precipitation, latitude and biodiversity. Photovoltaic energy functions best in areas that receive consistent sunlight. Because planners and scientists want to mitigate the harmful environmental effects of the construction of a solar farm, they commonly plan to put them in areas in which will have the least amount of adverse environmental impact. Generally, deserts are considered the most appropriate areas to build solar farms, as they have low amounts of rainfall, continuous sunlight, and consistently little cloud cover. There are large-scale solar farms in deserts and tropical regions (Turney & Fthnakis, 2011). Solar farms in deserts offer little potential environmental detriments due to the low density of both human and fauna (Turney & Fthnakis, 2011).

Potential environmental damage caused by solar farms is sometimes used as an argument against their development, as solar energy is commonly marketed as being more environmentally-friendly than fossil fuels. In addition to this argument, the use of farmland for solar panel installation has raised other concerns. Tsoutsos, Frantzeskaki, and Gekas (2005) explain the potential of environmental damage in more detail: "Furthermore, an application of a PV [photovoltaic] system in once-cultivable land is possible to damnify soil productive areas. The 'sentimental bind' of the cultivator and his cultivable land is likely to be the reason of several social disagreements and displeasure" (p. 292). As with any new construction, the clearing of land prior to the building is necessary, and this will lend to land use change. This is not in and of itself detrimental, as humans have been "moving" earth around for millennia. Clearing of land for development is often seen in forested areas, such as rainforests, where the sunlight is plentiful, but open land is not. In clearing land to build solar farms in these areas, both flora and fauna are harmed in the way of man creating new ways to harvest energy (Tsoutsos, Frantzeskaki, & Gekas, 2005). The controversy arises when this is done in the name of environmentalism but is, in turn, damaging the environment.

Another potential environmental hazard is the use of toxic chemicals in the manufacturing of the solar panels themselves. Tsoutsos, Frantzeskaki and Gekas (2005) write, "The production of current generation PV's [photovoltaic] is rather energy intensive…and large quantities of bulk materials are needed. …Also, small quantities of scare materials (Indium/Tellurium/Gallium) are required; also limited quantities of the toxic Cadmium" (p. 293). The depletion of these natural resources (usually through mining) is discussed as a potential detriment to the mass production of solar panels (Tsoutsos, Frantzeskaki, & Gekas, 2005). This, however, may not be a long-standing concern as scientists work to discover and develop safer materials and more effective ways to use the materials already being collected that would reduce the rate at which they are being consumed. As the technology advances, the theory is that the amount of Earth-damaging substances used will decrease, and more efficient and clean manufacturing methods for solar panels can be developed (Tsoutsos, Frantzeskaki, & Gekas, 2005).

There are, however, many positive aspects that the solar farms can bring to the areas in which they are constructed. Some of these are as follows (Tsoutsos, Frantzeskaki, & Gekas, 2005):

- Reduction of the emissions of the greenhouse gases (mainly CO_2 and NO_x) and prevention of toxic gas emissions (SO_2 particulates)
- Reclamation of degraded land (through better use of potentially once abandoned land e.g. cleanup, maintenance)
- Reduction of the required transmission lines of the electricity grids
- Improvement of the quality of water resources

As new, cleaner forms of energy are incorporated into an existing system, there will inevitably be a reduction in the usage of the older methods of energy production. As fossil fuels are burned less, the amount of greenhouse gases pumped into the atmosphere will decrease, and as both nitric oxide (NO_x) and sulfur dioxide (SO_2) are reduced, the quality of air improves. Additionally, with the replacement of the existing energy grid with a new one, more efficient energy distribution is possible thus eliminating the need for reliance on old and outdated systems.

Movements towards renewable energy resources are often associated with mitigation of climate change. Though resident attitudes toward climate change are not the central theme of this study, solar energy and its relationship with environmental impact is often linked to climate change. In discussing several opportunities for the benefits of solar farms, Sen and Ganguly (2017) mention climate change mitigation as “one of the important driving forces behind the growing demand for RE [renewable energy]” (p. 1173). They continue, “a key pillar of several countries’ mitigation strategies is decarbonization of the energy sector through renewable energy deployment” (Sen & Ganguly 2017, p. 1173). Renewables may have a significant positive impact on the environment, and these benefits may be well-known to residents. It is possible that living next to a solar farm increases awareness of these benefits, or may raise levels of environmental consciousness.

Solar Farms: Economic Impact

In looking at solar farms and their rapid development, it is essential to understand the impact that may have on the economy, in both micro and macro scales. While renewables such as wind and solar may not be currently dominant, their market share is growing. Their potential is acknowledged, but the challenges lie in penetration of the existing system (Jacobsson & Bergek, 2004). The existing global power grid relies heavily on the fossil-fuel industry, thus making system-wide changes difficult. Many European countries are setting a precedent in creating markets for renewables that will allow them to grow and become incorporated with the existing systems by introducing incentives for the adoption of renewable energies (Menanteau, Finon, and Lamy, 2003 p. 799-800). By introducing economic incentives for integration of renewables into the system, governments may be able to encourage quicker adoption. Stram (2016) reinforces this, "…If services are provided with energy saving technologies, less direct pollution and carbon are emitted thereby achieving carbon reduction goals. In addition assuming such measures are cost effective, potential increases in power costs associated with renewable integration are ameliorated" (p. 732).

Jacobsson and Bergek (2004) introduce studies on the diffusion of renewable energy technology in Sweden, Germany, and the Netherlands. Through these studies, scientists and economists sought to understand the market advantages of renewable energy technologies. Already established technologies—i.e., fossil fuels—are subsidized by governments, and to stimulate similar integration with renewables, some have argued for subsidies to be applied (and in many cases they are). They argue that the environmental hazards created by burning fossil fuels can be mitigated by the implementation of solar and wind energy, eventually offsetting the cost of the subsidies (Jacobsson & Bergek, 2004; Tsoutsos, Frantzeskaki, & Gekas, 2005). This is supported by Stram's (2016) statement above. While some may see this as idealistic, several European countries such as Germany and Spain have made strides forward in renewable energy incorporation with solar and wind farms, respectively.

There is concern that as renewable energy grows and develops greater market hold, it will result in market and job upheaval. This view is partially based on the fear that solar farms would result in job losses as they, at a glance, appear to operate on their own. Studies carried out on the economic viability of solar development suggest differently. The report mentioned above from Duke University states that "our assessment of the North Carolina utility-scale solar value chain find that at least $2 billion in direct investment has been made in the state, affecting at least 4,307 direct jobs in 450 companies" (Brun, Hamrick & Daly 2015, p. 3). As North Carolina continues to build on its existing solar market, particularly in rural areas, stimulation of the market and jobs will occur. In a rural area such as Eastern North Carolina, job growth and economic development may be seen as a boon. If residents are able to better understand the direct and indirect economic benefits (and shortcomings) of the solar farms, they can make more informed financial decisions accordingly.

In addition, there may be links between perceptions relating to environmental impacts of renewable energy and economic impacts of renewable energy. Fergen and Jacquet (2016), found evidence in their study that these two aspects may at least have a relationship in regard to wind energy. They write:

> This [study] indicated respondents with stronger environmental attitudes were more likely to expect more negative impacts to the environment (wildlife interference, health impacts, decreases in visual beauty) and were less satisfied with the perceived economic development of wind energy in their community (job creation, economic benefits to the County, tax benefits, decreases in energy prices). This finding suggests that individuals with high environmental attitudes prioritize the conservation of landscape for its natural setting over the economic gains associated with development of renewable energy. (p. 139)

Furthermore, they found that, "Although most respondents from both counties indicated that the wind energy project did not totally fulfill their expectations, 92% of the respondents support wind energy development in the U.S., with 91.2% supporting further wind energy development in their county" (Fergen & Jacquet, 2016, p. 139). While this study focused on wind energy development in South Dakota and both its environmental and economic impact, it remains to be seen if solar development has similar implications for residents of Eastern North Carolina. Learning what residents do and do not know about the economics of solar energy, along with what they believe are the economic side effects of solar farms, is essential in developing a more thorough comprehension of this aspect of solar farms.

Solar Farms: Socio-Political Impact

There are often various stakeholders in a solar farm project including policymakers, manufacturers, construction workers, contractors, environmental and transportation planners, community members, and consumers. Each of these entities may have different and sometimes conflicting interests, resulting in socio-political difficulties. The process to locate, plan, build and operate a solar farm requires each of these stakeholders to play an active role at some point. Studies conducted on the community and socio-political impacts of solar farms give understanding to what drives different entities in each project and how the solar farms themselves affect decision making.

One of the first major challenges of any renewable energy system, including solar farms, is the idea of acceptance. In finding connections that contribute to the overall acceptance of renewable energy across societal boundaries, three main categories should be recognized. These are socio-political acceptance, community acceptance and market acceptance (Wustenhagen, Wolsink, & Burer, 2007). This study of acceptance found that generally, across national lines there is support for the addition and development of renewable energy in communities, but these waters get murkier at the local level. The researchers found that while the acceptance was widespread on a global scale, once it came time to plan a project in a community, there was more kickback than expected. This was less a community issue than ignorance of local policies in regards to energy and an unwillingness to cooperate with the existing system (Wustenhagen, Wolsink, & Burer, 2007). This may be an issue in places in the U.S. where public access to government ordinances and permits is difficult. This study highlights the importance of a sense of connection between locals and the government implementing policy.

Van der Horst (2007) illustrated a universal acceptance of renewable energy development in a community; from negative to positive situations. In comparison, Wustenhagen, Wolsink, and Burer (2007) found a U-curve, which describes acceptance as positive at first, changing to more negative during the actual construction and incorporation process, and rising back up to similar positive acceptance levels after the project was completed. These attitudes may prove to be different in the U.S., where there is a different relationship between locals and the government. Factors that played a role in both studies in regards to community acceptance were the sharing of costs and benefits, communication between the residents, planners, and policymakers/government, and whether the information being exchanged in these communications was reliable and trustworthy (Wustenhagen, Wolsink, & Burer, 2007).

Communication and preconceived notions play a significant role in forming attitudes and mindsets. The aspect of trust is essential to the understanding of concepts across groups of people and individuals. Given that renewable energy projects involve so many different actors, trust and transparent communication are fundamental to fostering more community acceptance. If residents of communities in which renewables are being implemented do not trust the information fed to them and the actions of those coming in to work on the project—investors, contractors, government, etc.—then conceivably the positive perceptions will decrease. This aspect is mainly social and relies on understanding what factors play a role in shaping perceptions.

There is also a factor of civic engagement in regards to renewable energy. In studies conducted on public acceptance of the renewable energy industry, there has been a significant focus on the mentioned socio-political, community, and market aspects. In a sort of culmination of these three, civic engagement refers to the level at which the citizens affected by the newly implemented renewable energy system feel they can connect with the local government and investors, and in turn felt that their situations and opinions were valued (Walker et al., 2010). While similar to the both the socio-political and community aspects of acceptance, important lines are drawn here in considering civic engagement to be an essential part of understanding what forms these perceptions. One might wonder if citizens who feel engaged and involved in the decision-making process as well as potentially being allowed some level of ownership of the project may have a more favorable opinion of the renewable system than those who are purposefully excluded from the development (Walker et al., 2010). In including factors that would measure a level of civic engagement, research could more accurately take a look at how much of a role this plays in something that affects many lives and wallets. This may be applied to rural areas in the U.S., where residents often live far away from urban centers where decision-making takes place, which can leave them feeling uninvolved in any processes.

During this study, one county involved placed a one-year moratorium on solar farm development within the county lines. This moratorium was the result of frustration and petition from those in the county who wanted to see change in the policy regarding solar farm development. The case of the public forum followed by the moratorium is an example of socio-political action in a community affecting change. Civic responsibility and community belongingness played a large part in driving the push for change in this case, based on remarks from attendants at the event.

Lastly, market acceptance is affected on a global level by trade and government policies but is also shaped primarily by local forces. In geographic areas outside of those where the products to make solar panels and wind turbines are sourced, production relies on import. This, in turn, is affected by national and regional policy. Wustenhagen, Wolsink, and Burer (2007), like Jacobsson and Bergek (2004), make the point that the market for renewable energy is challenging to penetrate due to the persistence of the existing fossil-fuel power grid. It is believed that social acceptance is a predecessor of market acceptance, as investors and consumers will not buy into a market if they do not believe it will be beneficial for them or their community (Wustenhagen, Wolsink, & Burer, 2007). Where the consumers are looking for how it will affect the ways they operate in day to day life, the investors are looking for a return on their investment. A more in-depth review of how rural areas in the U.S. are impacted economically would lend further understanding here, as much of this data comes from the United Kingdom, where the business culture, local culture, and government are different.

