Functionality and Aesthetics of Small-Scale Renewable Energy Networks: The need to shift to sustainable resources and designed green energy systems

by

Nicholas Joseph Ferrara

A REPORT

submitted in partial fulfillment of the requirements for the degree

MASTER OF LANDSCAPE ARCHITECTURE

Department of Landscape Architecture and Regional & Community Planning
College of Architecture, Planning, and Design

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2021

Approved by:

Major Professor
Dr. Tim Keane

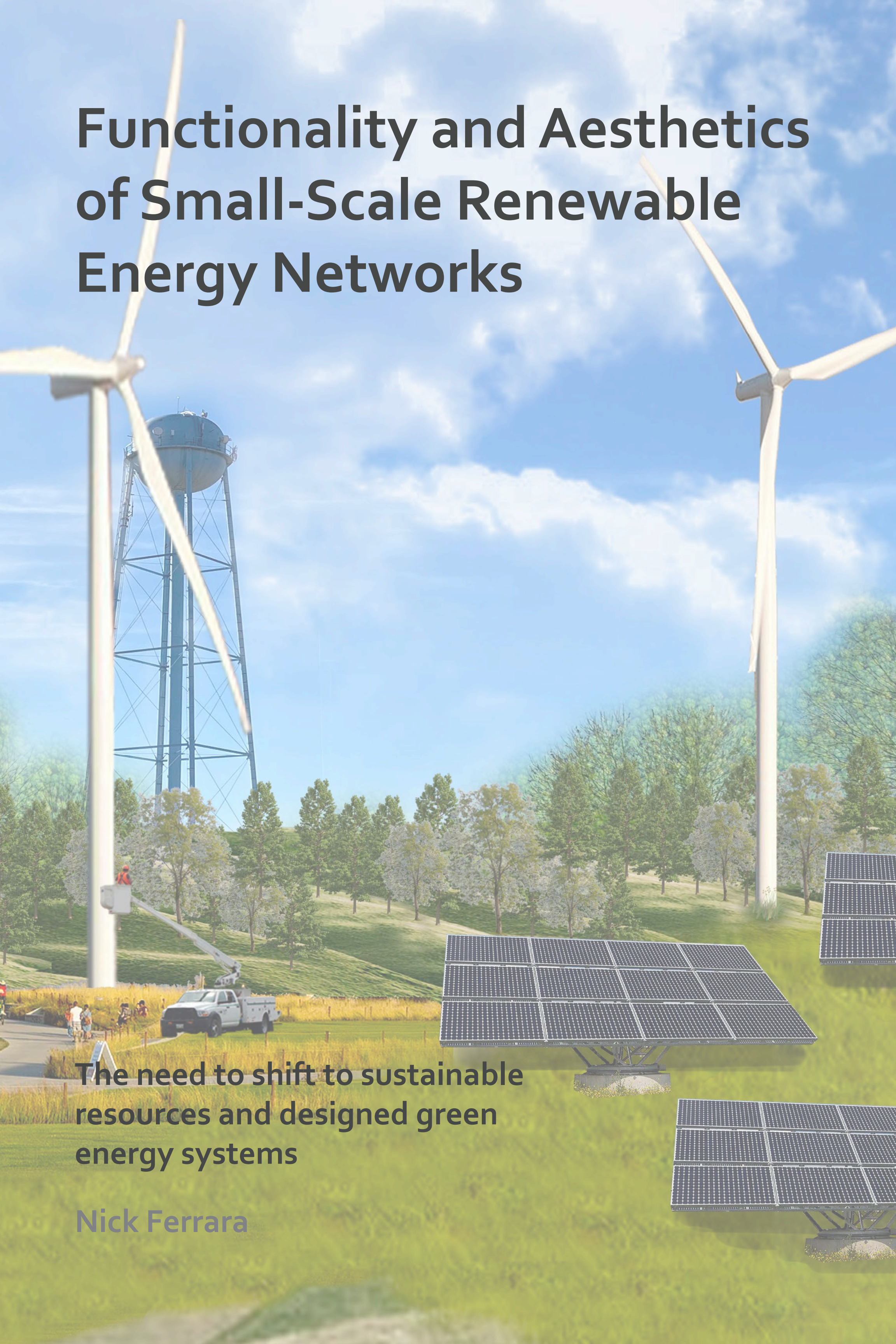
Abstract:

Renewable energy is becoming a major part of the energy generating infrastructure used in both the United States and in several nations throughout the world. While there are many technological and engineering issues surrounding renewable energy and its implementation into the current electrical "grid," there are also various social issues with renewable energy related to public perception and appearance within the landscape. Additionally, the current "grid" system in the United States is nationally connected meaning generated energy is created far from where it is consumed. This focus on nationally produced energy has led to the creation of hundreds of transmission lines spanning thousands of miles and at times interrupting scenic landscapes.

The study reported here examines a variety of key texts and case studies to create a general set of design guidelines and recommendations for the creation of small to medium-scale renewable energy landscapes within a specific region, namely eastern Kansas. Initial design guidelines informed the design of four potential renewable energy landscapes throughout the region along the eastern portion of the Kansas river. Two of the site designs in Eudora and De Soto (KS), were selected for further study by conducting a preference test with the local town's inhabitants and community members. The preference test utilized imagery from the renewable energy sites of both cities to determine respondent's preferences towards renewable energy type (wind and solar) and their attitudes about local scenery, environmental issues, and the importance of renewable energy.

The results suggest that people within eastern Kansas are hesitant to seeing renewable energy within their own landscapes, but that wind energy is preferred to solar energy or some combination of the two. Results also indicated that these people see eastern Kansas landscapes as scenic and that it is important to preserve the scenic attributes and unique character of these landscapes. Results were then used to reform the design guidelines and recommendations previously mentioned and adjust the four potential renewable energy sites accordingly.

Functionality and Aesthetics of Small-Scale Renewable Energy Networks



The need to shift to sustainable resources and designed green energy systems

Nick Ferrara

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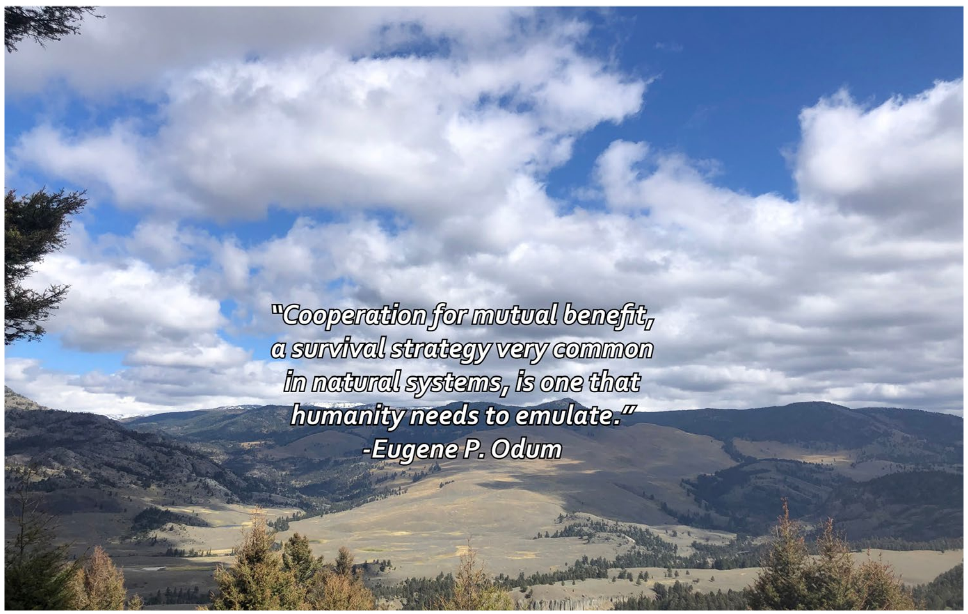

Abstract

Renewable energy is becoming a major part of the energy generating infrastructure used in both the United States and in several nations throughout the world. While there are many technological and engineering issues surrounding renewable energy and its implementation into the current electrical "grid," there are also various social issues with renewable energy related to public perception and appearance within the landscape. Additionally, the current "grid" system in the United States is nationally connected meaning generated energy is created far from where it is consumed. This focus on nationally produced energy has led to the creation of hundreds of transmission lines spanning thousands of miles and at times interrupting scenic landscapes.

The study reported here examines a variety of key texts and case studies to create a general set of design guidelines and recommendations for the creation of small to medium-scale renewable energy landscapes within a specific region, namely eastern Kansas. Initial design guidelines informed the design of four potential renewable energy landscapes throughout the region along the eastern portion of the Kansas river. Two of the site designs in Eudora and De Soto (KS), were selected for further study by conducting a preference test with the local town's inhabitants and community members. The preference test utilized imagery from the renewable energy sites of both cities to determine respondent's preferences towards renewable energy type (wind and solar) and their attitudes about local scenery, environmental issues, and the importance of renewable energy. The results suggest that people within eastern Kansas are hesitant to seeing renewable energy within their own landscapes, but that wind energy is preferred to solar energy or some combination of the two. Results also indicated that these people see eastern Kansas landscapes as scenic and that it is important to preserve the scenic attributes and unique character of these landscapes. Results were then used to reform the design guidelines and recommendations previously mentioned and adjust the four potential renewable energy sites accordingly.

Glossary of Terms & Concepts

Apparatuses: the tools, equipment, or machine that are used for the specific purposes they were designed for; in the case of this study, the renewable energy tools and equipment which consist of the turbines/solar panels themselves, the transmission lines, and the facilities that distribute electricity (Cambridge English Dictionary 2020).

British Thermal Units (Btu): "the measure of the heat content of fuels or energy sources. It is the quantity of heat required to raise the temperature of one pound of liquid water by 1 degree Fahrenheit at the temperature that water has its greatest density (approximately 39 degrees Fahrenheit)" (U.S. Energy Information Administration 2020, "Units and Calculators Explained")

Decarbonization: the reducing of carbon dioxide emissions by using energy sources that generate little to no carbon dioxide which assists in reducing the amount of greenhouse gases released into the atmosphere (The Welding Institute 2020).

Global Horizontal Irradiance: "the total amount of shortwave radiation received from above by a surface horizontal to the ground. This value is of particular interest to photovoltaic installations and includes both Direct Normal Irradiance (DNI) and Diffuse Horizontal Irradiance (DIF)" (Vaisala Energy 2020).

Luxury Energy: energy that is produced and used as an on-demand product paid for by the consumers of energy; the energy used by consumers as they want it; this generally results in higher emissions (Shue 2019).

Photovoltaics: also known as PV, technology concerned with generating electrical energy directly from sunlight using electronic processes that naturally occur within materials called semiconductors. The electrons within these materials are freed by solar energy and can be induced to travel through an electrical circuit and thus create electricity (Solar Energy Industries Association 2020).

Regional Energy Production: the strategy of producing energy at a regional level rather than a national level for the purposes of: creating energy resiliency, generating low-carbon electricity, creating more localized jobs stimulating regional economies, and lowering energy costs for all consumers (Kroh and Gordon 2012).