Solar Farms: Aesthetic Considerations

There is an element of building solar farms that should not be overlooked by the planners or developers: visual impact. Wind turbines are often considered to be the primary source of both visual and audio pollution in the renewable energy sphere, but solar farms have a visual impact as well (Van der Horst, 2007). While solar panels do not produce the decibel level of wind turbines, they do create some aesthetic concerns in the surrounding communities. Rodrigues, Montañés and Fueyo (2009) cite Shang and Bishop (2000), "Even for isolated projects, the assessment or quantification of the visual impact has several inherent difficulties, such as the selection of landscape components and attributes (visual size, contrast, color, shape, and texture, among others), and their assimilation with the judgement criteria from the observer" (p. 240). In essence, the size of an energy production facility may impact the opinions that those to whom it is visible hold towards it (Rodrigues, Montañés and Fueyo, 2009).

In many areas where the land is cleared for a solar farm, landscapes shift from what was once a forest or a field of crops to acres of gleaming black and silver. In studies on the perceptions of wind turbines, there is a consensus in an attitude or mindset called NIMBY (Not In My BackYard) phenomenon. Observations carried out in the United Kingdom yielded results that most people are okay with the inclusion of renewable energy (wind turbines in the case here, given that the U.K. is a prime location with continuous winds and coastline) as long as they do not have to see or hear it (Van der Horst, 2007). They also found that in communities that were surveyed before the implementation of a renewable energy system, the NIMBY attitude was stronger before the construction of the project than it was after the project was completed. That is to say, the negative preconceived notions of windmills were most impactful in the communities prior to the inhabitants ever seeing the effect that the windmills would have in their community. One of the conclusions drawn by this research was that, "consistent with the literature on risk communication, this shows that risk perception of the new and unfamiliar is an important factor in peoples' dislike of proposed wind farms and that with the actual local experience of the existing wind farm, this reason for opposition disappears" (Van der Horst, 2007, p. 2707).

A study conducted in Spain assessed local perceptions of the solar farms based on pre-selected criteria. In rural areas in Spain, researchers evaluated the perceptions of solar farms in regards to visibility, color, fractality, and concurrence between fixed and mobile panels (Torres-Sibillea, Cloquell-Ballester, & Darton, 2009). Visibility is used to refer to the amount that an object or phenomenon can be seen in day-to-day life. Color refers to the saturation and brightness of the solar farm in its setting; or, how well it fits into the landscape: grey and black vs. green and blue. Fractality is a measure of the linearity of the solar farm in relation to the surrounding landscape to determine if they align more or less naturally with the environment in which they are placed. Lastly, concurrence refers to their mobility, as some solar farms can be relocated under climate conditions. The research team surveyed individuals by showing them pictures of the solar farms and asked them to assess the farms based on these variables. A different group of individuals was interviewed to list their preference with respect to the same set of solar farms (Torres-Sibillea, Cloquell-Ballester, & Darton, 2009). This study indicated that the visual impact of solar farms, especially in regard to fitting in with the surrounding landscape, is a significant factor in affecting perceptions (Torres-Sibillea, Cloquell-Ballester, & Darton, 2009). Climate was also a factor, as farms situated in regions where the climate was colder or rainy were associated with less positive perceptions than farms in sunnier, clear areas (Torres-Sibillea, Cloquell-Ballester, & Darton, 2009).

In another study regarding visual appeal of solar farms, Karlsson, Aronsson, and Svensson (2003) measured aesthetic perception of solar farms using an array of effective appraisals such as naturalness, coherence, pleasantness, affection, and degree of protection. They found that post-implementation, the level of visual affection amongst interviewees declines, as some regarded the solar farm as not as attractive as the landscape that was there before construction. Some also believed that the naturalness of the land decreased, as this was a human-made structure placed in an otherwise untouched area. This can be interpreted to mean that even within areas that are widely rural, solar farms may negatively impact perceived aesthetics. These studies point to the importance of the visual impact of solar farms, along with what aspects within the visual impact are important to people who live near the facilities.

Solar Farms: Sense of Place

An aspect of geography, sense of place comprises the impact of geographic setting on a person's psyche. Hausmann et al. (2015) describe sense of place as follows, "the concept of sense of place embeds all dimensions of peoples' perceptions and interpretations of the environment, such as attachment, identity or symbolic meaning, and has the potential to link social and ecological issues" (p. 1). Williams et al. (1992) list several factors which comprise sense of place. The first, place dependence, looks at how an area serves the needs of the individual or group living there. Williams et al. (1992) cite Stokols and Shumaker (1981), “The concept of place-dependence as a form of attachment associated with the potential of a particular place to satisfy the needs and goals of an individual and the assessment of how the current place compares with other currently available settings that may satisfy the same set of needs” (p. 31). Similarly, one may also relate their sense of place to their identity. Williams et al. (1992) write, “Place-identity refers to ‘those dimensions of the self that define the individual’s identity in relation to the physical environment’ (Proshansky 1978, p. 155)” (p. 32). Lastly, sense of place is commonly linked deeply with a factor of attachment. This attachment may be physical, as in a farm or a house, but in dealing with a sense of place, it is commonly referred to as an emotional status. Williams et al. intimate:

> Consequently, variables that quantify the history of association between the person and the place are expected to be good predictors of place attachment. Similarly, community attachment and forced migration literature suggests that strong emotional ties to recreation settings will reduce the willingness to substitute setting and increase the level of concern regarding how a place is used and managed. (1992, p. 32-33)

Brandenburg and Carroll (1995) also describe sense of place as a sort of mental process that shapes personal values and worldview. They write, “Places are both enabling and embedding, in that physical locations affect people and people affect and construct the social meaning of those physical locations (Giddens, 1984). The creation of place consists of recurring patterns of interaction between individuals and their environment. Thus, a place is created by people/nature reciprocal relationships” (p. 395). In areas where land management is tied in with local culture when land use changes it may produce a cultural shift. While it may not be so dramatic as to cause residents of the area to move away, it may alter the way they view the land.

In the case of this study, sense of place will be tied in with Eastern North Carolina. The survey includes a section of questions tied directly to the environment, economy, and setting of Eastern North Carolina. In addition, there is a question asking participants how long they have been in Eastern North Carolina. I also included questions addressing whether residents feel at home in their neighborhood, and whether they feel that they know their neighbors. A sense of "home" may be deeply rooted in the ties one has to an area, and this is integrated with socio-political considerations as well. These questions are designed to gauge the ties that respondents have to the area and whether these ties play any significant role in shaping opinions on solar farms.

Solar Farms: Location & Proximity

Sanchez-Lozano et al. (2013) conducted a location study for solar farms in Spain, which emphasized the direct impact of these farms on the surrounding areas. Several variables were considered in the study regarding the planning process for location of solar farms. Among these are agrological capacity, slope, distance to roads, distance to power lines, distance to villages, and climate. Within these factors, distance to other objects (power lines, homes) was determined to be of importance, emphasizing the need to be able to incorporate the energy created into the existing grid effectively (Sanchez-Lozano et al., 2013). In assessing these factors, researchers were able to determine which areas would not be suitable for solar energy development.

Another study in Turkey discovered that there is often a hierarchy of priorities utilized by those in charge of planning the location of the solar farms (Uyan, 2013). Although this research did not consider the surrounding communities as in the study above, the researcher measured the environmental and geographic impacts of the solar farms. By revealing priorities like proximity to inhabited areas and buffer zones between the farm and other natural resources and environmentally protected areas, the study may lend insight into what factors are considered by people to be important in solar farm construction. Variables like geographic area are easily quantifiable and can be used to understand better what priorities people may have in their assessment of solar farms near them. The study discovered that the criteria for use in planning are similar to the criteria used in understanding perceptions of renewable energy, suggested by the other studies working with the community (Turney & Fthnakis, 2011; Uyan, 2013).

Another aspect of sense of place that may affect the relationship between people and the land surrounding them is proximity to other objects, be they neighbors or nature. Kearney (2006) found that proximity to neighborhood features affects neighborhood satisfaction. She writes, “One significant effect of proximity to shared nature on neighborhood satisfaction was found: Directly bordering shared nature areas or bordering green buffers with access to large shared nature areas from within the subdivision was related to greater satisfaction with nearby nature opportunities” (p. 134). She also found that visual access to nature was significant in affecting satisfaction, e.g. whether a person could see forest, field or natural landscape easily from their home. This research did not focus on energy facilities such a solar farms, but points about proximity to objects and visual access to nature apply in researching how solar farms themselves may affect resident satisfaction.

CHAPTER 3: RESEARCH METHODS

Survey Model

This research aims to find the associations between residents' satisfaction with solar farms and several aspects—environmental, socio-political, economic, aesthetic, sense of place and demographics. Figure 2 visualizes this model. This model is developed from parts of the literature review; elements of each question in the survey are structured from topics and themes found in the literature. The survey is broken down into sections based on topic.

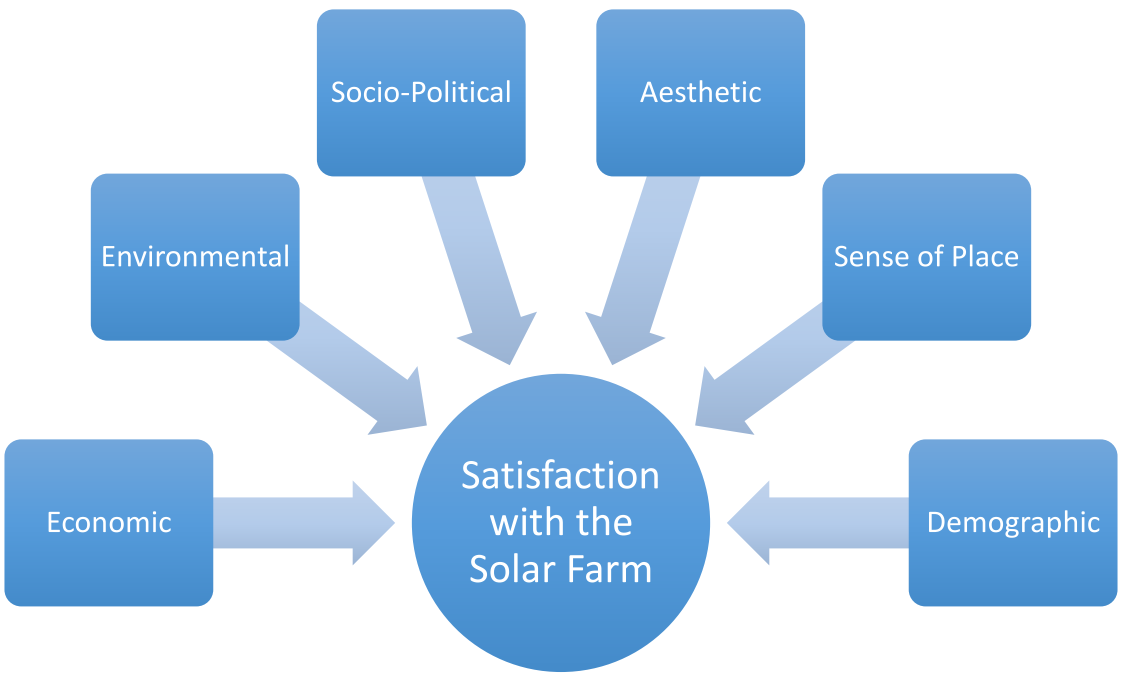


Figure 2: Visual Survey Model

Survey Design

The Resident Survey had eight sections which encompass the aspects noted in the above model. Starting with section two of the survey, questions were designed with quantitative analysis in mind. All questions except demographic questions, open-ended questions and yes/no questions were presented as statements, requiring respondents to answer their level of agreement using 7-Likert scale (1 as strongly disagree, 4 as neither agree nor disagree, and 7 as strongly agree). I used Vaglas's (2006) agreement and satisfaction scales. Survey sections are described here as follows:

The first section started with residents' preliminary impression of solar farms: what they think about solar farms in general and about their community being located near a solar farm (open-ended questions for qualitative understanding). The second section asked about each respondent's experience with the solar farm installation process. This included the yes/no question, "When I moved into this community, the solar farm was already there." The economic section of the survey focuses on the impacts of the solar farm on the region, profitability, investment and perceived benefits. Responses to economic impact can also provide info about whether respondents would funnel their money into solar energy if given the chance.

The environmental section is designed to understand people's perceptions on solar energy and solar farms (Tsoutsos, Frantzeskaki, & Gekas, 2005). In a rural region surrounded by forest and farms, residents of the area may have strong opinions about the environmental impact of solar farms and solar energy in land familiar to them. The socio-political section is geared toward the idea of civic engagement (Walker et al., 2010; Wustenhagen, Wolsink, & Burer, 2007). It also includes a question asking whether respondents feel they have a say in the decision-making process, an essential part of community involvement. Because many solar farms are the result of outside interventions (usually by an investor with large sums of money or by local or state governments), locals are often left out of the picture. This ties into the economic section in assessing whether respondents believe that solar farms could help to bring a community together.

The section on aesthetics seeks to understand visual impacts of solar farms. Aesthetic presence is widely considered to be one of the major roadblocks in solar energy incorporation. I asked respondents how they think about the solar farms in regard to visual appeal, whether they would be more likely to accept solar farms in their community if adequately screened, as well as whether or not the solar farms should be remotely located. Next, I looked at the solar farms and their impact in eastern North Carolina specifically. This section explores whether participants' attitudes and sense of place regarding eastern North Carolina may affect their opinions on the solar farms. Lastly, the demographic set of questions aims to gain general data on age, gender, income, political leaning and education to see if there are any relationships with these factors and satisfaction with the solar farm.

Survey Procedure

After selecting four solar farm sites (see the Study Site below for detailed information), I drew a one-mile radius from the center of the solar farms to identify the eligible neighborhoods for survey. Residents in nine neighborhoods were all qualified for the survey.

Instead of the traditional paper-and-pencil survey, I used an iPad with the questionnaire survey designed using Qualtrics application. Although the iPad was off-line (no cellular data or Wi-Fi on site), the responses were automatically uploaded to the Qualtrics system as soon as the device was linked to the internet. All collected data were later downloaded as an Excel file using the embedded tool in Qualtrics. I used SPSS for statistical analysis.

I conducted the door-to-door questionnaire survey on weekday evenings from July to October 2017. Difficulty arose in finding the most opportune time for people to take the time to complete the survey- I had to approach them after they returned home from work, but before sitting down to eat dinner and certainly before dark. Participants were selected through convenience sampling based on their accessibility, so the results of this research may be limited in their generalizability (Bornstein, Jager, & Putnick, 2013). I knocked on doors and asked for participation. After a brief introduction, I explained the purpose of the research along with a short description of the survey. If a resident agreed to participate, I handed them the iPad with the survey pre-loaded. I briefly explained the on-screen button controls, and if there were any participants who did not feel comfortable with using the iPad, I dictated the survey and they verbally gave me the answers. After each section, the participant and I reviewed to ensure their answers were accurate, if dictation was chosen. The majority of participants seemed receptive to using an iPad for the surveys, and most mentioned that it was easy to use. The survey took an average of 15 minutes to complete. No incentive was offered to participants.

I approached 175 homes and completed a total of 70 surveys, for an overall response rate of 40%. This includes homes where the door was unanswered. Response rate varied among study sites. Rams Horn Solar Center returned a 30% response rate, while Chocowinity Solar Center, Andrew Solar Center, and Albemarle Solar Center returned 40%, 40% and 50%, respectively. Nobody withdrew from the survey.

Study Sites

Solar Energy Industries Association (SEIA) (2017) provides data about all utility-scale solar projects in the U.S. For some solar farms, SEIA discloses ownership information, but for the solar farms involved in this study, this information was unavailable. It should be noted that in the autumn of 2017 SEIA's membership system changed, and this information was no longer available to the general public without a paid membership. North Carolina's solar farms generate more than 3,000 MWs as of 2017, with a concentration of utility-projects in the eastern region of the state (SEIA, 2017). Among them, I selected four solar farms in eastern North Carolina (Figure 2). These four farms range in size from 30.32 to 51.95 acres. The energy production capacity ranges from 4.15 MWs [megawatts] to 15 MWs (Table 1). All of them are sited with proximity to a residential area as shown in Figure 2. For this study, sites were designated as either adjacent to a residential area or distanced. All four have residential areas within a mile radius of their center, but two of the sites have homes directly adjacent to the facility, whereas the other two are set back farther from homes (and during spring and summer may be invisible due to tree cover and foliage). Geographic locations of sites in regard to North Carolina as a whole are noted in Figure 3 below.

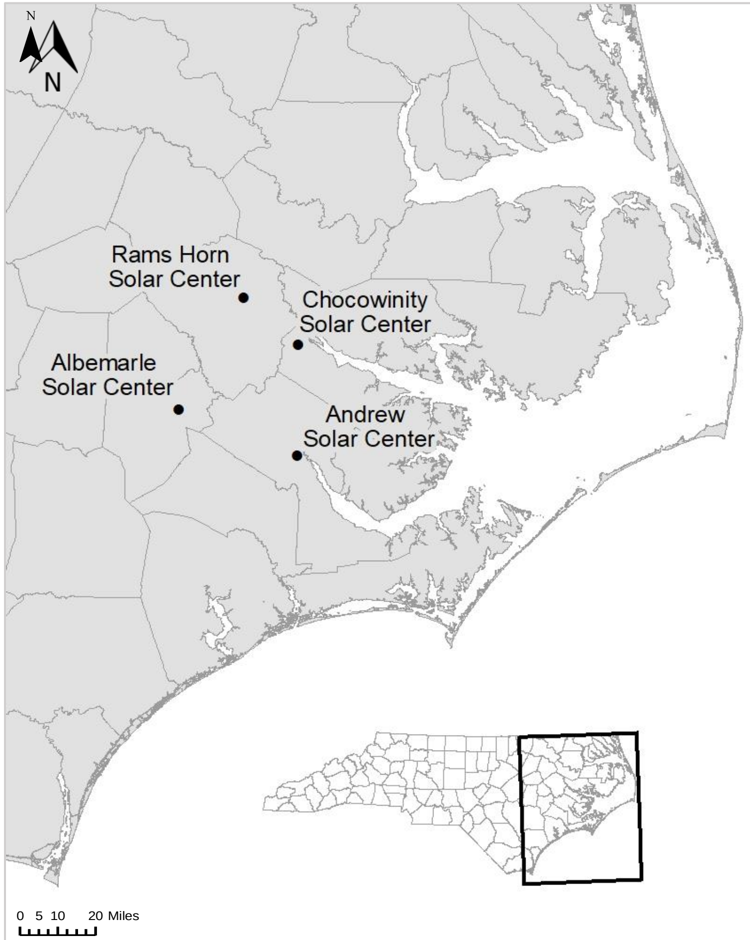


Figure 3: Geographic Distributions of the solar farm sites

Basemap: WGS1984

Table 1. Selected solar farms in eastern North Carolina

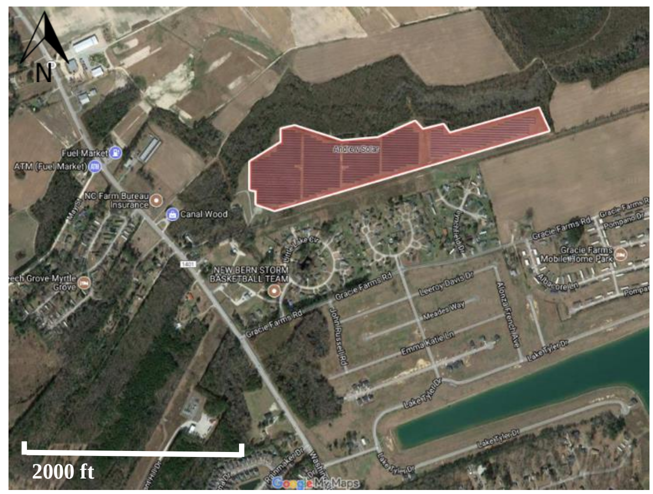
Name	Location	Type	Size (Acre)	Capacity (MW)
Rams Horn Solar Center	Greenville	Distanced	46.21	8.00
Chocowinity Solar	Chocowinity	Adjacent	51.95	4.15
Andrew Solar	New Bern	Adjacent	30.32	5.00
Albemarle Solar Center	Kinston	Distanced	33.34	15.00

** Note: Sizes were calculated in tools embedded in Google Maps. All other information was retrieved from Solar Energy Industries Association at http://www.seia.org/research-resources/major-solar-projects-list.*

Rams Horn Solar Center (Greenville)

Chocowinity Solar Center (Chocowinity)

Albemarle Solar Center (Kinston)



Andrew Solar (New Bern)

Figure 4. Satellite images of selected solar farms

Rams Horn Solar Center (Greenville) **[Distanced]**

Rams Horn Solar Center is located outside the city limits, roughly four-miles Northeast of downtown Greenville. The solar farm is surrounded by level fields and patches of forest. This was one of the larger solar farms and was classified as a distanced area. There is a small mobile home neighborhood along Whichard Road, which runs to the West of the solar farm. Behind the mobile-home neighborhood is a long dirt road, along which sit several larger single-family homes. These homes are not part of the same grouping of houses as the mobile homes, and appear to be of a higher income level. I received one response from the mobile home area, and none from the larger single-family homes. All other responses from this study site came from the neighborhood described below.

Directly across the street from the solar farm sits a larger, middle-class neighborhood named Northwoods. There is only one entry/exit to/from Northwoods, and from this one can see the solar panels in the field. From one or two of the houses at the front of the neighborhood, it is possible to see the panels from a front or back porch (depending on the direction the home faces), but for the majority of residents, the only way for them to see the solar farm from their neighborhood is when they are coming or going. Several participants with whom I spoke mentioned that they were aware of the solar farm, but many did not give it more than a first glance. There are approximately 60 houses in the neighborhood.

Figure 5: Rams Horn Solar Center study site

Responses from this site were collected throughout July 2017, generally between 17:00-20:00 during weekdays. There posed a difficulty in approaching homes between the time people arrived home from work and before and after dinner. The response rate for this study site was 30% of homes approached.

Chocowinity Solar Center (Chocowinity) **[Adjacent]**

The solar farm at this site is not denoted with a specific name. In the SEIA (2017) database, it is noted as "Chocowinity Solar." This site is just west of U.S. 17 in the town of Chocowinity and is the largest solar facility in the study. Bordering the facility directly to the South is a large mobile home park. The roads in this neighborhood are unpaved, and the area seems largely ignored by everyone in the town proper (about a mile and a half to the North), save for the police, who frequent the area. I was instructed not to be in this area after sunset by a local, but overall I did not feel unsafe at this site. Access to this neighborhood was limited during any storm, as the roads would completely wash out and were inaccessible to all but cars with 4-wheel drive. In such a case, one would have to park elsewhere and walk to the home. All of the homes in the neighborhood are mobile homes. Toward the front of the neighborhood, there is new construction, and the houses appeared more tidy and well-kept. There was a clear division in the neighborhood, denoted by a set of railroad tracks that run down the back third of the neighborhood. Though neither side would be considered a wealthy area, the side of the site to the West of the tracks was more dilapidated.

Data from this site was collected through August and September of 2017, mostly during the evening hours, before sunset. From this site, I received 16 responses, and the response rate was 40% of homes approached. All in the neighborhood were aware of the solar farm, but most stated they had little to no information about it, and they would have liked some communication from someone. The solar farm adjacent to this neighborhood had the most visibility, as many of the homes were directly behind it or across the street from it.

Figure 6: Chocowinity Solar Center study site

Andrew Solar Center (New Bern) **[Adjacent]**

The solar farm at this site is named Andrew Solar. This site is located northwest of the city center of New Bern. This site consists of a solar farm which borders three small residential subdivisions. Each of these subdivisions has a unique shape and layout. The first and second consist of mainly single-family homes, while the third is comprised largely of mobile homes. All have at least some vantage point to see the solar farm from either their homes or the street. There is a large mobile home park to the Southeast of the solar farm, but it is mostly uninhabited, and none of the homes in this division have any vantage point from which to see the solar farm, nor do they pass by it in coming or going.