Renewable Energy: "energy from sources that are naturally replenishing but flow-limited; renewable resources are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time" (U.S. Energy Information Administration 2020).

Subsistence Energy: energy that is produced and used by consumers on a needed basis; the energy used by consumers when they need it; this generally results in lower emissions (Shue 2019).
"The Grid": the network of power plants, transformer stations, major transmission lines and minor distribution lines that deliver electricity from energy producers to consumers (U.S. Energy Information Administration 2020).

Visual Assessment: the evaluation of places and landscapes to assess their overall visual and scenic characteristics for the purposes of preserving their unique qualities (U.S. Bureau of Land Management 2019).

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Introduction - Project Definition

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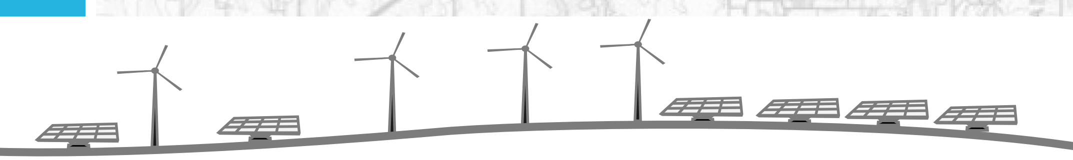

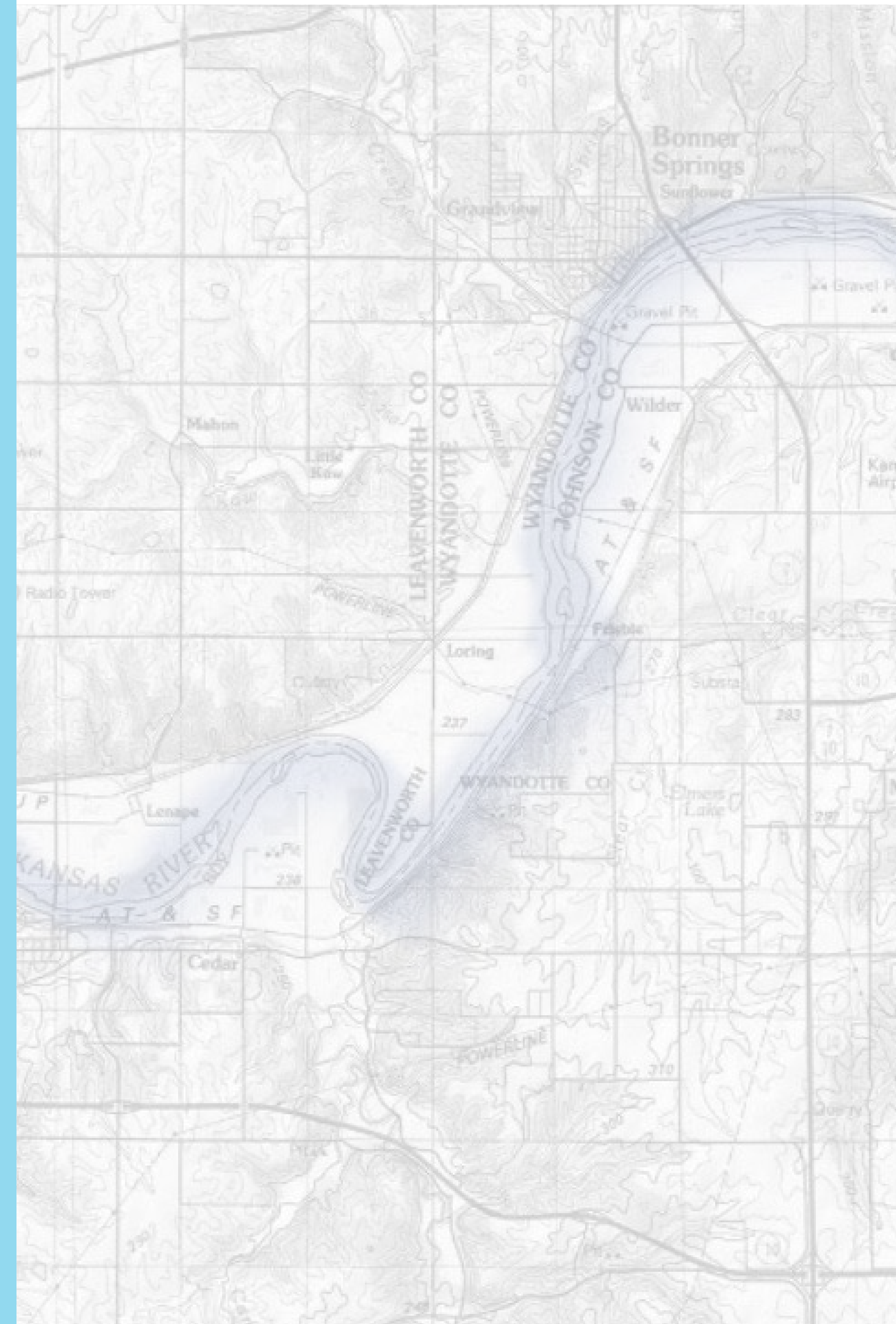

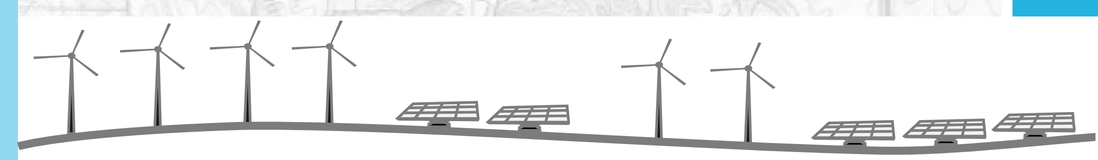

Problem:

Climate change is drastically changing the environment around us. Man's impact on climate is a serious issue that will lead to the migration of plants and animals. Our electricity in the U.S. is primarily produced by the burning of fossil fuels which gives off large amounts of CO_2. According to the U.S. Energy Information Administration, the United States gets about 62% of its electrical power from fossil fuels, about 20% from nuclear energy, and about 18% from renewable energy (U.S. Energy Information Administration 2020). A shift in how we produce and distribute electricity is needed to mitigate the effects of climate change. As a society, we must focus on using renewable sources of energy as well as shifting to using less energy over time. Renewable sources of energy could alter the way our cities, towns, and communities are shaped and could lead to many lifestyle changes.

Question:

The research question for this study is, how do small or medium-scale renewable energy systems fit, or aesthetically appear, in the fabric of our cities, towns, and communities? In *The Renewable Energy Landscape*, by Dean Apostal 2017, the author implies that large scale renewable energy farms are met with backlash as they can have drastic visual impacts on the landscape (Apostal 2017). My project focuses on studying the impacts of installing small-scale renewable energy in the form of rural/local cooperatives near small town communities and how they can be designed to be aesthetically pleasing.

For the purposes of this study, it is best to examine how smaller communities within the Great Plains can adapt to relying on small or medium-scale renewable energy networks for their electrical energy needs. A small to medium-scale renewable energy network would be relevant because it relates to the potential future design of cities and towns as they will have to adapt to the impacts of climate change, exurban migration, and the need to shift from a system of luxury energy to a system of subsistence energy. In this case, luxury energy is the energy used by consumers when they want it, and subsistence energy is energy available to consumers when they need it. To understand this topic more clearly and lead to an answer to the research question, it would be best to examine case studies of smaller renewable energy systems in cities or towns and examine their impacts (both good and bad) on the community. This would involve case study research, interviewing project designers, stakeholders, and engineers. I would like to examine case studies that demonstrate successful (as measured by successful implementation and output) small or medium-scale renewable energy networks and examine them for their strengths, weaknesses, and overall aesthetic appeal to the people that experience them. I would then use this information to write an initial set of design guidelines and policy measures to create a renewable energy pilot project. The project would need to be based in an area where there is both sufficient renewable energy potential and multiple small-town communities to support the idea of creating a small to medium-scale renewable energy network. Therefore, the region of Eastern Kansas along the Kansas River Corridor has been selected as the study region. There are several small-town communities within the area and the renewable energy potential remains high. This region also presents the opportunity to demonstrate how communities can sustainably shift from relying on fossil fuel sources for the creation of electrical energy to renewable sources (such as wind and solar) for the creation of electrical energy.

Background:

The Kansas River has served as a resource for humans since at least 200 B.C. and throughout its history, has provided people with water, food, energy, and valuable mineral resources. The eastern section of the Kansas River corridor is one of the most vital regions of the state as it serves important ecological, economic, and cultural functions. An estimated 40% of the state's population lives along the banks of the river (Kansas Geological Survey 1998). There are various power plants along the river corridor and within the immediate region. Many of them run on fossil fuels apart from the Bowersock Mills & Power Company in Lawrence.

Kansas consumes about 40 TWh (terawatt-hour) each year and produces around 44.5 TWh (US Energy Information Administration 2020). The state and its citizens consumed 1.134 trillion Btu's (British thermal unit) of energy in 2018 or 390 million Btu's per capita leading to the state ranking 16th in the nation for overall energy consumption and 19th overall in energy production (U.S. Energy Information Administration 2020). Overall carbon emissions of the region are not regularly measured, but carbon emissions are measured by how much carbon is emitted at the state level. Kansas emitted 58 million metric tons of CO_2 in 2017, however, this should be encouraging because it is a decrease in emissions from the previous year by about 15.8% (U.S. Energy Information Administration 2017).

The renewable energy potential of the region remains high as much of the state has high wind energy potential according to the National Renewable Energy Laboratory and is seen in the figure below. As of 2019 wind turbines were responsible for most of the energy produced in the state producing 41% of the state's energy production (U.S. Energy Information Administration 2020). Kansas is also recognized as one of the sunniest states in the country with solar potentials ranking near that of Florida, but the state produces little solar energy used as a utility (U.S. Energy Information Administration 2020). The following Figures 1 and 2, from the National Renewable Energy Laboratory, display the overall wind and solar resources potentials in the U.S.

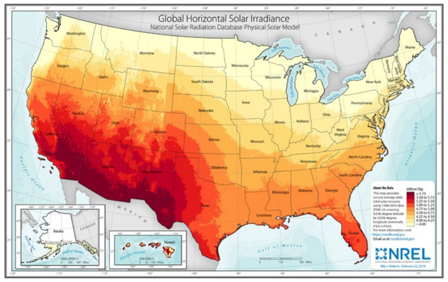

Figure 01: Solar Potential Map of the US – This map displays the solar potential for the whole country. States like Kansas, Texas, & Colorado are dynamic and have a wide range of GHI (National Renewable Energy Laboratory 2020).

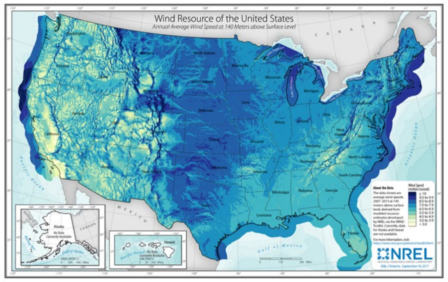

Figure 02: Wind Resources of the United States. Darker blues represent higher wind speeds and thus higher wind renewable energy potentials (National Renewable Energy Laboratory 2020).

Project Process

The research project followed a simple process that allowed for quantifiable results within regards to people's perceptions of renewable energy and how their perceptions impacted the design of renewable energy landscapes. A literature review and the case study analysis provided a stable base of knowledge needed to form the design guidelines which led to the creation of the pilot project. Imagery and graphics from the pilot project will be used in a survey created for the preference study which gathered the necessary information to discern people's perceptions of renewable energy equipment within their local communities. The results of the survey then helped reform the initial design guidelines and led to necessary changes in the pilot project. The figure below summarizes the entire project process the details of each step.

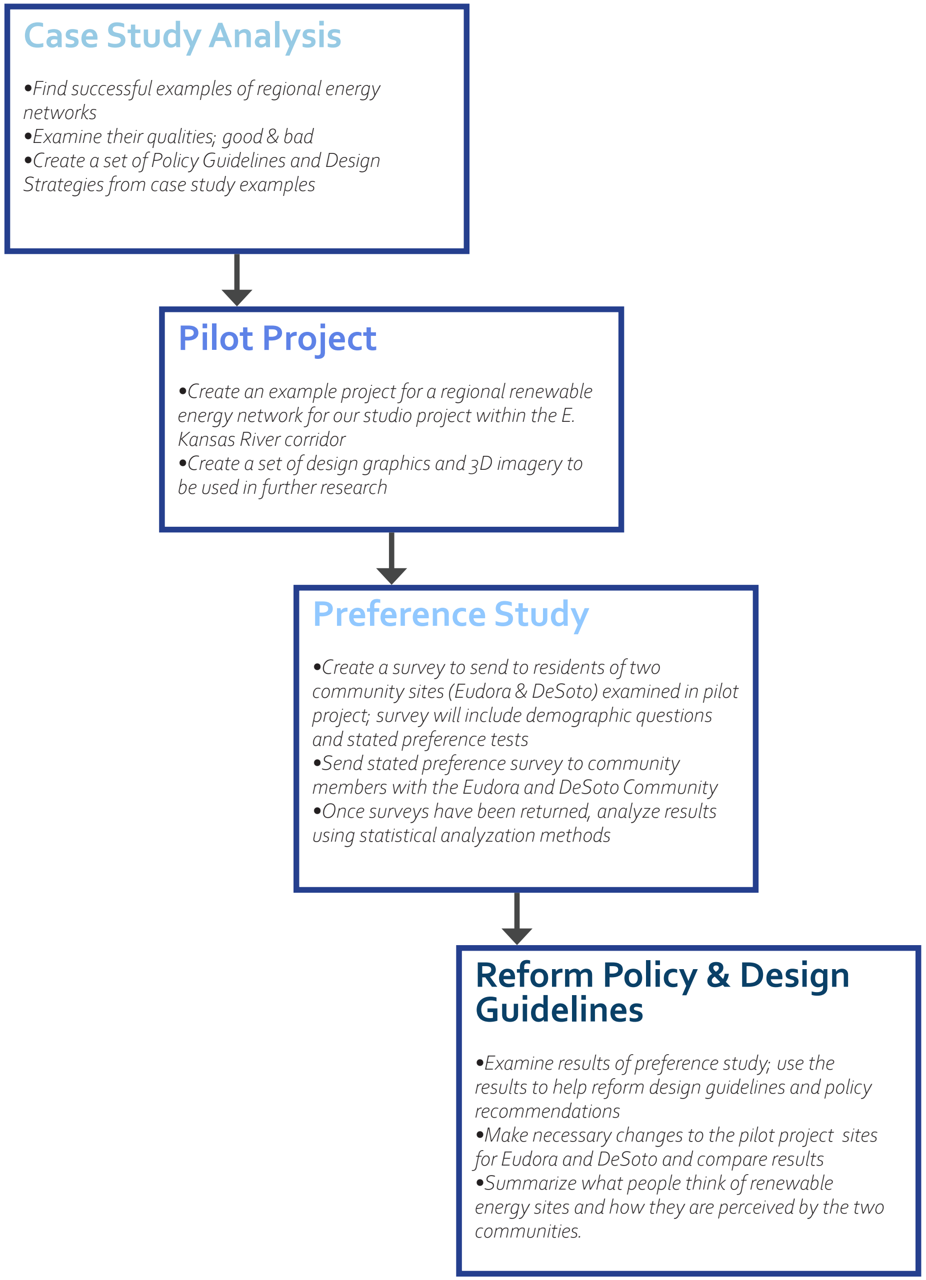

Figure 03: Flow chart diagram that displays the project process followed for the purposes of this study (Ferrara, 2020).

Literature Review

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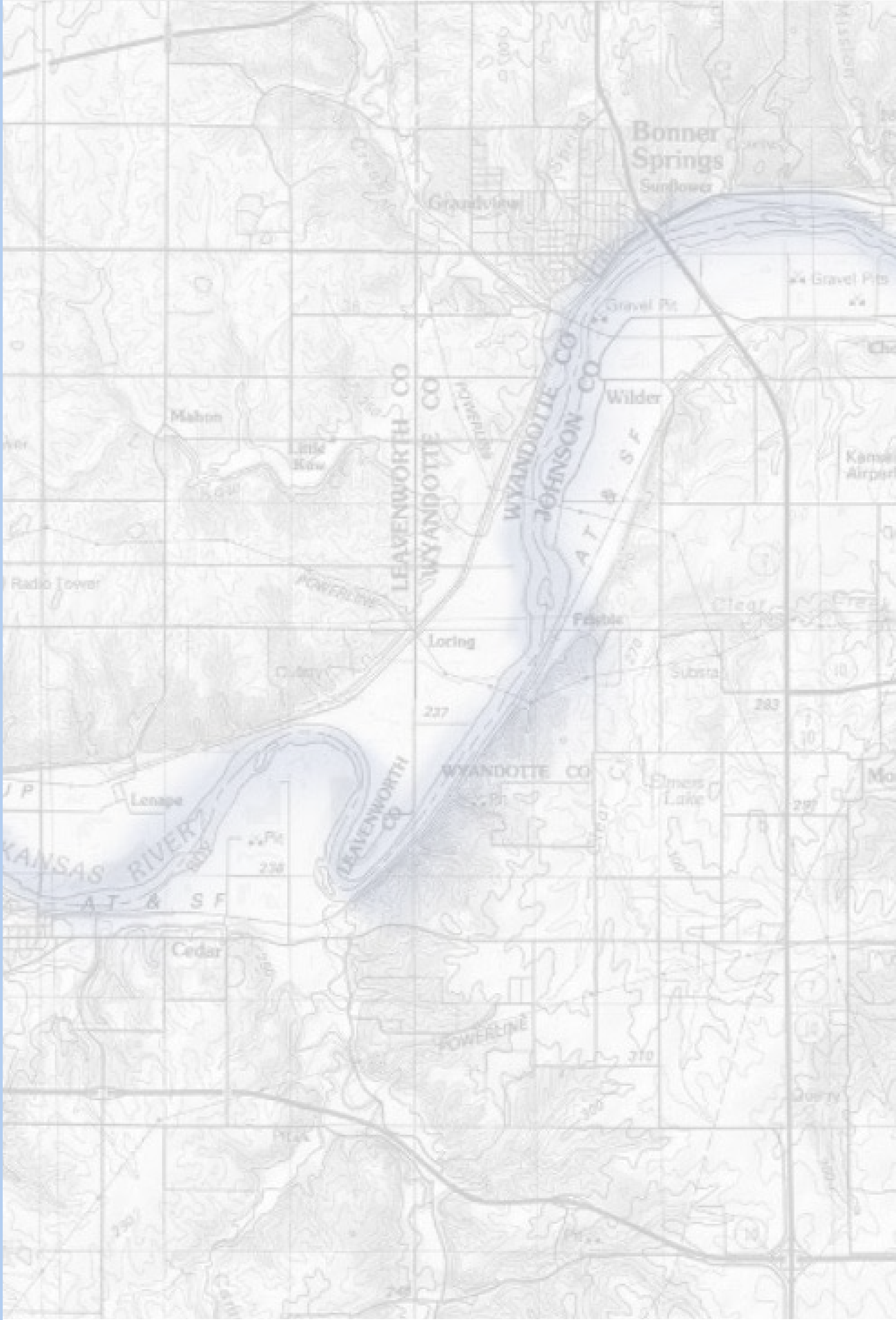

Electricity is at the center of our lives. We use it without even realizing we are using it and with climate change being one of the most drastic issues of our time, we must examine producing energy using more renewable sources. How does renewable energy equipment look when placed or sited on the landscape? My research focuses on how small to medium scale renewable energy systems can lead to more localized energy networks and how these networks are perceived by those who experience these renewable energy landscapes. This involves examining how small towns or communities can be retrofitted to rely upon small scale renewable energy systems. It also involves understanding how renewable energy infrastructure affects how we see space. The placement of undesirable elements, or messy elements, on the landscape, reminds me of what Joan Nassauer discussed in her highly regarded article "Messy Ecosystems, Orderly Frames." She is analyzing what a "natural" or an ecologically sound landscape looks like and what designers should do to support the needs of nature and humanity (Nassauer 1995, 161). In the same way, there are specific problems we as designers must approach when designing renewable energy installations so that these systems are not only producing energy, but that they are also working with the land to preserve its identity and character.

Areas of Concern:

The subtopics to be reviewed include areas that are specifically related to both small-scale renewable energy and landscape aesthetics. The subtopics were chosen as frequent themes within the articles, books, and references collected for this literature review. Several key texts from these subtopics are also discussed as they contain highly relevant information about renewable energy The first subtopic is grid changes which studies how the current energy grid would change as a result of implementing renewable energy systems. I examine both landscape changes and technical changes to energy systems. The next subtopic is apparatuses and equipment which examines how both solar and wind farms are sited and designed and the impacts they have on a given site. The third subtopic discussed is the effect of energy & aesthetics on communities. This section will examine how energy issues have been historically addressed, how small communities are impacted by current trends, and how social issues impact energy production. The final subtopic is regional scale energy production, which will explain how energy production is viewed nationally in the U.S. and provide case study examples where regional scale energy production has been successful.

Grid Flexibility:

Renewable energy brings significant changes to both the landscape and the way that the energy grid functions. It is important to understand how the integration of renewable energy systems will impact grid operations so that the new systems can be effectively managed and that natural uncertainties can be dealt with. Investing in renewable energy research and infrastructure now will inevitably pay off for future generations and lead to a more flexible energy grid (Jones et al. 2014, 11).