Figure 7: Andrew Solar Center study site

These responses were collected from August to October of 2017 during the evening hours, and occasionally on the weekends during the day. Overall, 16 responses were received from this neighborhood. The response rate for this study site was 40%. Some residents of this site noted that when the solar farm was in the installation process, the employees of the construction company drew lines across their private property and made them move objects in their backyards (including a large shed), citing claims of eminent domain. I was unable to reach a representative of the company to confirm this. If true, there could potentially be issues if the residents of the neighborhood take complaints to the city council or the planning board as an eminent domain can only be used by the federal government to take land for public good, not for private development.

Albemarle Solar Center (Kinston) **[Distanced]**

The fourth site was located in the suburbs of Kinston, North Carolina. It is a mostly rural area near Kinston High School. The solar facility is known as Albemarle Solar Center and is set back off the main road by about 100 yards. This is the only site that cannot be seen directly from the houses in the neighborhoods, except for the winter months when the vegetation thins out, and one can see through the trees. Three neighborhoods were selected within the one-mile radius of the solar farm. One was a series of duplex homes, of which I discovered almost half to be uninhabited. The second neighborhood consisted of large, single-family homes. This was an upper-middle class neighborhood. Lastly, there was another middle-class neighborhood of ranch-style brick homes. These neighborhoods were similar to the Greenville location in that some of the houses could not see the solar farm directly, but they had to drive by it to get into the neighborhood. The third neighborhood was able to see the facility from some of the houses.

Responses from the Kinston site were collected in September and October 2017, during evening hours. In total, 17 responses were obtained from this site. The response rate from this study site was 50% of homes approached. Respondents in Kinston were generally the most receptive of the four sites, and I had success talking to them and getting stories about the solar farms in the area. They did not necessarily pay attention to Albemarle Solar Center but were aware of its existence. Many of them mentioned the other solar production facilities located in the area and demonstrated their awareness, though they did not know to whom they belonged. This pattern was reflected in the other neighborhoods.

Figure 8: Albemarle Solar Center study site

Survey Data Analysis

For descriptive statistical analysis of survey data, I used Microsoft Excel. I used both the “AVERAGE” formula to calculate the average/mean of specified columns, and the “STDEV” function to calculate the standard deviations.

The factor analysis is a method when the researcher has obtained measures on many variables but is unsure of the number and nature of the underlying factors. With an assumption that all common elements are correlated, the researcher uses the results of the analysis to help define the number and content of the factor (Hatcher, 1994). IBM SPSS Statistics, version 25, was used for analysis. Three models—all data together, data from the distanced areas, data from the adjacent areas— were run to determine the factors separately. SPSS produces a scree plot which tells the researcher how many factors can be extracted from the data. After factors were extracted, principal components analysis with Varimax rotation was used to identify and compute composite scores for the factors.

Based on the primary factor loadings of each factor (greater than 0.4), distinct factors were determined. Each factor was named followed by the questions/variables from the survey which comprised it. Overall, the factor names were identical between models because the patterns were consistent with minor variations. Table 8 shows the names of each factor for all three models and Appendix 4 lists all variables associated with each factor. Excluded variables were the Yes/No Questions, "The solar farm is visible from my house" and "When I moved to the community, the solar farm was already there." Also removed was the variable, "I am comfortable living near a solar farm." Factor values were then extracted for additional regression analysis.

The factor analysis stored each factor value for regression analysis. Using the linear regression tool in SPSS, regression analysis was performed with the factors from the previous factor analysis, along with demographic responses, set as independent variables and the value for "I am satisfied with living near a solar farm" as the dependent variable. Table 9 summarizes all three regression models included in this research. Model 1 included all data to see the overall factors and their impacts on residents' satisfaction with a nearby solar farm. Models 2 and 3 looked at the differences between geographic locations—distanced vs. adjacent areas, with the same independent and dependent variable. Each model was run with factors pertinent to each factor analysis: e.g. Regression Model with All Data was run with the factors from the All Data group.

Stakeholder Interviews

The research also consists of interviews with stakeholders in the energy/utility sector, and those in the planning sector. These interviews were designed to develop a better understanding of the solar farms from a governmental and utility-level perspective.

Utility Professionals

During March and April of 2017, I conducted a pilot study to understand the current renewable energy industry in the area from the professionals' perspectives. I performed ten interviews with professionals who work in electrical co-ops across eastern North Carolina. The sample electric co-ops were strategically selected: I first listed the co-ops that maintain the unique member-owner relationship and then among those applicable, I chose one co-op serving ten Eastern North Carolina districts—Roanoke, Halifax, Edgecombe-Martin, Washington, Tideland, Pitt, Tri-County, Jones-Onslow, Four County and Cape Hatteras. Although the exact job title of interviewees vary based on how each co-op is structured, the interviewees were identified to be the person in charge of renewable energy and to some degree, community relations. Interviews were set up via email. I met six of the participants in their office or a conference room on-site. The other four interviews were conducted over the phone. Offices and conference rooms varied from individual to individual, but the overall air of each interview was comfortable. I wore business attire to each in-person interview.

The interview questions were the same for each interview, and each question was asked to each participant. Sometimes during an answer, a participant would add an anecdote or pertinent story, which I also recorded. I asked additional questions in some cases where clarification of a previous answer was needed. I did not record any of the interviews, but wrote down each answer during the interview and later coded the answers into Microsoft Excel where the answers were stored confidentially. No interviewee requested confidentiality, but prior to each interview I specified that their answers were confidential and would be stored securely.

County Planners

For the regulations of land use among the different localities in which respondents lived, I conducted two interviews with individuals from counties involved in the survey study. The research focused on four different counties, as rules can vary widely even among adjacent counties in regard to land use and regulation strategies. Two land use planners in both adjacent and distanced areas gave insight into the background of how the solar farms became prominent in eastern North Carolina. A full list of questions asked during interviews can be found in Appendix 1. Interviews were conducted in November 2017, one in the Pitt County governmental complex (Rams Horn Solar Center) and the other in the Beaufort County Planning Department (Chocowinity Solar Center). Interviews were set up through email and were conducted in-person, and attire was the same as for the utility-sector interviews.

Both interviews were conducted in the individual’s office, and the overall air of each interview was comfortable. I asked the same set of questions to each participant (though different from the co-op interviews), with additional questions for clarification as needed. I recorded neither interview, but wrote down each answer as with the utility professionals’ interviews and coded them into Excel. Neither individual asked for confidentiality, but I stated while setting up the interview that their answers would be stored securely.

CHAPTER 4: RESULTS

Survey Participants

Altogether, the gender of participants was balanced with 38 males and 31 females. However, when compared by geographic settings, there were nearly double the male respondents from the two distanced sites (n = 25) than in the adjacent sites (n = 13). Female respondents were distributed similarly across both geographic settings, distanced (n = 13) and adjacent (n = 18) with one missing response.

Most respondents were 31-years-old and older (64 out of 70 people). The “46-60 years old” age category had the highest number of participants (n = 25). Generally, participants in the distanced sites were older, with 29 of 38 reporting 46 years plus of age. Age distribution in the adjacent sites was more balanced, with 16 reporting 45 years of age or less, and 16 reporting 46 years of age or more.

The study had more Non-Hispanic Whites (n = 41) than any other race/ethnicity. African Americans were the second largest group of participants (n = 21). It should be noted, however, that the distanced sites reported majority White (n = 26 out of 37). The adjacent sites balanced more evenly between responses of White and African American, with 15 and 14, respectively. The study had only a few respondents with other races, with three Hispanics, two Asian or Pacific Islanders, and two Others. Interestingly, one of the participants reporting “Other” specified “Moor” in the open-ended answer box for this question, indicating ancestry from refugee settlement from the Moors of Morocco and Spain.

The two most mentioned income groups amongst research participants were “$46,501-$73,300” (n = 20) and “$73,301-$160,400” (n = 18). All other income levels were somewhat evenly distributed. Participants in the distanced sites reported a generally higher level of income than participants in the adjacent areas. All respondents who reported the highest income bracket, "$160,401 or more" came from the distanced sites.

Education levels of respondents varied with most participants reporting the "high school and above" level of educational attainment. Similar to the trend in the income, participants from the distanced sites seemed to have a relatively higher level of education compared to those from the adjacent sites.

I included both "moderate" and "no opinion" as answer choices on the political affiliation question in order to give a choice to those who preferred to indicate a position between conservative and liberal and those who wished to indicate no position. A number of participants (n = 16) showed their political affiliation in between conservative and liberal—"Moderate." Political affiliation of respondents varied among the four sites, but overall skewed conservative. Those who answered either "Very conservative" or "Somewhat conservative" totaled 31 (of 70 total). Across all participants, ten answered they were either "Somewhat liberal" or "Very liberal." The study also had 14 respondents with "No opinion," which may indicate that there were some respondents who preferred to give no political affiliation.

The majority have lived in eastern North Carolina for more than ten years (n = 63) and were homeowners (n = 61). There was no significant difference between sites for both tenure and homeownership.

Table 2: Demographic characteristics of participants

Category	Demographics	All (*n* = 70)	Distanced (*n* = 38)	Adjacent (*n* = 32)
Gender	Male	38	25	13
	Female	31	13	18
	Missing	1	0	1
Age	18-30 years old	6	2	4
	31-45 years old	19	7	12
	46-60 years old	25	16	9
	60+ years old	20	13	7
Ethnicity	White (non-Hispanic)	41	26	15
	African American	21	7	14
	Hispanic	3	1	2
	Asian or Pacific Islander	2	2	0
	Other (please specify)	2	1	1
Income	$10,600 or less	6	1	5
	$10,601 - $27,700	5	1	4
	$27,701 - $46,500	8	4	4
	$46,501 - $73,300	20	6	14
	$73,301 - $160,400	18	16	2
	$160,401 or more	6	6	0
Education	Some high school, no diploma	3	0	3
	High school graduate or equivalent	20	7	13
	Trade, technical college or Associate's degree	13	5	8
	Bachelor's degree	18	12	6
	Master's Degree	8	6	2
	Professional or Doctoral Degree	8	8	0
Political Affiliation	Very conservative	11	9	2
	Somewhat conservative	17	11	6
	Moderate	16	7	9
	Somewhat liberal	6	2	4
	Very liberal	4	2	2
	No Opinion	14	5	9
Length of time in eastern NC	1-5 years	4	3	1
	6-10 years	3	1	2
	Over 10 years	63	34	29
Homeownership	Renter	8	4	4
	Homeowner	61	34	26

Qualitative Understanding: Resident's Impression of Solar Farms

Word Frequency

I asked respondents what they think "about solar farms in general" and "regarding their neighborhood being located near a solar farm" in the survey. Participants were asked to give a max of three answers for each question. All answers were visualized in word-clouds using http://www.wordle.net/. Frequently mentioned words appeared with greater prominence.

The first survey question asked respondents to describe what they think about solar farms. Participants were asked to give a max of three answers. All answers were visualized in word-clouds using *http://www.wordle.net/* (Figure 9). In the Wordle, frequently mentioned words appeared with greater prominence. The words were coded for positive, negative and neutral connotations. Examples of words with positive connotations include "savings," "great," and "efficient." Words with negative connotations included "dumb," "waste of space" and "harmful to wildlife." Neutrally connoted words include "ok," "fine" and "sunlight." Of a total of 118 responses, 73 words (62%) were positive, 15 (13 percent) were negative, and 30 (25 percent) were neutral.

Figure 9: Wordle 1- Describe your feelings about solar farms

I also asked respondents their opinion regarding their neighborhood being located near a solar farm. As in the previous question, three open-ended text entry answer options were provided. The same coding process used for the first open-ended question was used for this second question. Responses were balanced between positive and neutral for this question. Among a total of 93 replies, 43 (46%) carried positive connotations. Seven words carried negative connotations (eight percent). The remaining 43 words (46%) had neutral connotations. It should be noted that the most commonly occurring word was “ok,” indicating that many respondents did not mind their neighborhood being located near a solar farm. Some said that they did not care to see it every day; and the others stated that it (solar farm) did not cross their mind any more than seeing trees in the area. Figure 10 visualizes the Word frequency. See Appendices 5 and 6 for word frequency tables.

Although most participants did not express distaste with the solar farm directly, they shared their desire to know more about the neighboring solar farm such as who owns and operates the facility, and how it could benefit the community. The Chocowinity Solar Study site was the center of a county land use controversy which ended in a one-year moratorium on new solar energy production facilities in the county (see Stakeholder Interviews results).