Landscape Changes:

Renewable energy undoubtedly changes how we, as humans, see the landscape, especially those that we deem to be scenic. In the book *The Renewable Energy Landscape: preserving scenic values in our sustainable future* by Dean Apostol (2017), the author explains the importance of understanding the imposition of such renewable energy farms or sites. He writes about what needs to be done to combat landscape issues facing renewable energy which include issues of size and scale, visual assessment, lack of mitigation and policy framework, but most interestingly he notes that there is a lack of relevant landscape perception studies regarding renewable energy systems (Apostal 2017, 10). Visual and scenic resource assessment is conducted in a variety of ways, but most assessments are determined using existing governmental standards. In the US, many of these standards stem from federal agencies that provide highly generalized and blanketed policies while there are little regulatory measures for visual resource management from local and state levels (Apostal 2017, 11). Assessing visual characteristics of landscapes also presents various challenges around site selection. These systems of producing energy can often be overwhelming to the point where site specific challenges may arise (Apostal 2017, 19). Half of Apostal's book provides conservationists, policymakers, designers, and energy providers with a toolbox of scenic conservation ideas, approaches, and methods that can have a positive effect on the implementation of these systems. These approaches are generally used or applied to large scale renewable energy systems but could just as easily be applied to medium to small scale systems or networks. In Europe, where towns are much more compact and space is not a luxury, strategic regional planning is used to site renewable energy installments so that pre-existing plans and developments are not disturbed and to ensure that the visual capacity of the landscape is not compromised (Apostal 2017, 88). Landscape changes also involve adapting existing land and land planning measures to meet the needs of renewable energy equipment so that the full potential of renewable energy equipment can be achieved. This requires designers and planners to create energy-conscious concepts and regional plans. A study performed in the Netherlands called "Incorporating Renewable Energy Science in Regional Landscape Design: Results from a Competition in The Netherlands" (2015) examines this very subject. The authors of the article focus on four key strategies that designers and planners should employ to be energy conscious.

The first strategy focuses on reductions in energy demand to create less energy waste and promote energy efficiency (Waal et al. 2015, 4810). The second strategy examined is the diversity of energy supply which involves relying on more than one source of energy. This strategy also makes it crucial for designers to consider siting and landscape analysis so that the greatest output can be achieved from renewable energy systems (Waal et al. 2015, 4810). Next, it is vital that the reduction of fossil fuel emissions when fossil fuels are the only source of energy available to a given place or region. Carbon Capture & Storage is a useful technique that curbs some of the negative effects of fossil fuels while the transition from fossil fuels to renewable energy takes place (Waal et al. 2015, 4811). The final strategy discussed is the consideration of the energy system components which involves the actual conversion of the energy, its transmission, and how the energy is stored. The changes renewable energy bring to these elements are going to impact our image and interpretation of the landscape (Waal et al. 2015, 4811).

Visual interruptions can drastically change our understanding of the land that surrounds them. Our sense of space, scale, and atmosphere can entirely change if a big tree falls in our yard, or if a new tower is built in an urban environment. The thought of constructing multiple towers to support wind turbines or arranging solar arrays on large swaths of land could have serious visual ramifications. One study called "Wind turbines location: How many and how far?" discusses the negative impacts of wind turbines, how many were visible, and the distances of the wind turbines from the observer (Betakova et al. 2015). The researchers found that landscapes with the highest levels of aesthetic value were evaluated to have been most impacted by the addition of wind turbines. In the same study, they also found that those landscapes with the least aesthetic value were evaluated to have been least impacted by the addition of wind turbines within the landscape (Betakova et al. 2015, 30). Using a set of predetermined images, researchers found that distance from the wind turbines played a major role in how favorable respondents found the images. The researchers also found that the number of wind turbines within the image plays a huge role in how favorable respondents found

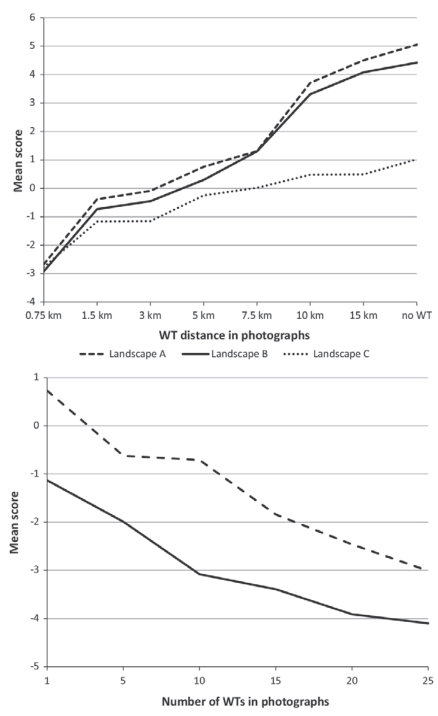

Figure 04: Graphs that display how respondents scored landscape based on how far they were from the wind turbines (left) and how respondents scored landscape based on the number of wind turbines within the photograph (right) (Betakova et al. 2015, 27).

the images (Betakova et al. 2015). The graphs below present their findings.

Technical Changes:

A variety of technical changes to the way we produce energy would also be necessary to pursue not only a state of decarbonization, but also an energy grid that focuses less on luxury energy and more on subsistence energy. There are various kinds of technical changes that can and will be made to energy grids across the country and at a variety of scales. From massive power grids that transmit electricity to southern California to small scale electrical generation for farms in Minnesota, technical changes to the energy grid will have major impacts on how society uses energy.

A report "Avangrid Renewables Tule Wind Farm: Demonstration of Capability to Provide Essential Grid Services" from California ISO, Avangrid Renewables, GE, and the NREL looks at how well a wind-powered large-scale farm can provide ancillary generation, or secondary services, to the electrical energy grid in California. What makes this farm significant is the Power Plant Controller (PPC) system developed by GE. It regulates the wind farm to act as one single generation unit would. The following tests are to see how well the entire system functions. It features Automatic Generation Control tests, Frequency Controls, and Reactive Power and Voltage Control Tests (Loutan & Vahan 2020, 17). The study found that wind power plant (WPP), was able to regulate the flow of energy both up and down as demand increased or decreased. It also demonstrated the ability of the system to respond to spikes in energy consumption and immediately inform the system which runs the grid to ramp production and control the voltage along transmission lines (Loutan

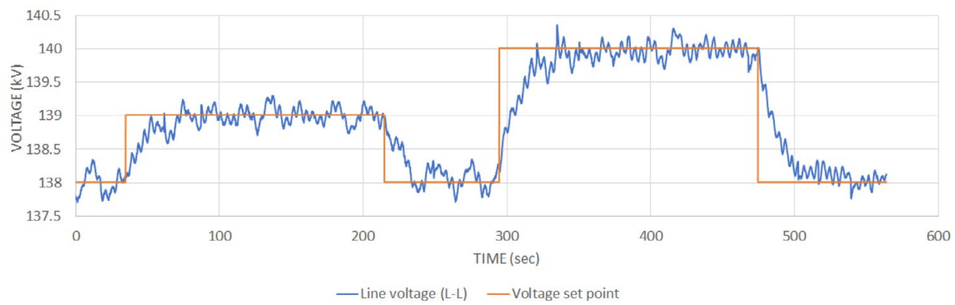

Figure 05: *Graph that shows how the system at the Avangrid Renewables Tule Wind Farm responds to changes in the set Voltage of the system. As shown above, the system can respond quickly to changes in the voltage set point (Loutan & Vahan 2020).*

& Vahan 2020). The figure below displays the results of a voltage test at the Avangrid Renewables Tule Wind Farm.

Similarly, but at a much smaller scale, a research project undertaken by a student at the University of Minnesota called "Optimizing Renewable Electric Energy Generation on Minnesota Dairy Farms" looks at the feasibility of renewable energy generation on Minnesota dairy farms and how it can reduce their carbon footprint. With three solar arrays and two wind turbines, the project looked at monitoring energy consumption using a variety of methods from several countries to determine the efficiency of the systems (Reese 2017). It was determined that the most energy consumptive part of the dairy farm was milk cooling which made 31% of the overall energy consumption with water heating and milking each averaging about 20% of the overall energy consumption (Reese 2017, 14). Although the project did not prove to be totally carbon free, it did result in a 32% net reduction of fossil fuels used to power the farm and proved that small-scale renewable energy does contribute to the reduction of carbon footprint (Reese 2017).

Another work from Lawrence Jones titled Renewable Energy Integration: Practical Management of Variability, Uncertainty, and Flexibility in Power Grids looks at how implementing renewables will affect not only the grid, but the energy markets as well. The book takes a slightly different approach to renewable energy, however, as it examines the potential of a global energy grid to harness renewable energy which could happen for three reasons (Jones 2014). The need to harvest remote energy resources, taking advantage of peak energy periods between continents and economic benefits associated with selling power globally are all reasons why a global energy grid would be possible (Jones 2014, 176). A global energy network would certainly lead to mass production of "green" energy, but this also presents several limitations at the social, economic, and political levels. Such a system would require massive capital upfront and would take 18-35 years before nations see a return on investments (Jones 2014, 184).

The flexibility of our energy grids must be fully understood if renewable energy is to continue to grow as a more common source of energy. These renewable energy systems must be able to work with current grid contributors and function in primary and secondary roles for the energy grid. It is also important to consider the possible impact of the renewable energy equipment itself as it could lead to changes in how we see the landscape and how the environments they are in are impacted visually and environmentally.

Apparatuses & Equipment

The actual components of wind and solar energy, the wind turbines and solar panels themselves, play an important role in the selection of sites, the design of renewable energy systems, and ultimately the impacts these systems will have on a given landscape. The typical wind turbine that stands around 260 feet tall generally generate about 1.8 megawatts of electrical power (National Geographic 2019). The typical solar installation needs about 100 square feet for every 1kW of energy desired which means that a 1 MW PV solar power plant would need to be about 2.5 acres in size (Landmark Dividend 2019). Renewable energy equipment also presents challenges with transmission, storage of energy for peak times, and negative impacts on wildlife.

Site Selection:

When considering new sites for renewable energy, a variety of factors must be considered for the benefit of both the land and the generation of energy. Site selection plays an important role in more than just energy generation, but also in energy conservation. A fairly well-known text from 1977 called *Landscape Planning for Energy Conservation* by Gary Robinette examine how landscape design must thoroughly examines sites by understanding the local region, it's climate, and the micro-climate of the site so that designs maximize the ability of a location to conserve both resources and energy (Robinette 1977). Sites must be analyzed so that overlapping areas of solar and wind potentials are utilized for optimum development locations. The orientation of structures, elements, and areas of activity also leads to the preservation of the natural character and scenic values a site has to offer (Robinette 1977, 96). Whereas Robinette was concerned with landscape design that could conserve energy and limit the potential impacts of solar and wind patterns, this literature review seeks to examine landscapes that can be designed to capitalize on the power of both solar and wind energy. Although the overall goals are different, the methods of site analysis are the same. Designers must determine how much sun or wind the site receives, how often, the peak times of day, existing site impediments, seasonal patterns, and ways in which the terrain must be manipulated to ensure the greatest solar and/or wind potential of the site (Robinette 1977, 137). The figure on the right displays general on-site solar panel applications.

A study from Brazil looks at the similar ideas discussed by Robinette. The study is titled "Electric energy generation from small-scale solar and wind power in Brazil," and it examines how location, area, and shape play

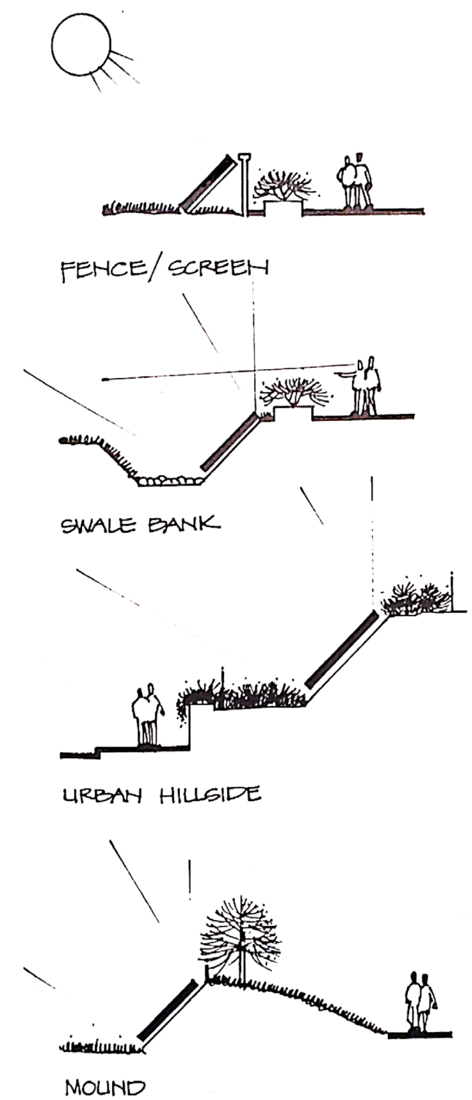

Figure 06: *The solar applications depicted above demonstrate how solar panels can be screened from view while remaining effective and face sunlight (Robinette 1977).*

a role in small-scale renewable energy generation (Ribeiro et al. 2015). The study looks at two sites and examines them in four stages. Stage 1 looked at the location, area, and shape, stage 2 looked at the arrangement of renewable energy systems, stage 3 looked at the amount of energy harnessed and the best possible arrangement, and stage 4 compared the two sites in a comparative analysis (Ribeiro et al. 2015, 556-557). The results showed that site location has a strong influence on the arrangement of PV panels, the separation between them, and the number of panels on the site. For wind turbines, it was observed that location does not directly impact the arrangement of towers on the site. The study did demonstrate that site area and location are important factors for both solar and wind systems in determining overall energy production, while the shape and arrangement of the system only impacted solar energy apparatuses (Ribeiro et al. 2015, 561-562).

System Design & Design Methods:

Renewable energy systems are designed for the site. There is no generic copy and paste system that can be applied time and time again on a variety of sites and scales. When considering small-scale wind power, we must first determine what it is. In the book titled Small-Scale Wind Power: design, analysis, and environmental impacts, author J.P. Abraham and Brian Plourde define it as, "wind energy that is generated at the site of utilization and is typically in the few kilowatt range. Small-scale wind turbines are often connected directly to the devices that require electricity, or more commonly, to a power charging station such as a battery array" (Abraham & Plourde 2014, 2). These wind systems can take a variety of forms and functions in several applications which include use at the residential, commercial, and social/public levels (Abraham & Plourde 2014, 7). These systems present various advantages and opportunities to communities and individuals, the most significant of which is that it reduces dependence on grid-level power systems. This is especially important in rural and outlying areas outages and power connectivity is difficult (Abraham & Plourde 2014, 9). There are also disadvantages and limitations to small-scale wind systems. The cost of installation and maintenance of the wind energy system must be compared to the cost of other energies to determine if the system is monetarily viable. Issues also arise with wind availability and variability meaning that site-specific courses of action must be programmed into the control electronics of the system so that constant power to the system can be maintained (Abraham & Plourde 2014, 13). Additionally, some people may protest the construction and implementation of such systems which is why necessary steps must be taken to ensure the character of the site and community are preserved.

There are several methods and approaches used in the design of renewable energy sites and various organizations which have created standards for how to properly design them. Some of the most recognized and widely consulted works and organizations focused on the design of wind farms include:

1) ***The European Wind Energy Association (EWEA): European Best Practice Guidelines for Wind Energy Development***
2) ***The American Wind Energy Association (AWEA): Wind Energy Siting Handbook, the AWEA fact sheets and the standards for wind energy industry***
3) ***The British Wind Energy Association (BWEA or RenewableUK): Best Practice Guidelines for Wind Energy Development***
4) ***Wind Energy Handbook, Chapter 9: Wind-turbine Installations and Wind Farms (Herbert-Acero et al. 2014).***

Wind farm design and sizing is dependent upon several factors including site size, geographic region, and expected power demand. It is important to consider the specific spatial coordinates of individual wind turbines, how they are connected, and the communication and engineering infrastructure associated with the installation. Wind farm designers must also conduct economic simulations to account for the available incentives and quantify the expected economic profits of the renewable energy system (Herbert-Acero et al. 2014, 6933).

Solar energy has been used throughout history for a variety of practices such as drying, disinfecting, and curing, but in the past few decades, there has been a shift in how humanity uses solar energy. Solar panels have allowed us to collect solar irradiation from the sun and convert it into electricity to power our homes and facilities. Chapter 5 of *Wind and Solar Based Energy Systems for Communities* titled "Community-level solar thermal systems" examines a study conducted in India looking at how solar energy can be used to provide hot water for households within a given community. The researchers identify two key strategies for the utilization of solar energy: 1) non-concentrated type collectors that are used for lower temperature applications and 2) concentrated type collectors that are used for higher temperature applications (Carriveau et al. 2018, 98). Here the non-concentrated type collectors are used for water and air heating, hot air drying, and passive building heating while the concentrate type collectors, which are far more powerful, are used for steam generation, industrial processes, and electrical power generation. (Carriveau et al. 2018, 98). These concentrated collectors are those more likely to be found at solar energy generation plants or solar arrays. Focusing on concentrating photovoltaic (PV) panels together for small-medium scale energy generation is crucial to system success and as indicated in the chapter, they show real promise for being applied in a variety of circumstances.

Wind turbines and solar panels as equipment themselves do not have to look and be designed in the typical ways that we always think about them. Before wind turbines were utilized to produce energy, windmills were used to mill grain and pump water in smaller towns and especially in the rural farm settings. Today, we have diverged from the original purposes of the windmill, but the concept has remained the same only our windmills are much larger, and they are all painted white. However, who says this is the only way to make windmills? Can windmills take different form or can solar panels be shaped into other non-rectangular forms? An article in Landscape Architecture Magazine titled The Art of Infrastructure by Timothy Schuler looks at these questions. He cites the levels of opposition that wind turbines faced at the beginning of the 21st century and notes that as more turbines are erected across the landscape they will become more noticeable and lead to serious visual changes in the landscape (Schuler 2017). Mitigating these intrusions in the landscape can be done in several ways, but the Land Art Generator Initiative (LAGI) seeks to change the way we design renewable energy generation systems and seriously consider how they can be designed to function well and be aesthetically pleasing (Schuler 2017). The LAGI puts on a design competition every year usually providing a prompt and a given site for people to work with. The power generation systems produced because of the competition present unique ways

Figure 07: *Image that shows a different approach to the design of wind turbines that does not use any turbine blades. Instead, the vertical elements are lined with grooves that allow them to harness wind and convert it into energy (Schuler, Dalziel + Scullion, Qmulus Ltd., Yeadon Space Agency, and ZM Architecture 2017).*

of looking at how energy designs can be site specific and how these can be closer to reality than we think (Schuler 2017). Another design project that took place in Glasgow, Scotland looked at a similar solution for the community and a team of landscape architects and designers worked together to produce wind turbines that have no blades and instead use a series of groves. These highly sculptural elements were to be sited on a brownfield site that had been an eyesore to the town, but with this project the site would ultimately become a kind of park power plant (Schuler 2017). As landscape architects and designers, it is our place to not only serve people and communities through our regular practices, but to also be the innovators that come up with unique and reliable designs for products that work for the communities we serve. The figure above displays an example of artful infrastructure for a renewable energy site in Scotland.

Impacts:

Renewable energies, like any source of energy, have an impact on the environment they are a part of. There are visual, ecological, and societal changes that occur and these often vary in degree and scale depending on the location and scale of the energy system or network. Wind and solar systems can produce a myriad of challenges and if careful siting is not considered or a system is not designed to meet the needs of the community it serves, it could result in unpredictable problems with costly solutions (Robinette 1977). With both wind and solar, there are serious ecological concerns. Solar energy can present issues with reflection, glare, and a refracted light. Wind energy presents habitat issues with animal communities and can harm certain avian species. A study conducted at Kansas State University titled "Environmental Impacts of Wind Power Development on the Population Biology of Greater Prairie-Chickens" investigates seven potential impacts of wind farms on the great prairie chicken, a unique species indigenous to Kansas. The study examined lek (mating ritual) attendance, mating behavior, use of breeding habitat, fecundity rate, dispersal, population numbers, and survival rates (Sandercock 2012). They discovered that greater prairie chickens were not as heavily impacted by wind farms as first thoughts might have suggested. There were some impacts on lek behavior around wind farms and certain behaviors indicate their attempt to avoid areas around wind turbines themselves, but they also found there were no impacts on nesting, female reproductive success, or population numbers (Sandercock 201, 3). Additionally, they discovered a positive impact that these turbines had on female survival rates citing that turbines increased survival rates especially when females were in their nesting period because the turbines helped to ward off predator species (Sandercock 2012, 52). The ecological effects of renewable energy do exist, but it is also important to ask what the ecological effects of not embracing renewable energy are and what dire situations face the environment because of fossil fuel energies. It is a matter of weighing the situations and determining which is the greater threat. Still, others complain about the visual impacts of renewable energy, mainly in the development of wind energy.