Figure 10: Wordle 2- Describe how you feel about your neighborhood being located near a solar farm

Comparisons by geographic setting

The first three columns of Figure 11 show the percentile distribution of positive, negative and neutral word choices about what residents think about the solar farms. The answers were largely positive, with a slightly higher percentage of positive answers from the adjacent sites than from the distanced sites.

The second three columns of Figure 11 show the percentile distribution of respondents' positive/negative word choices about their neighborhood sitting near a solar farm. These answers were more evenly distributed among sites, with percentages being almost identical between the distanced and adjacent sites.

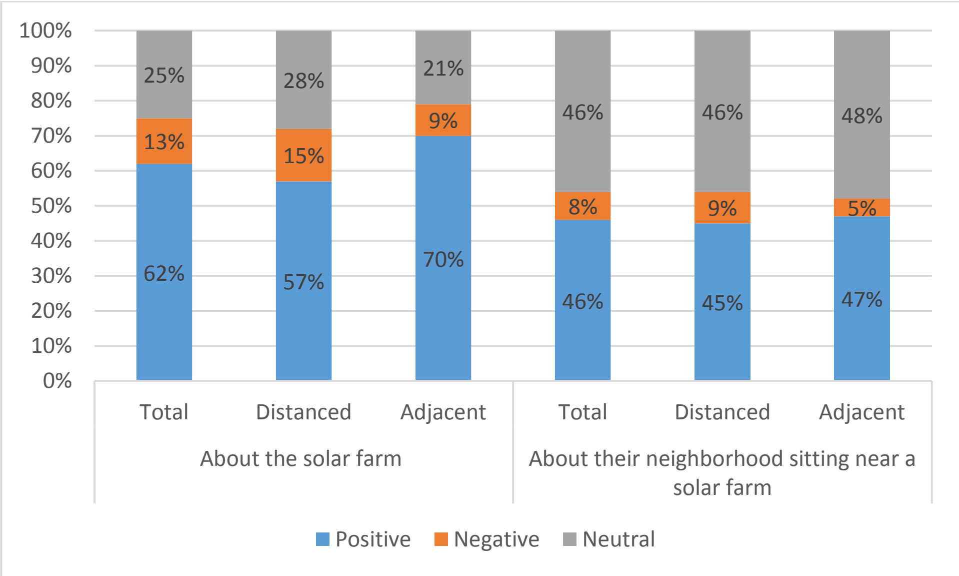


Figure 11: Residents' positive/negative word choices by geographic setting for both questions

Descriptive Statistical Analysis

Overall satisfaction and sense of place

The survey contained several statements designed to gauge residents' overall satisfaction with the solar farms and their sense of place. There did not appear to be any outright distaste for the solar farms, but answers did vary some among respondents. With a Likert-scale mean of 2.24

(4.00 being neutral), there was no indication that respondents would move out of the community because of the solar farm. There was also not much variation between the distanced sites and the adjacent sites. It should be noted that the average in the adjacent sites (M = 2.46) was slightly higher than that of the distanced sites (M = 2.01), indicating there may be a slightly higher desire to relocate; however, the average is still below 4.00 (neutral) in value. Both satisfaction and comfort with living near a solar farm hovered around the average value indicating "slightly agree," and there was not much variation between the distanced and the adjacent sites. Answers trended toward more disagreeable in regard to the statement, "The community has experienced positive changes after the solar farm," demonstrating that respondents may not feel that their community has changed for the better, or rather that the solar farm did not bring any positive change to their community directly. Answers between sites did not widely vary for this statement. Also, respondents input their agreement/disagreement to the statement, "I am personally happy with the change." With an overall average of 3.93 among all groups, answers trended towards neutral. Similarly, there was not much variation between the two sets of study sites for this statement.

Two statements that measure residents' sense of place yielded agreeable results as well. The mean values for the statement "I feel at home in this neighborhood" were 6.25 and "I know my neighbors" was 5.76, indicating a high sense of place and community connectedness in the study sites. In the sites where the solar farms were distanced away from the homes, there seemed to be a stronger sense of place as average values were higher.

Table 3. Descriptive statistics of residents' overall satisfaction (including sense of place)

Variable	All Participants		Distanced		Adjacent	
	M	**SD**	**M**	**SD**	**M**	**SD**
I plan to move out of the community because of the solar farm.	2.24	1.21	2.01	0.83	2.46	1.53
I am comfortable living near a solar farm.	5.01	1.53	4.99	1.41	5.03	1.70
I am satisfied with living near a solar farm.	4.93	1.54	4.85	1.42	5.03	1.72
The community has experienced positive changes after the solar farm.	3.42	1.20	3.46	1.03	3.37	1.31
I am personally happy with the change.	3.93	1.42	3.99	1.19	3.89	1.79
I know my neighbors.	5.76	1.16	6.08	0.97	5.36	1.26
I feel at home in this neighborhood.	6.25	0.97	6.45	0.58	5.99	1.23

Environmental considerations

Respondents were agreeable in the statement that the solar farm is making a positive impact on the environment with an overall average of 4.80 where 5.00 indicates slightly agree. No major differences were noted between sites, but the average was slightly higher in the sites where the solar farm was adjacent to the homes of respondents. There were general neutral feelings toward the statement, "Living near a solar farm makes me more environmentally conscious." I believed this would elicit similar responses to the sentiment that some participants expressed about how solar farms made them think about "green living," but that did not surface. It could be that respondents speculated about how other people make decisions based on housing proximity or distance from a solar farm, rather than themselves individually.

In understanding the environmental considerations of respondents, it is important to include aspects of climate change. Given the rural setting of this study, I was personally concerned that many respondents would balk at this topic and refuse to answer, but most seemed willing to talk about it at the very least; some indicated wanting to learn more, as they were overall unsure. Participants indicated slight agreement that they were concerned about global climate change, and solar energy could help combat global climate change. For both statements, average scores were higher in the sites where the solar farm was adjacent than the sites where it was farther away.

Table 4. Descriptive statistics of residents' perceptions of environmental considerations

Variable	All Participants		Distanced		Adjacent	
	M	**SD**	**M**	**SD**	**M**	**SD**
The solar farm is making a positive impact on the environment.	4.80	1.46	4.76	1.43	4.89	1.61
Living near a solar farm makes me more environmentally conscious.	4.18	1.51	4.28	1.47	4.13	1.60
Solar energy has a positive impact on the surrounding environment in Eastern NC.	4.82	1.42	4.88	1.10	4.72	1.82
I am concerned about global climate change.	4.84	1.82	4.78	1.91	4.94	1.82
Solar energy can help combat global climate change.	4.76	1.56	4.56	1.53	4.99	1.62

Economic considerations

Respondents were also asked to indicate their agreement with aspects related to the economic impact of solar farms. Similarly to the statement, "I would support a solar farm if my community owned it," respondents indicated that if given the opportunity, they would invest in a solar farm. An average score of 4.68 demonstrates a slight trend towards agreement overall. There was slightly higher agreement in the distanced sites than in the adjacent sites. In aggregate, participants slightly disagree with the idea that their community benefits economically from the solar farm (M = 3.76). When presented with this statement, many of them questioned back to me where the electricity generated by the panels goes. Per my interviews with professionals in the electric co-ops in Eastern NC, some power transmits to the north due to the proximity of many of the power grids in this part of the state to the PJM (Pennsylvania-Jersey-Maryland) transmission lines. It is also possible that these particular solar farms benefit privately owned facilities, but this information is not readily available.

There was not a high level of concern about property values decreasing because of the solar farm, and not much variation between the adjacent and the distanced sites was noted. Some of the participants stated that some people might want to purchase a home near a solar farm because it would elevate their sense of "green living." This last question became a talking point during some of the surveys, and since the majority of respondents were homeowners, property value and property appeal were a genuine concern. The results show that respondents generally do not believe the solar farms pose a threat to their property values.

I included several statements that tie aspects to one another, counting a few that were centered around the impact of the solar farms in eastern North Carolina specifically. There were general positive indications that solar farms can create jobs in eastern North Carolina; no large variations were noted between study sites. Respondents were also asked to indicate whether they believe that solar farms are more profitable than the agricultural industry; answers for this statement trended towards neutral on the whole, but were higher in the adjacent sites than in the distanced sites.

There were neutral to "slightly agree" indications as to whether solar farms can have a positive impact on the economy of eastern North Carolina. Sentiments trended more towards agreement in the sites where the solar farms were adjacent to homes than in the distanced sites.

Table 5. Descriptive statistics of residents' perceptions of economic considerations

Variable	All Participants		Distanced		Adjacent	
	M	**SD**	**M**	**SD**	**M**	**SD**
Given the opportunity, I would invest in a solar farm.	4.68	1.62	4.82	1.41	4.46	1.84
My community benefits economically from the nearby solar farm.	3.76	1.71	3.75	1.56	3.78	2.01
I am concerned that my property value may be reduced due to the solar farm.	3.46	1.69	3.46	1.41	3.52	1.82
Solar farms can create jobs in eastern NC.	4.84	1.42	4.88	1.10	4.72	1.82
Solar farms are more profitable than the agricultural industry (for example, tobacco farms)	4.05	1.51	3.75	1.53	4.49	1.43
Solar farms have a positive impact on the economy of eastern NC.	4.69	1.33	4.60	1.15	4.82	1.60

Socio-Political Aspects

I asked respondents' role in their community and their perceptions about political considerations. First, I asked whether they felt having a say in regards to the renewable energy becoming a part of their community. The mean value of the answer for all respondents was 3.64, indicating slight disagreement on the statement. Interestingly, respondents of the adjacent areas were less vocal—or felt they had less of a say—compared to the survey participants in the distanced areas. There was also a sense of exclusion from the decision-making process in general among respondents. An overall average of 2.58 indicates they felt removed from said process. There was just slightly higher agreement in the distanced sites, but both distanced and adjacent sites trended toward disagreement for this statement.

When asked about whether the solar farm company worked well with the community members through active communications regarding any potential and actual issues, respondents disagreed (*M* = 3.32). Participants' experience with the solar farm company were slightly lower in distanced areas than in the adjacent areas (although they both trended towards disagreement). Lastly, I asked participants if they would support a solar farm if their community owns it. The answers were generally favorable and hovered around similar values in the distanced and adjacent sites. This indicates that possibly, with more community involvement and with more say in the process, there may be more support for the solar facility in general. The positive answers suggest that when those who it may affect feel involved, there may be more favorable opinions towards it.

Table 6. Descriptive statistics of residents' perceptions of socio-political considerations.

Variable	All Participants		Distanced		Adjacent	
	M	**SD**	**M**	**SD**	**M**	**SD**
I have a say in determining whether renewable energy becomes a part of my community.	3.64	1.54	3.78	1.51	3.45	1.65
My community was involved in the decision-making process when the solar farm was installed.	2.58	1.52	2.69	1.12	2.46	1.96
The solar farm company works well with the community members through active communications regarding any potential/actual issues.	3.32	1.42	3.25	1.38	3.36	1.25
I would support a solar farm if my community owned it.	4.94	1.69	4.92	1.62	4.86	1.68

Aesthetic considerations

The aesthetic questions aimed to gauge participant feelings towards the physical appearance or physical attractiveness of the solar farm located near their neighborhood. In general, responses were slightly negative in tone. People “somewhat disagreed” with the questions about the solar farm enhancing the attractiveness of the community along with whether they thought it was visually pleasing. On the other hand, they “slightly agreed” on the statements that solar farms should be screened with trees and whether they believed it should be located at an isolated location. Average scores were higher for these latter two statements in the sites where the solar farm is farther away, indicating that the distance from homes may be seen as a good thing. In the Albemarle Solar site, the solar farm had been screened with trees, and only during the winter months when the trees shed their leaves could residents see the panels from their homes. Given that the surveys were administered during the summer to early fall, the solar farm was all but invisible. Interestingly, a few respondents specifically mentioned that they had never thought about the solar farm as something they would gauge on an attractiveness scale.

For the question about the heat from the solar panels or reflections from the sun, people slightly disagreed with the statements; it seems that the solar panels do not generate many environmental concerns. One participant mentioned that it was interesting how the panels would pivot on their bases as the sun moved in the sky, and did not say the reflection to be an issue. Another respondent was even unaware that the “mirrors in the field” were solar panels. Neither had any complaints about potential damage done to the environment.

Lastly, sentiments hovered around “slightly agree” for the statement, “The solar farm fits in the surround nature of Eastern NC.” There was a marginally higher level of agreement in the sites with a closer solar farm than those where the solar farm was farther away.