In the book Wind Power in View: Energy Landscapes in a Crowded World authors Martin Pasqualetti, Paul Gipe, and Robert Righter examine what visual impacts stem from the wind turbines themselves and what can be done about them. The authors pose an interesting idea at the beginning of the book regarding what renewable energy means for landscape when they ask, "To what degree are we willing to give up landscape quality for qualities of life?" They argue that while fossil fuel energies make our lives easier, we often must sacrifice the quality of our landscapes especially when those fossil fuel energy centers cause unnecessary waste. The author counters with another question saying, "We are not asking anything new; rather, it is a question of how to best balance the nature we want with the energy need" (Gipe et al. 2002, 3). The authors go on to argue that the wind turbines of energy farms today are not all that different from the picturesque stone or wood windmills found throughout Europe or the utilitarian farming windmills found on the American plains in the 19th and 20th centuries. The argument that most people have with wind energy is not that it is a bad thing or that they are opposed to it, but they are opposed to the idea of medium to large scale wind farms being sited near them, citing the "not in my backyard" or NIMBY policy (Gipe et al. 2002, 12). Renewable energy, in particular wind energy

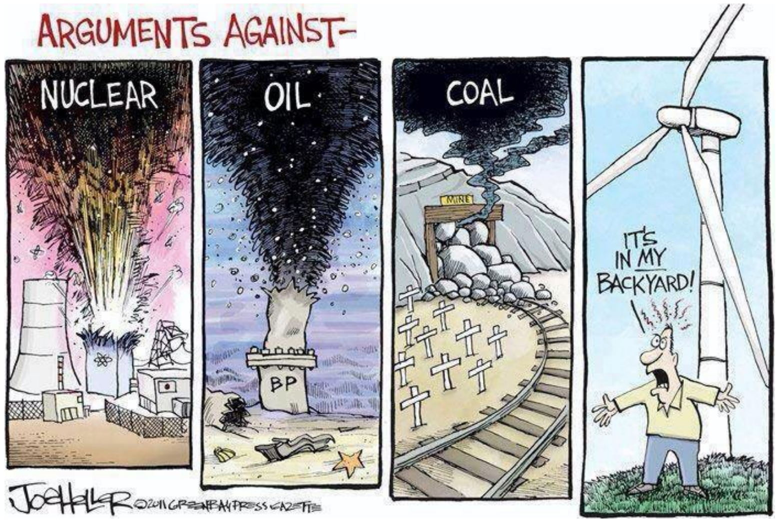

Figure 08: The cartoon depicts the commonly understood dilemmas and problems with nuclear energy plants, offshore oil rigs, coal mines, and wind turbines. The first three present disastrous problems while the final image presents a commonly understood issue (Heller 2011).

systems, is seen by some as visual impediments that impact how we see the landscape, but it is important to put this idea of visual impediments into context. The spaces, places, and landscapes we encounter regularly are almost all impacted by visual impairments in the form of buildings, trees, radio towers, airplanes, and several other objects. That is why renewable energy infrastructure must be treated like other new building or development projects. Impacts must be accessed, the communities voice in the matter must be heard, and guidelines must be followed to ensure the future of renewable energy sources (Gipe et al. 2002, 177).

The installation of renewable energy infrastructure will undoubtedly change how we see the land, but there are various design methods, principles, and guidelines that can be used to ensure that there are minimal impacts upon the landscape both visually and environmentally. There are also clever designs and unique ways of rethinking how the renewable energy apparatuses and equipment are shaped and used within the landscape. Energy has also played a major role in how our communities are formed, how they grow, and how they function. Figure 8 above is a cartoon that demonstrates the commonly understood concept of NIMBY.

Effects on Communities

Energy has impacted how our communities have been shaped throughout human history. In the early 20th century, energy was mainly only available in large urban centers and rural communities were in desperate need of reliable sources of energy. Energy has also continued to influence how we function in today's society. We have become accustomed to the idea that energy is available on demand provided the consumer pay for it. A shift to renewable energy is more than just a shift from one energy source to another. It could also mean a shift in how we live our daily lives.

Historical & Contemporary Trends

Historically, energy and access to energy have been an important concern to many people and the government over the past 100 years. Many of the agencies developed under the New Deal in the 1930s, were concerned with access and the use of public infrastructure and utilities. Programs such as the Rural Electrification Administration (REA) and the Tennessee Valley Authority (TVA) helped to bring electricity to rural areas and set up various electrical generation systems along rivers and reservoirs throughout the country. In the article called "Flip the Switch" from Carl Kitchens and Price Fishback (2015), the situation of providing energy in the 1930s is examined as well as the impacts the Rural Electrification Administration had in providing farm and farm towns with electricity. Through economic support and loan programs, the REA managed to increase rural farm electrification by 230% which brought increases in both crop productivity and output (Kitchens and Fishback 2015, 1161). The REA also managed to bring about increases to land value and the value of farm structures including barns, silos, and farming

storage facilities (Kitchens and Fishback 2015, 1181). Without the economic and financial support of the REA, many small-medium sized farms would have gone completely bankrupt because without electricity farms could not sustainably continue operations. Today, many rural communities and towns face new issues primarily concerned with declines in their populations and shrinkage of community character.

Brian Alexander, a journalist at The Atlantic, wrote an article titled "What America is Losing as Its Small Towns Struggle" which examines an older article from the same magazine discussing the importance of small towns and communities in America and how it translates to trends in our society now. The New Deal and many of its programs had given small towns and communities a fighting chance both economically and infrastructurally, but in today's world, small-town America struggles primarily because there is often little incentive for young people to return to their home towns. The author notes this, "Small towns have always risked losing young people for good, but especially after the Great Recession, the American economy has conspired against returners" (Alexander 2017). With few industries, massively scaled farming, and lowering wages, young people had little choice and opportunity to return to their hometowns. Due to these problems, many people worry that the nation will lose not just its small towns, but also its character. The places that many people have come to know and love for their charming nature and unique character are at risk of vanishing because of current trends (Alexander 2017). Despite these problems, there are efforts to revitalize and rejuvenate rural towns throughout America, but Alexander argues that these towns

Figure 09: *Gadsden, Alabama is one of the many smaller towns throughout America. Small towns face several issues as we continue into the 21st century regarding job creation, loss of economy, and shifting human populations (Pixaby 2016).*

need to consider what goals they want to set and keep an open mind to the opportunities that present themselves to it (Alexander 2017). Figure 9 shows one of the many small towns throughout America.

Perception of Land

As landscape architects, it is obviously important that we understand how the clients, communities, and user groups we serve perceive landscapes. Much has been written on the subject, but in order to understand the key principles of landscape perception that pertain to renewable energy landscapes, there are a couple of key texts that can help understand the concepts of perceiving and understanding land. Both texts challenge the normal ways that people and society see and perceive the landscape and attempt to establish a new way of looking at what it means for any landscape to possess scenic value or be considered a visual amenity.

In America, the round or oval trees, regularly trimmed shrubs, and the pristinely cut green lawn are the marks of a maintained yard and well-kept home. The picturesque views we see in paintings or in photographs taken so literally in our society that we attempt to emulate them in our cities, towns, and neighborhoods. In "Messy Ecosystems, Orderly Frames" originally published in the Landscape Journal, Joan Nassauer makes the argument that these picturesque notions of landscape

are mistaken for ecological quality (Nassauer 1995, 161). In fact, she argues that many times when we try and recreate picturesque or scenic landscapes, we often cause more environmental harm than good. She argues that landscape architects must find ways to bring ecologically sound landscapes to the forefront so that we can show how unfamiliar systems and forms can be presented in beautiful ways (Nassauer 1995, 161). She also makes comments discussing how ecological function must be presented in the landscape for human experience so that landscapes are understood and maintained in ecological ways (Nassauer 1995, 163). She concludes her thoughts with, "Orderly frames are not a means of dominating ecological phenomena for the sake of human pleasure. Orderly frames can be used to construct a widely recognizable cultural framework for ecological quality" (Nassauer 1995, 169). Figure 10 captures the idea of messy ecosystems and orderly

Figure 10: *What Nassauer refers to as "messy ecosystems within orderly frames" is well encapsulated in this image. This is the town of Parung Kuda in Indonesia. The town itself is centrally oriented with rice paddy farmlands around it. Although the landscape in the image is not what we consider neat or tidy, it is a well-taken care of orderly system. This visualization demonstrates how landscapes can be "messy" yet maintain a basic orderly system ecologically (Fisk 2018).*

frames. In simpler terms, she is saying that the parameters of landscape design do not need to control nature, rather our designs should focus on creating systems so the people we design for can see and recognize the benefit of ecological quality. This reading relates to renewable energy in many ways. As landscape architects, we can design landscapes to support renewable energy systems and demonstrate their benefits. In other words, to design for renewable energy there must be ordered landscape systems based upon policy and guidelines, so we can create well-designed networks.

Creating landscape systems must also be considered from a theoretical perspective. Landscape management is practiced by more than just designers. It includes homeowners, municipalities, and even the Federal government through agencies such as the Bureau of Land Management (BLM) and the U.S. Forest Service (USFS). The work titled "Landscape Perception: Research, Application, and Theory" discussed how landscape perception was understood at the time it was written (1982) and what concepts are used to determine if a landscape has value. The USFS and the BLM follow federal legislation which mandates they maintain and care for the scenic areas of our lands which sparked a new body of research regarding assessing landscape value (Zube et al. 1982, 2). The study examined various works discussing landscape perception or aesthetic landscape value and it found there were four emerging understandings or paradigms which include 1) the expert paradigm, 2) the psychological paradigm, 3) the cognitive paradigm, and 4) the experiential paradigm (Zube et al. 1982, 8). The authors found that in order to move to a theory of landscape perception, the

interaction between humans, the landscape, and the outcomes must be assessed and analyzed for how landscapes improve well-being and quality of life (Zube et al. 1982, 24). Overall, the review found there is a lack of a central theory of landscape perception.

Subsistence Energy vs Luxury Energy

With impending changes to the climate and the way we produce our energy, there are other concerns that must also be addressed involving the amount of energy people use. Many nations throughout the world have power available to their citizens on demand without limit to how much you want to use (provided you pay your electric bill every month). With changing climates and energy production methods, society must shift from a lifestyle of luxury energy, where energy is used as wanted, to a lifestyle of subsistence energy, where energy is used as needed.

Author Henry Shue has written extensively on this subject. His article first published in 1993 in the Law & Policy journal called "Subsistence Emissions vs Luxury Emissions" covers The United Nations early approach to handling issues of climate change in the early 1990s. The author asks four questions to understand how costs will be allocated to address issues surrounding changes in production, social changes, and economic changes and how much emissions should each nation be allowed to produce? The article makes many suggestions about how the U.N. should proceed, but ultimately, he concludes that it would be wrong to demand all nations equally begin remediation practices. Not all nations are as fortunate as others and Shue makes this clear when he says, "The central point about equity is that it is not equitable to ask some people to surrender necessities so that other people can retain luxuries" (Shue 1993, 56). For example, Shue argues that a "least-cost" measure approach where the incremental costs for reducing emissions are based on an ability to pay scheme. Shue argues this would be a fundamentally viable approach to the problem and that it could certainly lead to the reduction of emissions of greenhouse gases (Shue 1993, 56). In terms of energy and the production of energy, those nations with the greatest ability to switch from fossil fuels to renewable energy ought to front most of the costs while those people of poorer nations (or poorer areas within large nations) should not be expected to pay as much for such a drastic change. This idea has undoubtedly been highly disputed, however, Shue wrote another article as a response. Shue's recent article from 2019 titled "Subsistence protection and mitigation ambition: Necessities, economic and climatic" notes that the previous article was reflective of what was going on at the time this new article certainly expresses more urgency. Shue argues that now societies must make alternative energy more accessible and affordable for the poorest populations and that ultimately subsistence energy is highly tied with lifting the poor out of poverty (Shue 2019, 254). The change from fossil fuel energy to renewable energy is more important now than it was in 1993, especially when you consider the rapid development of some nations (India and China) over the past three decades. The fossil fuel regime threatens all people and thousands of other species and Shue accurately concludes the luxury vs. subsistence energy situation with,

"this necessary transition to an alternative energy regime can take any of several sharply different economic and political paths. It would be contemptible to choose – or blunder into – a path on which the sacrifices were imposed on those struggling away from the threatening edge of subsistence tomorrow, by those consuming along in the secure lap of luxury today" (Shue 2019, 259).