Table 7. Descriptive statistics of residents' perceptions of aesthetic considerations

Variable	All Participants		Distanced		Adjacent	
	M	**SD**	**M**	**SD**	**M**	**SD**
The solar farm enhances the attractiveness of my community.	3.42	1.44	3.32	1.41	3.57	1.53
Solar farms should be screened with trees.	4.36	1.67	4.71	1.42	3.84	1.74
Solar farms should be located at an isolated location.	4.34	1.38	4.51	1.12	4.09	1.74
The solar farm is visually pleasing.	3.44	1.51	3.37	1.26	3.57	1.76
I am concerned about heat from the solar panels.	2.90	1.32	3.04	1.27	2.76	1.37
The glass on the solar panels reflects too much sunlight.	3.24	1.39	3.24	1.25	3.39	1.63
The solar farm fits into the surrounding nature of Eastern NC	4.76	1.56	4.56	1.53	4.99	1.62

Factor Analysis & Regression Analysis

To restate, the scree plots in factor analysis suggest three factors for all models. Based on the primary factor loadings of each factor (greater than 0.4), distinct factors were determined. Each factor was named followed by the questions/variables from the survey which comprised it. Overall, the factor names were identical between models because the patterns were consistent with minor variations. Table 8 shows names for each factor for all three models and Appendix 4 lists all variables associated with each factor.

Table 8. Models and the factors

Model	Factor
Model 1. All data	Factor1: *Perceived benefits of the solar farm*
	Factor2: *Taking action (personal or in the community)*
	Factor3: *Concerns in regard to the solar farm*
Model 2. From Distanced areas	Factor1: *Perceived benefits of the solar farm*
	Factor4: *Appeal of the solar farm (physical, aesthetic)*
	Factor3: *Concerns in regard to the solar farm*
Model 3. From Adjacent areas	Factor1: *Perceived benefits of the solar farm*
	Factor2: *Taking action (personal or in the community)*
	Factor3: *Concerns in regard to the solar farm*

Table 9 summarizes all three regression models included in this research. Model 1 included all data to see the overall factors and their impacts on residents' satisfaction with the nearby solar farm. Models 2 and 3 looked at the differences between geographic locations—distanced vs. adjacent areas.

Satisfaction with nearby solar farm: All data included

Three factors from the factor analysis along with all demographic variables—age, income, education level, political affiliation, and length of time in eastern NC—were used as independent variables to estimate the satisfaction with nearby solar farm model. Model 1 (all data model, *n* =70, R^2=.62, *F*=7.79, *p*<.000) had two statistically significant variables. *Perceived benefits of the solar farm* was the most significant. This indicates that when respondents perceive higher benefits of the solar farm, their overall satisfaction with living nearby solar farm also get increases. Additionally, income level stood out as a negative effect, which indicates that people with lower levels of income tend to have higher overall levels of satisfaction in regard to living near the solar farm. The effects of both significant variables were strong with coefficients over .30. Cohen (1977) explained that the effect size over .30 is considered to be large, from .10 and .30 as moderate, and from .00 and .10 as a small effect in social science. The effect size of *Perceived benefits of the solar farm* was almost doubly more significant than income. No other variables turned out to be statistically significant in this model.

<u>*Satisfaction with nearby solar farm: Differences between geographic locations*</u>

Model 2 included data from distanced (*n* = 38, R^2=67, *F*=7.73, *p*<.000) areas. Among factors, both *Perceived benefits of the solar farm* and *Appeal of the solar farm (physical and aesthetic*) were statistically significant at the 99 percent confidence level. When perceived benefits of the solar farm increase, respondents' satisfaction level with their tenure near a solar farm tends to also increase. Additionally, the *Appeal of the solar farms* was also a significant positive factor in affecting their satisfaction with living near the solar farm. Those who believed the facility to be more physically appealing had a higher level of satisfaction. In fact, to the distanced residents, *Appeal of the solar farm (physical and aesthetic)* was the greatest factor in comparison to the other variables with overall satisfaction with a nearby solar farm. As in Model 1, the *Income* factor turned out to have a negatively significant effect on satisfaction.

Respondents with higher education levels turned out to be more satisfied with living near the solar farms. All significant variables had large effect sizes, which all were above .40.

The adjacent region data were used for Model 3 (n = 32, R^2=.33, F=2.24, p<.101). Among all independent variables included, only the *Perceived benefits of the solar farms* turned out to be statistically significant in affecting satisfaction in regard to living near the solar farm with the effect size of .74.

Table 9. Standardized regression coefficients to predict overall satisfaction with nearby solar farm

Variable	Model 1. All data	Differences between proximity	
		Model 2. From distanced areas	Model 3. From adjacent areas
	n =70 R^2 = .62 F = 7.89 (p < .000)	n =38 R^2 = .67 F = 7.73 (p < .000)	n = 32 R^2 = .33 F = 2.24 (p <.101)
Factor1: "Perceived benefits of the solar farm"	.69***	.46**	.74**
Factor2: "Taking action (personal or in the community)"	.06		.09
Factor3: "Concerns in regard to the solar farm"	.15	.00	-.13
Factor4: "Appeal of the solar farm (physical, aesthetic)"		.54**	
Age	.10	.13	.18
Income	-.36*	-.46*	-.16
Education	.29	.40*	.10
Political affiliation	-.07	-.15	-.04
Length of time in eastern NC	-.06	-.15	.12

*Note: * p < 0.05 level; ** p < 0.01 level; *** p < 0.001 level*
Note: Shaded areas were not included in the model. Factor 4: Appeal of the solar farm was only suggested for Model 2

Stakeholder Interviews

Interview with Utility Professionals

In North Carolina, if an entity buys its electricity from a co-op, that entity is by default a part owner of that co-op. It fosters a relationship between buyer and seller that is different from the larger, municipal power grid systems.

Seven of the ten co-ops had operational utility-scale solar in their service area, but it did not always serve their consumer base. Most often, it was leased out to a third-party developer who would then sell the energy produced by Duke Energy or other corporate entity. At times, the co-op would repurchase this energy from the central state distributor and utilize it in their system, but said set-up was generally not the case. Of the three that did not have solar farms in their service area, they all bordered a co-op's service area that did. All ten of them utilized some form of renewable energy in their system, ranging from rooftop solar to hog waste production.

This study also found that geographic location played the most extensive role in determining decisions made regarding renewable energy. For example, one co-op had limited amounts of open land, which restricted the development of large-scale renewable energy projects. The co-op was forced to buy energy produced by other co-ops to incorporate renewables into their system in some way. Conversely, other co-ops with large, open spaces in their service area were considered desirable for renewable energy projects because the land was inexpensive and the opportunities to develop greater. This supports Sanchez-Lozano et al. (2013) in that geographic location played a significant role in both shaping perceptions of renewable energy and the decision-making process regarding renewable energy.

There was no significant difference in opinion on renewable energy between the co-ops, but a seven-to-ten majority viewed them favorably as opposed to a negative or indifferent opinion. A need for community involvement was emphasized among the co-ops, with all of them communicating to their consumer base in some way. All ten printed or emailed a newsletter at varying degrees of frequency and a half used social media in a significant capacity. They communicated the necessity of the involvement of a consumer base, given the unique member-owner setup. Due to this closer relationship, a more profound knowledge of the consumer base was also demonstrated. Respondents reported a concern that outside developers would take advantage of the rural populations, believing them to be less intelligent and thus more malleable to their ends. Overall, there was a stress on more open channels of communication in the future between the co-ops on both ends: with their consumer base and with the broader state/national energy systems.

An aspect of geographic location, I found that professionals in co-ops that serve rural areas believe that their customers feel positively toward the idea of renewable energy, but they do not warm up to the idea of it being forced on them. The professionals stated that they would be more open to the idea of it being community-based; being able to say, "I had a hand in this development."

Interviews with County Planners

One of the differences by geographic area noted by a planner in a county with a distanced site was that counties in Eastern North Carolina often must include wetland protections in their land use plans (Eric Gooby, Personal Communication, November 8 2017). Many areas in eastern North Carolina flood frequently, and the environmental importance of this should be noted. Flooding must be accounted for given that a concern expressed from some of the respondents that the solar farm would pose a danger to wildlife (Eric Gooby, Personal Communication, November 8 2017). Many of the areas in which the solar farms are located were once farmland or an open field, and that land is now being used for a different purpose. Because these are energy generation facilities, they often have barbed wire fences around them and cannot be easily accessed. This kind of structure in an area of previously open land brought a concern to some of the residents, especially those whose backyards bordered the site (Eric Gooby, Personal Communication, November 8 2017).

Also, the topography of the land plays a large part in deciding about land use development. The eastern part of North Carolina is mostly level and less developed than the Piedmont and mountainous regions of the state. Solar farms are less frequent in hilly areas due to more difficulty developing the facility on the side of a hill than on flat land. An added complication is the necessary direction that solar farms must face to produce the most energy. Given the location in the Northern hemisphere, most developed solar farms face in a southerly direction in order to get the most sunlight. With flat land, adjusting for a structure to face a specific direction is more straightforward than trying to find a hill that both faces the desired direction and can be built upon. The combination of the flat land and the relatively inexpensive land prices of eastern North Carolina make it a prime area for solar farm development.

At the time of this study, one of the adjacent site counties had little to no land use regulation or zoning. The unspoken rule was that if someone owned the land, they could do whatever they wanted to with it (Seth Laughlin, Personal Communication, November 3 2017). This led to a sort of “free-for-all” with solar farm development. This opened the door for developers from northern States with financial capital to buy up land in Beaufort, Lenoir, Pitt and Craven counties and develop it. This became an issue in Beaufort county with the lack of land use regulations because the developers would take advantage of the system and develop wherever they viewed as most profitable (Seth Laughlin, Personal Communication, November 3 2017). The county government could do little to stop them, as there was nothing illegal about it. After interviewing the Beaufort County planner, we were invited to attend a Board of Commissioners meeting the following week which involved the discussion of a one-year moratorium on solar farm development. The goal behind the moratorium was for the county government take a proverbial "step back" and figure out how to better implement land use regulations.

This meeting was open to the public and was well-attended by those from all over the county. Many of the smaller towns in the county, such as Bath, Pantego, and Chocowinity were represented in the meeting. The communities of Pantego and Bath brought several concerns before the council. Two residents from Bath reported that they surveyed in the town to obtain residents' opinions on the solar development in the area. At the time of the meeting, they reported a collective 80 responses. The overall feelings towards the solar farms represented at the meeting were negative, and the proposition for the moratorium was generally supported. One man asked that the moratorium be stopped (thus letting the system continue as it was) so that he would be able to sell his farmland to have it developed into a solar farm. He believed converting his agricultural farmland to a solar farm would be a method of income for his family in the future (Beaufort County Board of Commissioners Meeting, November 6 2017). His was the only voice of dissidence in the crowd. Another man mentioned that all renewable energy was a government scam, stating that "Germany has all the renewables and their electric bills are three times higher than ours." (Beaufort County Board of Commissioners Meeting, November 6 2017). Echoes of support from the crowd followed this. A woman scheduled to speak about the moratorium began to cry in front of the Board of Commissioners, stating that she could not imagine a future with her children and grandchildren running around fields injuring themselves on the glass of the solar panels (Beaufort County Board of Commissioners Meeting, November 6 2017). As before mentioned, these facilities are surrounded by barbed wire, so perhaps a question of trespassing, in this case, is more appropriate.

The level of civic participation here also shows a willingness of the people to bring their problems to the government and push for changes that they want. There is, however, an issue of misinformation; participants in the meeting made statements without any hard evidence to support their assertions. Nobody in the crowd, nor the Board, questioned the sources of this information. The emotionally charged perceptions of the attendees appeared to contribute to the moratorium decision. The moratorium passed, but it was not a smooth path.