Social Challenges to Renewable Energy

The social challenges associated with renewable energy have posited serious concern as they hold back the transition from fossil fuels to renewable energy. The main challenge is often concerned with the cost of implementing renewable energy infrastructure. It is generally, cheaper to produce energy via fossil fuels, but there are also other barriers holding back renewable energy and some even have to do with the landscape itself. Still, regionally integrated renewable energy systems must work with the resources available and meet the social needs of the communities if such systems are to be successful.

"Social Barriers to Renewable Energy Landscapes" by Martin Pasqualetti, is a work that has examined the various challenges that renewable energy poses to conventional resources and why people often resist the shift from fossil fuels to renewable energy. The author examines barriers to the three major forms of renewable energy: geothermal power, solar power, and wind power. With all three forms, each sees issues concerning footprint, lack of designated resource in certain areas, and site-specific issues regarding property rights, views, and municipal limitations (Pasqualetti 2019). If these issues are not properly addressed by those who support renewable energy, then there will be continuous increases to greenhouse gas emissions, continued use of fossil fuels, and stronger turns toward the importation of energy (Pasqualetti

2019, 218). To solve the challenges of renewable energy, there are three key steps to follow. They are:

1) attend to social considerations just as much as technical considerations, 2) thoroughly analyze sites and examine outcomes before installing renewable energy systems, and 3) ensure people truly benefit from the installation of renewable energy infrastructure (Pasqualetti 2019).

Pasqualetti's article is highly generalized and it presents general ways to break down barriers to renewable energy, but as he mentions, there will undoubtedly be site-specific challenges to address.

In present times, it is important to understand site-specific or regionally specific issues to renewable energy can lead more communities to believe that there are energy alternatives to fossil fuels. A study called "Regional integration of renewable energy systems in Ireland – The role of hybrid energy systems for small communities" examines this very concept. Ireland does not have the vast fossil fuel resources available that other nations have and as such much of their energy needs are met by importing energy from external sources (Goodbody et al. 2012). This study breaks down how a focus on regional renewable energy can lead to locally sourced energy and a decentralized grid throughout the island nation. To demonstrate this, the nation was divided up into eight regions and the resources available to them (both renewable and non-renewable). The results found that the incorporation of regional renewable energy systems when working with current fossil fuel sources, could drastically lower the net costs of energy and reduce CO_2 emissions enough to meet emission limits without the trading of carbon credits (Goodbody et al 2012). Overall, the system demonstrates that regional hybrid energy systems present feasible solutions to further renewable energy. However, the authors note that there are urban planning concerns with hybrid renewable systems and that associated upfront costs may make such a system unattainable without public support.

Renewable energy poses many changes to our lives, especially in American society, but it also poses social challenges and potential benefits to communities who are starting to make the shift. Communities can become less dependent upon the importation of energy and focus on regional production of energy which would benefit them both the environment and the people within individual regions. It could lead to new growth economically and create more equitable energy prices for everyone within communities that make the shift to renewable energy.

Regional Scale Energy Production

To understand how energy is produced regionally, we must first understand the current energy system that governs us. Much of the information on how energy is produced in the U.S. and its individual states comes from the U.S. Energy Information Administration (EIA). In many countries, including the U.S. energy is produced at the national level and all power plants, whether they are fossil fuel, nuclear, or renewable plants, produce energy that is sent to the "grid" (U.S. Energy Information Administration 2019).

Energy Generation

The grid is best described as the series of substations, transformers, and power lines that are interconnected for reliability and commercial reasons, so that planned and organized energy networks are formed (U.S. Energy Information Administration 2019). The current energy network of the Lower 48 states is made up of three main interconnections which are the Eastern Interconnection, the Western Interconnection, and the Electric Reliability Council of Texas (ERCOT). The structure of the network is designed for redundancy so that multiple flow routes of high voltage energy provide power to various load centers to prevent mass interruptions in energy service (U.S. Energy Information Administration 2019).

In the state of Kansas, wind energy is now the dominant source of energy for the state. Wind turbines produced most of the electricity in the year 2019 for the first time, accounting for 41% of all electricity produced in the state. (U.S. Energy Information Administration 2020). This was considered a major step forward for the state. The state's only nuclear power plant, Wolf Creek accounted for 18% of all energy produced in the state (U.S. Energy Information Administration 2020). The state of Kansas has the potential for greater use of sustainable resources in the future as the industries of wind and solar energy continues to grow. The Advanced Power Alliance (formerly the Wind Coalition) is a multi-state group that promotes the growth and development of clean renewable energies, specifically wind. The group has influence in fourteen states that help support the Electric Reliability Council of Texas and the Southwest Power Pool by creating advocacy programs that work to expand capacity, increase the use of renewables, and promote safe transmission of energy (Advanced Power Alliance 2020). The group has successfully helped open renewable energy markets in several states, including Kansas, Oklahoma, Texas, and Nebraska since 2004 (Advanced Power Alliance 2020).

Visualization Case Studies

A research project from a master's student of landscape architecture at Kansas State University called "Visualization Tools for Visual Impact Assessments: A study of immersive technologies," examines how 3D model imagery can substitute 2D images in visual impact assessments. The study examines various precedents of how other organizations and institutions formulate their own visual impacts assessments/visual resource management guides and what they aim to do. The four visualization guides examined in the study were 1) the Contrast Rating System from the Bureau of Land Management (BLM), 2) the Scenery Management System from the United States Forest Service (USFS), 3) the VIA for Highway Projects from the Federal Highways Administration (FHA), 4) the Visual Resource Inventory from the National Parks

Service (NPS), and the Landscape Character Assessment from the Scottish National Heritage (DePriest 2018). An example of the flow chart used by the BLM to measure the contrast rating of a particular landscape can be seen in figure 11. The methods of the study use Rachel Kaplan's "Rated Preference and Complexity for Natural and Urban Visual Material" (1972) for participants to judge a series of images using different visualization methods and the

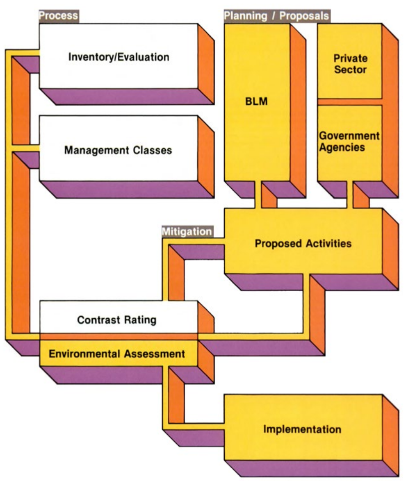

Figure 11: Flow chart displaying how the Visual Resource Management program is used and implemented by the Bureau of Land Management (Braverman et al.1980).

participant focus group was made up of various landscape and planning industry experts (DePriest 2018, 27). The results showed that 3D photosphere images were more successful in allowing greater development than those 2D or Google Earth images. The author notes that successful photosphere imagery could be used by industry professionals to conduct visual impact assessments, but that higher quality technology would be required in order to make visual impact assessments more feasible for regular use (DePriest 2018, 43).

Regional Energy Production Case Studies

Research studies involving energy production and aesthetics have come far in the past twenty years and while renewable energy is an up-and-coming industry, there is still much research to be conducted regarding this subtopic. There are two primary studies that standout.

The first case study comes from researchers at the Institute of Geonics at the Czech Academy of Sciences titled, "The importance of on-site evaluation for placing renewable energy in the landscape: A case study of the Búrfell wind farm (Iceland)." This is a large regional wind farm found in the central highlands region of Iceland. Researchers wanted to understand to what degree this renewable energy system dominated the surrounding landscape and how people's subjective opinions ultimately shape perceptions and attitudes of landscapes. The wind farm can be seen in figure 12. Iceland is a nation with an abundance of renewable energy natural resources including wind, solar, and geothermal (Frantál et al. 2017, 234). This has led to many investments in renewable energy throughout the country especially as the energy needs of the country have expanded due to the diversification of its economy primarily because of tourism and

Figure 12: The Búrfell wind farm in Iceland is found within the central highlands region of the nation. The authors of the article have described the wind farm as the gateway into the central highlands (Frantál et al. 2017).

newfound industries (Frantál et al. 2017, 236). The country saw renewable energy as a practical solution, but there have been challenges concerning the native landscape and aesthetics.

The research approach involved asking a set of empirical research questions to a target group of professionals with specific backgrounds which included geographers, sociologists, urban planning, landscape architects, and engineers (Frantál et al. 2017). Questions were focused on the general character of the landscape, important visual elements of the landscape, compatibility of the landscape with wind turbines, and how perceptions and public opinion shaped the outcomes of the project. Participants attended a site visit where they wrote down their observations and emotional experiences and the day after the visit researchers created a summary of verbal adjectives collected from the participant group (Frantál et al. 2017, 238). Together, selected participants and researchers drew cognitive mental maps as a way of visualizing the characteristics and emotions from the site visit.

The results showed that renewable energy systems and equipment (specifically wind turbines) in the landscape remains a debated issue even amongst groups of professionals. The research and mental mapping showed that some people perceived wind turbines as negatively impacted the landscape while others noted positive associations with them (Frantál et al. 2017, 243). Survey questions were also sent out to participants who visited the site, and they were asked to rate the compatibility of wind turbines with the Búrfell landscape. Half of the respondents said that the wind turbines were not compatible with the landscape while about one-third found the turbines to be compatible (Frantál et al. 2017, 243). Overall, the project reveals that most of the public has a negative opinion of wind turbines within the landscape because they take away from the natural characteristics or beauty of the landscape. Additionally, the survey also found that those respondents from denser nations where wind energy is common, to have more favorable views of wind turbines. However, the survey also found that those from places where there are pending approvals to construct wind turbines or no wind turbines at all had mostly unfavorable views of wind turbines.

Another study from south-east Finland examines how available resources within the region affect the production of renewable energy. The study called "The role of local renewable energy sources in regional energy production: The case of south-east Finland" discusses challenges EU member nations face and the methods of promoting and/or utilizing renewable energy resources from a regional standpoint (Laihanen et al. 2016). The study also examines what actions should be taken to obtain a regional focus of renewable energy by combining current supplies of regional energy with available supplies of regional energy and presents the results to stakeholders, producers, local and national government officials, and research organizations/authorities (Laihanen et al. 2016, 90).

The study also revealed that there is a heavy potential within the region for the utilization of wood as a biofuel and that it will be a significant part of regional energy production in the future. The authors also found that a switch to biofuels could help reduce dependence on fossil fuel sources in heating plants and in larger residences and structures (Laihanen et al. 2016, 92).

The region also has significant

potential for increased wind energy production. The current system supports 17 wind turbines with an electrical power of 43 MW. By 2020 the number is expected to increase to 70 turbines with a power potential of 210 MW. This new capacity is expected to increase self-sufficiency in terms of electrical energy production and lead to overall renewable energy expansion moving forward (Laihanen et al. 2016, 93).