A different system is in place in Pitt County, the location of one of the distanced sites. The planner interviewed at this site explained that if there is an issue of land use, and someone wants to file a standard rezoning complaint, they must have documentable evidence to back up any claim they may make (Eric Gooby, Personal Communication, November 8 2017). For example, if a landowner went to city council to complain that their land value would depreciate due to proximity to a solar farm, they would be required to have an appraiser with them or have a certified report from an appraiser, verifying this claim. Besides, in Pitt County, the developers are encouraged to speak with the people in the area. They are required to inform them about the new development and make sure that all of those who need to know will know about the solar farm. In this county, a common practice is to send out a mailed notice to those within a specific buffer zone and to place a rezoning hearing sign near the target property (Eric Gooby, Personal Communication, November 8 2017). At the time of the interview with the county planner, the buffer was 100-ft from the edge of the solar farm property, but this leaves many in the area out of receiving necessary information. The buffer was in the process of being increased to 500-ft from the same edge. Also, although there is a sign, it is a dull yard-sign with no design on it (black texts on white background). Having a tiny sign at the edge of a vast farm field is likely ineffective in terms of the dissemination of the message to nearby residents. In Pitt County, no major complaints were noted other than the people expressing that they did not want to see it every day. At the time of the surveys with the residents, many of them did not show a problem with it.

In Beaufort County, very little to no information was sent out regarding the solar farm development in the area. Mailing the information to the adjacent residents is not required. The planner mentioned that there was a newspaper notice sent out about a public hearing for the solar farm at the site in Chocowinity that the research focused on, so people did have the chance to go (Seth Laughlin, Personal Communication, November 3 2017). However, it turned out that the newspaper announcement did not work. Many did not attend (Seth Laughlin, Personal Communication, November 3 2017). This was the only example of information dissemination about the solar farm development noted in the locality. A question posed during the interview was, “Do you think there is a better way to get information to people?” to which the answer was, “There is no reason to invite input when their input cannot make a difference” (Seth Laughlin, Personal Communication, November 3 2017). Though this answer seems contrary, it was truthful in that with no regulations, people who have problems with land use have limited legal paths to take; thus, they can complain but there is little real regulation, so their complaints usually have no effect. This changed quite a bit with the passing of the moratorium.

One concern expressed by planning professionals in both counties was that any landowner who intends to sell land to a solar farm developer should have a lawyer present at any negotiations between the solar farm company and themselves. The interviewees stated that developers might try to take advantage of landowners who may not know specific clauses and legal terminology that comes into play when selling or leasing land. There was mention but no specific examples of landowners taking deals that seemed beneficial to them on the surface, but left them monetarily worse off. The Pitt County planner stated that the salvage value for the solar equipment is more than the decommissioning cost, so even if the landowner has to clean up the solar farm when it eventually shuts down (on average 25-30 years), they can still make money. This may, however, vary along with market and location.

CHAPTER 5: DISCUSSION

The data collected through this study, along with the statistical analyses lent insight into the factors that shape residents' opinions about solar farms in eastern North Carolina. Interviews with county officials for the locations of each study site further helped in understanding the processes that go into the solar farm development, information dissemination, and cooperation with locals, private companies, and the energy grid.

Findings showed that the most consistent factor affecting residential satisfaction with the solar farms was the *Perceived benefits of the solar farm*. This benefit factor loaded variables such as economic benefits (job creation, cost savings) and environmental benefits (combating global climate change, having a positive impact on the environment). Respondents' attitudes generally trended in favor of the benefits of solar farms, with frequent answers to the open-ended questions being "Environmentally Friendly" and "Savings." The significance of this factor indicates that even though residents may not actually see any benefits of the solar farm in their day to day lives, their satisfaction levels increase when they perceive that they are benefitting. This can impact the way that information is shared about the solar farms, as well as marketing practices used when installing a solar farm in an area. There was a desire for more transparency noted from many participants, and the lack of information available about the solar farms was frustrating to many. With an increase in satisfaction linked to perceived benefits, stakeholders in the planning/governmental, utility sector and private (solar development) sector may adapt the way they communicate about the solar farms, increasing transparent communication and education efforts.

Intriguingly, respondents who reported lower income levels indicated a higher level of satisfaction with the solar farms. This could be indicative of the potential economic benefits of the solar farms, bringing the potential for cost savings and improving the economic status of a community; however, it would stand to reason that anyone would appreciate the economic benefits of a solar farm. This may be due to differences in the amount of knowledge had about the economic impacts of solar farms, but I believe overall it is indicative of hope for better economic prospects that is held by those reporting lower income levels. Those reporting higher levels of education also indicated higher levels of satisfaction with the solar farms. This may be attributed to better access to information about the solar farms, though information about these private enterprises is still generally restricted.

In the distanced solar farm study sites, the factor *Appeal of the solar farm (physical and aesthetic)* in the regression model was statistically significant in affecting satisfaction levels toward the solar farms. This supports the research in rural Spain, where residents expressed that the visual aspects of the solar farms in their areas impacted their opinions of them (Torres-Sibillea, Cloquell-Ballester, & Darton 2009). While this particular study focused on issues of the solar farms themselves such as mobility and fractality, it found that the aesthetic impacts of the solar farms did have a role in the day-to-day life of the residents of the areas surrounding them. This was the case in my study as well, as residents expressed in some cases that they would prefer the solar farm to be screened with trees, and in some cases to be located in a more isolated location. This may be applicable in future land use planning: when looking at land sites on which solar farms can/will be built, planners can take more aesthetics into consideration. Perhaps the change in land use will be better received if more isolated, or more screened with trees.

There was little concern that the solar farm could reduce their property value. In at least one of the counties in which the study sites were located, residents must take an appraiser with them to any government function if they wish to protest against a solar farm on the basis that it may reduce their property value. In the distanced sites, the solar farms were not directly adjacent to any homes and were set back farther from the road. This is interesting to note as well, since it may indicate that solar farms with less visual impact and/or those which are "out of sight and out of mind" are more appealing.

In general, respondents had positive feelings toward the solar farms as they stood. This is supported by the open-ended answers given in the first two questions of the survey, where the majority of the responses were affirming. Respondents expressed concern for lack of information provided about the development and construction of the solar farms. The county planners mentioned that there was a process of information dissemination with the people living within a certain radius of the solar farm, indicating that to some degree, the local government made an effort to inform those who may be impacted by the construction. The residents in the study sites did not mention any such information given to them and expressed opinions of the opposite. They did not feel they were informed about the developments in their neighborhood, and simply would have liked to be kept in the know. Some county governments are required to have a public hearing about any new developments that will be implemented, but it is unclear whether advertisement about these meetings is distributed to the residents in the to-be-affected areas; some respondents stated they had no idea of any town hall meetings or any contact from their local government. The only advertisements for said proceedings that were widely available were in newspapers, in a small local government "classified" section.

Though I was not able to directly give more information to participants about the solar farms, I had the chance to sit and talk with many of the respondents who expressed concerns in general about the solar farms; some of these concerns were addressed in the survey. However, they were not significant when compared with the whole. The most consistent interest iterated was the lack of information available about the solar farms. All of the farms in this study were privately held, and as such there was no easy way to find out where the generated electricity went. One of the respondents posed a statement which was echoed by others to varying degrees and wordings: “The farm has been there for two or three years, but my electric bill has not dropped. I get that they are costly to put in at first, but at some point, you would hope there would be some savings.” Because these are privately held facilities, it may be that the electricity produced does not go to their neighborhood, but because of the opacity and lack of information, there is no easy way to find this out. Perhaps this sentiment is best summed up in the following statement, from a respondent in the Chocowinity study site, “I would like to get more information on those solar panels. Who owns them? Where does the power go? Why hasn’t my electric bill dropped? I feel that I should be able to find this information if I’m the one who has to see them every day.”

While the land used for the solar farms is often leased from farmers, the companies developing the solar farm are private, and there is not a clear channel of information in which to find out where the electricity produced by the solar farm goes. As discovered in the pilot study, many of the solar farms are connected into the larger PJM (Pennsylvania-Jersey-Maryland) grid that travels to northern states, where the electricity is then distributed. While some of the solar farms in the area may be connected to this grid, there is no clear way to find out which are and which are not. In bettering information dissemination with the residents who live near the solar farms, it is vital that they know who benefits from the solar farm in their backyard.

CHAPTER 6: CONCLUSIONS

While this study did present several challenges and limitations, it may open some doors for future research. A comparison of people who live near solar farms and people who live near wind farms would be an exciting extension of this research. While wind farms are common in the American West and Europe, they are scarce in eastern North Carolina. The only one in operation in this portion of the state is outside Elizabeth City in Pasquotank County and powers an Amazon facility in Chesapeake, Virginia. The Elizabeth City wind farm is located across from a large state prison, and there are little residential areas near this wind farm. Although the current wind farm location is not viable for a study about residential satisfaction, future wind farm developments in eastern NC would consider such research.

Another opportunity for further research would be comparisons of land use planning policies between different states and challenges and successes of renewable energy in these spaces. This study found that even in counties which border each other, land use regulations can vary widely. Comparing regulations between different states and even different countries may help disseminate lessons learned from different places, encouraging better policy writing. An example may be between states in differing regions in the U.S., such as in the Southeast, the Midwest and the Southwest.

A significant limitation of this study was the small sample size as the result of the difficulty in data collection. While North Carolina is one of the nation’s vanguard states for solar development, the majority of said development is taking place in rural, sparsely populated areas. This made data collection difficult, as the geographic location for the studies needed to be specific. Door-to-door surveys can be physically and emotionally draining, and many hours were spent with no results to show. This small sample size made some analyses difficult as regression analysis is not as effective with small sample sizes.

Another limitation of this study could be the low external validity due to the unique geographic platform of eastern North Carolina where this research was conducted. The geography and topography of North Carolina are different from other sizeable solar development states such as California, Arizona, and Nevada. Solar energy production may be more isolated in vast expanses of desert and thus perceptions and satisfaction levels affected by different factors.

This research may also be able to help contribute to policy implementation in better information dissemination and more transparency. In working with local governments on land use planning and zoning, as well as information dissemination to the public these governments serve, such research may prove useful. A better understanding of these factors may aid in future policy decisions regarding energy development and land use planning. Because one of the main concerns expressed by respondents in the study was the lack of communications and information, more public information sessions on the installation of the solar farms could be helpful. While as the public officials interviewed stated, there is a public hearing as a standard rezoning process, it is understood that the advertisement is generally in a small section in the newspaper and the government and the developer provide limited communication efforts. A call for better transparency between the private companies, local governments, and the general public who live in areas adjacent to these energy facilities is essential. Even if the energy is not going directly to residents' homes, they expressed that they would like to know where it does go. This is information that may be easily shared, but it is currently not. Also, public forums indicate to residents that the local government values their input and would be further helpful in building trust in a community. While social factors were not as significant in determining satisfaction levels in regards to a solar farm, they are indeed important in creating a healthy community, and a government that is transparent with the people and shows them that their input is valued is one that the populace can better trust.

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Appendix 1. Semi-Structured Interview Questions for County Planners

1. Explain the typical procedure from planning to installment of a solar farm.

2. What factors go into planning renewable energy here?

3. What factors go into incorporating renewable energy here?

4. How do you incorporate community opinions into the process?

5. What kind of interaction takes place with local people—before, during, and after a solar farm installment?

6. How do you think geographic location affects your policies on renewable energy?

7. How do you think geographic location affects your attitudes and perceptions in regard to renewable energy?

Appendix 2: Semi-Structured Interview Questions for Utility-Sector Individuals

1. Tell me more about the renewable energy situation in [county/area name].
2. What factors go into planning renewable energy here?
3. What factors go into incorporating renewable energy here?
4. What is your experience with solar farms?
5. What are the plans to utilize wind energy in [this area]?
6. What do you believe the attitudes are towards solar farms among the coworkers in your department?
7. Do you work with other county utility departments/co-ops in ENC?
8. If not, what is the potential for inter-county cooperation?
9. Has your department set any goals in regards to achieving a certain level of renewable utilization?
10. What is the role of community opinions in developing modes of energy production?
11. What kind of interaction takes place with local folks?
12. Do members of your department go out in the field and work one-on-one with residents of your area?
13. How do you think geographic location affects your policies on renewable energy?
14. How do you think geographic location affects your attitudes and perceptions in regard to renewable energy?
15. What do you personally think your department/co-op should do with ren. Energy?
16. Overall, would you say you are more eager or more reluctant to embrace the new technology?

Appendix 3. The Resident Survey

Section 1 – Solar Farm Impressions: Your preliminary impressions of solar farms in general.

1. List three words that describe what you think about solar farms:
   a. ____
   b. ____
   c. ____
2. List three words that describe what you think about your community sitting near a solar farm:
   a. ____
   b. ____
   c. ____

Section 2- Solar farm installation: Your experience with the solar farm installation process.

3. The solar farm is visible from my house.
   - ○ Yes ○ No
4. When I moved into this community, the solar farm was already there:
   - ○ Yes ○ No

A. For those who answered **No** above (#4), to what degree do you agree with the following statements?

	Strongly Disagree	Mostly Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Mostly Agree	Strongly Agree
5. My community was involved in the decision making process when the solar farm was installed.							
6. The community has experienced positive changes after the solar farm.							
7. I am personally happy with the change.							

Section 3 – Community Considerations: Your opinion on the social aspects of solar farms, including the dynamics of your community. To what degree do you agree with the following statements?

	Strongly Disagree	Mostly Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Mostly Agree	Strongly Agree
8. I have a say in determining whether renewable energy becomes a part of my community.							
9. I know my neighbors.							
10. I feel at home in this neighborhood.							
11. The solar farm company works well with the community members through active communications regarding any potential/actual issues.							
12. I would support a solar farm if my community owned it.							

Section 4 – Economic Considerations: Your opinion on the economic effects of solar farms. To what degree do you agree-disagree with the following statements?

	Strongly Disagree	Mostly Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Mostly Agree	Strongly Agree
13. Given the opportunity, I would invest in a solar farm.							
14. My community benefits economically from the nearby solar farm.							
15. I am concerned that my property value may be reduced due to the solar farm.							

Section 5 – Environmental Considerations: Your opinions on the environmental effects of solar farms. To what degree do you agree-disagree with the following statements?

	Strongly Disagree	Mostly Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Mostly Agree	Strongly Agree
16. The solar farm is making a positive impact on the environment.							
17. I am concerned about the heat from the solar panels.							
18. Living near a solar farm makes me more environmentally conscious.							
19. The glass on the solar panels reflects too much sunlight.							

Section 6 – Aesthetic considerations: Your opinions on the visual appeal and effects of solar farms. To what degree do you agree-disagree with the following statements?

	Strongly Disagree	Mostly Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Mostly Agree	Strongly Agree
20. The solar farm enhances the attractiveness of my community.							
21. Solar farms should be screened with trees.							
22. Solar farms should be located at an isolated location.							
23. The solar farm is visually pleasing.							

Section 7 – Solar farm satisfaction: Your concerns and satisfaction with living near a solar farm. To what degree do you agree-disagree with the following statements?

	Strongly Disagree	Mostly Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Mostly Agree	Strongly Agree
24. I plan to move out of this community because of the solar farm.							
25. I am comfortable living near a solar farm.							
26. I am satisfied with living near a solar farm.							

Section 8 – Solar Farms in Eastern NC: Your opinion on solar farms in the larger setting of eastern North Carolina. To what degree do you agree-disagree with the following statements?

	Strongly Disagree	Mostly Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Mostly Agree	Strongly Agree
27. Solar energy has a positive impact on the surrounding environment in eastern NC.							
28. Solar farms can create jobs in eastern NC.							
29. Solar farms are more profitable than the agricultural industry (for example, tobacco farms).							
30. Solar farms have a positive impact on the economy of eastern NC.							
31. The solar farm fits in the surrounding nature in Eastern NC.							
32. I am concerned about global climate change.							
33. Solar energy can help combat global climate change.							

Section 9 – About you

34. What is your gender?
    - o Male
    - o Female
    - o Prefer not to say

35. What is your age?
    - o 18-30 years old
    - o 31-45 years old
    - o 46-60 years old
    - o 60+ years old

36. Please specify your ethnicity.
    - o White (Non-Hispanic)
    - o African American
    - o Asian or Pacific Islander
    - o Hispanic
    - o Other (please specify) ________

37. Please specify your household income range:
    - o $10,600 or less
    - o $10,601 - $27,700
    - o $27,701 - $46,500
    - o $46,501 - $73,300
    - o $73,301 - $160,400
    - o $160,401 or more

38. What is the highest degree or level of school you completed? If you are currently enrolled, what is the highest degree you have received?
    - o Some high school, no diploma
    - o High school graduate or equivalent
    - o Trade, technical college or Associate's degree
    - o Bachelor's degree
    - o Master's degree
    - o Professional or Doctoral degree

39. In general, how would you describe your political views?
    - o Very conservative
    - o Somewhat conservative
    - o Moderate
    - o Somewhat liberal
    - o Very liberal
    - o No opinion

40. How long have you lived in eastern North Carolina?
    - o Less than a year
    - o 1-5 years
    - o 6-10 years
    - o Over 10 years

41. I am: o A homeowner o A renter

Appendix 4. Factors and Their Variables

Model	Factor	Variable included
Model 1: All data	Factor1: Perceived benefits of the solar farm	I know my neighbors. I feel at home in this neighborhood. I would support a solar farm if my community owned it. Given the opportunity, I would invest in a solar farm. My comm benefits economically from the nearby solar farm. The solar farm is making a positive impact on the environment. Living near a solar farm makes me more environmentally conscious. The solar farm enhances the attractiveness of my community. Solar energy has a positive impact on the surrounding environment in ENC (Eastern North Carolina). Solar farms can create jobs in ENC. Solar farms are more profitable than the agricultural industry. Solar farms have a positive impact on the economy of ENC. The solar farm fits in the surrounding nature in ENC. I am concerned about global climate change. Solar farms can help combat global climate change.
	Factor2: Taking action (personal or in the community)	My community was involved in the decision-making process. The community has experienced positive changes after the solar farm. I am personally happy with the change. I have a say in determining whether renewable energy becomes a part of my community The solar farm company works well with the community etc. The solar farm is visually pleasing. (R) I plan to move out of this community because of the solar farm (R)
	Factor3: Concerns in regard to the solar farm	I am concerned that my property value may be reduced because of the solar farm. I am concerned about the heat from the solar panels. The glass on the solar panels reflects too much sunlight. Solar farms should be screened with trees. Solar farms should be located at an isolated location (R)
Model 2: From distanced areas	Factor1: Perceived Benefits of the solar farm	My community was involved in the decision-making process The community has experiences positive changes after the solar farm. I am personally happy with the change. I have a saw in determining whether renewable energy becomes a part of my community. I know my neighbors. The solar farm company works well with the community etc. I would support a solar farm if my community owned it. Given the opportunity, I would invest in a solar farm. My community benefits economically from the nearby solar farm. The solar farm is making a positive impact on the environment.

		Living near a solar farm makes me more environmentally conscious. The solar farm enhances the attractiveness of my community. The solar farm is visually pleasing (R) I am concerned about global climate change. Solar farms can help combat global climate change.
	Factor2: Appeal of the solar farm	The glass on the solar panels reflects too much sunlight. Solar farms should be located at an isolated location (R) Solar energy has a positive impact on the surrounding environment in ENC. Solar farms can create jobs in ENC. Solar farms have a positive impact on the economy of ENC. The solar farm fits in the surrounding nature in ENC.
	Factor3: Concerns in regard to the solar farm	I feel at home in this neighborhood. I am concerned that my property value may be reduced because of the solar farm (R) I am concerned about the heat from the solar panels. (R) I plan to move out of this community because of the solar farm (R) Solar farms are more profitable than the agricultural industry.
Model 3: From adjacent areas	Factor1: Perceived benefits of the solar farm	I know my neighbors. I feel at home in this neighborhood. I would support a solar farm if my community owned it. Given the opportunity, I would invest in a solar farm. The solar farm is making a positive impact on the environment. Living near a solar farm makes me more environmentally conscious. Solar energy has a positive impact on the surrounding environment in ENC. Solar farms can create jobs in ENC. Solar farms are more profitable than the agricultural industry. Solar farms have a positive impact on the economy of ENC. The solar farm fits in the surrounding nature in ENC. I am concerned about global climate change. Solar farms can help combat global climate change.
	Factor2: Taking action (personal or in the community)	My community was involved in the decision-making process. The community has experienced positive changes after the solar farm. I am personally happy with the change. I have a say in determining whether renewable energy becomes a part of my community. My community benefits economically from the nearby solar farm. The solar farm enhances the attractiveness of my community. The solar farm is visually pleasing (R) I plan to move out of this community because of the solar farm (R)

	Factor3: Concerns in regard to the solar farm	I am concerned that my property value may be reeducated because of the solar farm. I am concerned about the heat from the solar panels. The glass on the solar panels reflects too much sunlight. Solar farms should be screened with trees. Solar farms should be located at an isolated location (R).

*Note: (R) indicated in the rotated component matrices that this variable had a negative value.

Appendix 5: Word Frequency Table for Open-Ended Question 1: List three words or phrases that describe your feelings about solar farms.

Frequency	1	2	3	4	5	6
Responses	Harmful-to- wildlife Wasteful Utilitarian Unsightly Waste-of-time Sunlight Waste-of- space Solar Safe Right Resourceful Requirements Replace Questionable Progressive Progress Overwhelming Opaque Not-Sure Neutral Necessary Natural Waste-of- Money Modern Limited Landscape Large Investigational Intelligent Hopeful Harmful Future Eyesore Electric Efficiency Earthly Dumb Don't-Know	Uncertain Smart Positive Nice Interesting Helpful Green Futuristic Fine Expensive Environmentally- Friendly Economic Clean	Needed Big	Ok Great Energy Efficient	Useful Good	Savings

	Daytime Crucial Costly Convenient Conservation Cheaper Big-Requirements Better Bad-for-Landscape Awesome Alternative Alright Affordable Advanced					

Appendix 6: Frequency Table for Open-Ended Question 2: List three words or phrases that describe your feelings about living near a solar farm.

Frequency	1	2	4	5	9	11
Responses	Wonderful Useful Unobtrusive Unnoticeable Unchangeable Trees Supporting Smart Siteful Shiny Self-Reliant Savings Rural Recycle Purposeful Progressive Poisonous Ok-if-quiet Noiseless No-Harm No-Issues No-Information Neat More Lucky Loud Leading-Science Issues Innovative Harm Good-Idea Glad Future Family-Oriented Eyesore Expensive Environmentally-Friendly Energy Efficient Economic	Safe Nice Information Good	Uncertain Neutral Quiet	Great	Fine	Ok

	Don’t-know Don’t-mind Dislike Different Dangerous Cool Consequential Benefits Backyard Appealing Apathy Amazing					

Appendix 7: Utility Professional Interviews- IRB Approval

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board Office
4N-70 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office 252-744-2914 · Fax 252-744-2284 · www.ecu.edu/ORIC/irb

Notification of Exempt Certification

From: Social/Behavioral IRB
To: Zachary Dickerson
CC:
Christine Avenarius
Date: 6/14/2017
Re: UMCIRB 17-000974
Analysis of Perceptions of Renewable Energy Among Electric Co-Ops in Eastern NC

I am pleased to inform you that your research submission has been certified as exempt on 6/14/2017. This study is eligible for Exempt Certification under category #4.

It is your responsibility to ensure that this research is conducted in the manner reported in your application and/or protocol, as well as being consistent with the ethical principles of the Belmont Report and your profession.

This research study does not require any additional interaction with the UMCIRB unless there are proposed changes to this study. Any change, prior to implementing that change, must be submitted to the UMCIRB for review and approval. The UMCIRB will determine if the change impacts the eligibility of the research for exempt status. If more substantive review is required, you will be notified within five business days.

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

IRB00000705 East Carolina U IRB #1 (Biomedical) IORG0000418
IRB00003781 East Carolina U IRB #2 (Behavioral/SS) IORG0000418

Appendix 8: Thesis IRB Approval

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board Office
4N-70 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office 252-744-2914 · Fax 252-744-2284 · www.ecu.edu/ORIC/irb

Notification of Exempt Certification

From: Social/Behavioral IRB
To: Zachary Dickerson
CC:
Misun Hur
Date: 7/10/2017
Re: UMCIRB 17-001448
A Solar Farm in My Backyard? Resident Perceptions on Utility-Scale Solar in Eastern North Carolina

I am pleased to inform you that your research submission has been certified as exempt on 7/10/2017. This study is eligible for Exempt Certification under category #2.

It is your responsibility to ensure that this research is conducted in the manner reported in your application and/or protocol, as well as being consistent with the ethical principles of the Belmont Report and your profession.

This research study does not require any additional interaction with the UMCIRB unless there are proposed changes to this study. Any change, prior to implementing that change, must be submitted to the UMCIRB for review and approval. The UMCIRB will determine if the change impacts the eligibility of the research for exempt status. If more substantive review is required, you will be notified within five business days.

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

IRB00000705 East Carolina U IRB #1 (Biomedical) IORG0000418
IRB00003781 East Carolina U IRB #2 (Behavioral/SS) IORG0000418