The system is anticipated to increase the overall use of all renewables from 2010 to 2020 as the region's share of renewable energy could rise from 57% to 63% primarily due to sources of forest biomass and wind power (Laihanen et al. 2016, 94). While the most important source of renewable energy for the region is forest biomass, wind and solar energy retain the greatest growth potential, and if operational conditions continue to improve for wind and solar technologies, then renewable energy will become more competitive from an economic standpoint and support new jobs and guaranteed energy production to consumers (Laihanen et al. 2016, 95).

Focusing on producing energy at the regional level, rather than the national level, would result in various benefits for both cities, towns, and municipal governments. It would help lead to a shift in not only energy generation, but also in energy transmission and distribution as it would no longer require the transportation or purchasing of energy sources such as coal, oil, and natural gas. This would also help lead to a cultural shift in how we utilize energy in the United States and our society to focus on a system of subsistence energy rather than a system of luxury energy.

Methodology & Methods

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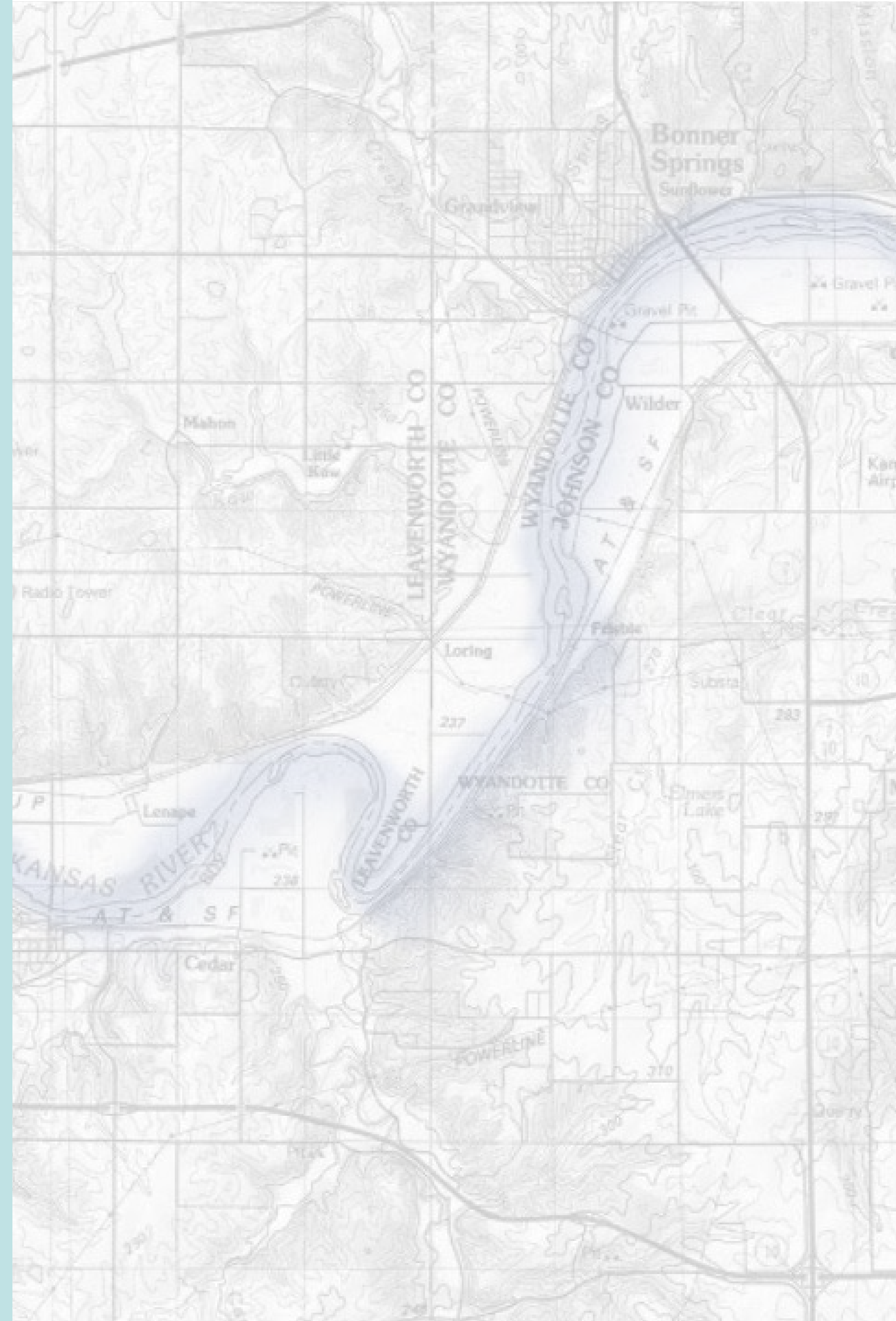

After examining a variety of literature regarding renewable energy and its impacts upon the landscape, social systems, and the production of electrical energy, it was found that there are several factors that impact the implementation of renewable energy within our society. One of the primary issues being the impact the equipment itself, such as the wind turbine towers and the large solar arrays, has upon human perceptions of the landscape. It is often seen as marring or interrupting the landscape, especially when it is in and around human settlement. This issue of appearance or aesthetics for renewable energy prompted some of the following research questions.

Research Questions:

1. *How do small or medium-scale renewable energy systems fit, or aesthetically appear, in the fabric of our cities, towns, and communities?*
2. *Can renewable sources of energy meet the energy demands of entire regions to form renewable energy networks?*
3. *What impacts would occur if we changed how we generate energy by shifting from a focus on national energy production to a focus on regional energy production?*
4. *What key site design strategies lead to successful integration of renewable energy landscapes near to or surrounding small towns and communities?*

Goals:

- Examine various precedents in a precedent study to search for potential design ideas
- Conducted case study analysis based on research from Literature Review to examine what regional renewable energy systems have done and how successful (in terms of aesthetic feasibility and design strategies used) they have been
- Created pilot project that examines how a small or medium-scale renewable energy network can be created along the eastern Kansas River corridor by:
- Established technological and economic Feasibility
- Examine and select sites
- Creating conceptual plan and section graphics
- Rendering Photomontage Graphics & 3D imagery
- Used pilot design project images to create a stated preference test; select two of the sites from the four sites used in the pilot project study; the two sites to be used are those of Eudora and DeSoto, KS; use imagery of these two sites to complete preference testing
- For preference testing, four images will display what each site might look like with a different strategy used for renewable energy generation while one image will show the site as it currently exists. The images will display these four conditions for the site:
    - Site as a Solar Array
    - Site as a Wind Farm
    - Site as a Solar and Wind Farm
    - Site with No Change
- Respondents ranked surveys would rank the four images for each site in Eudora and DeSoto respectively with 1 being the most preferred and 4 being the least preferred

- Surveys included a mix of demographic questions along with the image ranking preference tests
- Analyzed results of preference tests using statistical program R to display the quantified results in graphs and charts.
- Utilized results of preference study to create a new set of design guidelines and policy initiatives and
- Adjusted pilot project imagery to meet the new design guidelines and policy standards

Case Study Analysis:

I began by examining the example projects early and determined which were most suitable as an examples of case studies. I examined places where regional renewable energy has been achieved and looked at their advantages and disadvantages. Using case studies, I created an initial set of design guidelines and policy recommendations that I believed could inform and aid in the design of a regional renewable energy network. Policy recommendations reflected what was learned in the design and creation of case study projects and what lessons ccould be applied to similar designs.

Pilot Project:

A set of initial design guidelines and policies/procedures were produced to create a projective/pilot design project for a set of small-scale renewable energy systems that form a regional renewable energy network. The pilot project was conducted in alignment with the goals and objectives of the Master's Project Studio and the Landscape Architecture Foundation Super Studio. In 2020, the Landscape Architecture Foundation joined in the American Society of Landscape Architects, the Council of Educators in Landscape Architecture, and various other organizations to invite designers to explore the ideas and core missions of HR 109 of the 116th Congress otherwise known as the Green New Deal. The event was targeted to the 2020-2021 academic school year. It welcomed students, professors, educators, and professionals to participate by studying the impacts that design and planning projects might have if they were to focus on decarbonization, justice, and jobs (the three main tenants of the Green New Deal). The three sections of the Master' Project Studio at Kansas State University chose to partake in the event and explore the possible outcomes of implementing the three aforementioned tenants of the Green New Deal.

Preference Study:

The graphics created for this pilot project were used as an example project to conduct a stated preference test. The test was sent out in the form of a survey. Images and graphics of the same site will be placed alongside one another to display what the site looks like as:

1) a wind farm,
2) a solar array,
3) a solar and wind farm mix, and
4) the site exists.

Respondents ranked which scenario they find most preferrable (1 being most preferrable and 4 being least preferrable). The surveys were sent to sample populations of the towns the sites are within (Eudora and DeSoto, Kansas). The survey asked questions relating to the backgrounds and individual preferences of the respondents. The goal of the survey was to demonstrate people's preferences when it comes to renewable energy and how well these systems of renewable energy fit into the community's surrounding landscape.

Reform & Adjust Policy Recommendations, Design Guidelines, & Graphics:

Respondents answers were then used to inform site changes and shape new design guidelines, policies, and procedures that would lead to the creation of regional renewable energy networks. Additionally, the reformed policies and procedures produced from this study might enable community leaders and policymakers to explore the possibilities of such a project in the eastern Kansas region. The newly formed standards and guidelines were used to adjust the graphics produced from the pilot project and determine what changes to the pilot project are necessary.

Anticipated Outcomes & Limitations:

The project revealed people's preferences and attitudes towards renewable energy within their own communities. The project was also designed to understand how people view the visual impacts of renewable energy equipment. This contributed to landscape architecture, planning, and other design professions in helping us to understand how we can properly design renewable energy landscapes and identify strategies of design that are effective in shaping low visual impact sites. Furthermore, it also helped advance the cause for renewable energy and emphasize the ability of design professions to respond to the climate crisis.

However, the study/report does have a few limitations regarding the specifics of people's aesthetic preferences. Firstly, this study does not attempt to define what beauty is or what the best landscapes aesthetics are. Individuals are bound to have different opinions regarding what they perceive as beautiful and aesthetically pleasing in the landscape. Some might prefer more wild or unkempt landscapes that reflect the historically natural characteristics of the land while others might prefer a more agrarian scene with neat fields and picturesque farming structures dotting the landscape. Opinions regarding landscape differ from person to person and this study does not attempt to group people with similar perspectives on landscape aesthetics together and measure the opinions of these groups within regards to renewable energy in or near small towns.

Secondly, the study and report also only examines people from the selected towns where the pilot project sites are located. People taking the survey are from either Eudora or DeSoto and their view of renewable energy infrastructure within their communities might be different than someone who is not immediately from those communities or from the areas near those communities. Individuals from outside of these communities that come from different population densities, such as people from suburban and urban areas, may have diverging opinions of renewable energy landscapes. While this is a limitation of the conducted study, a future study could explore this issue further and understand how people's opinion vary within regards to renewable energy within small community landscapes depending on their background and the population density they come from.

Case Study Analysis

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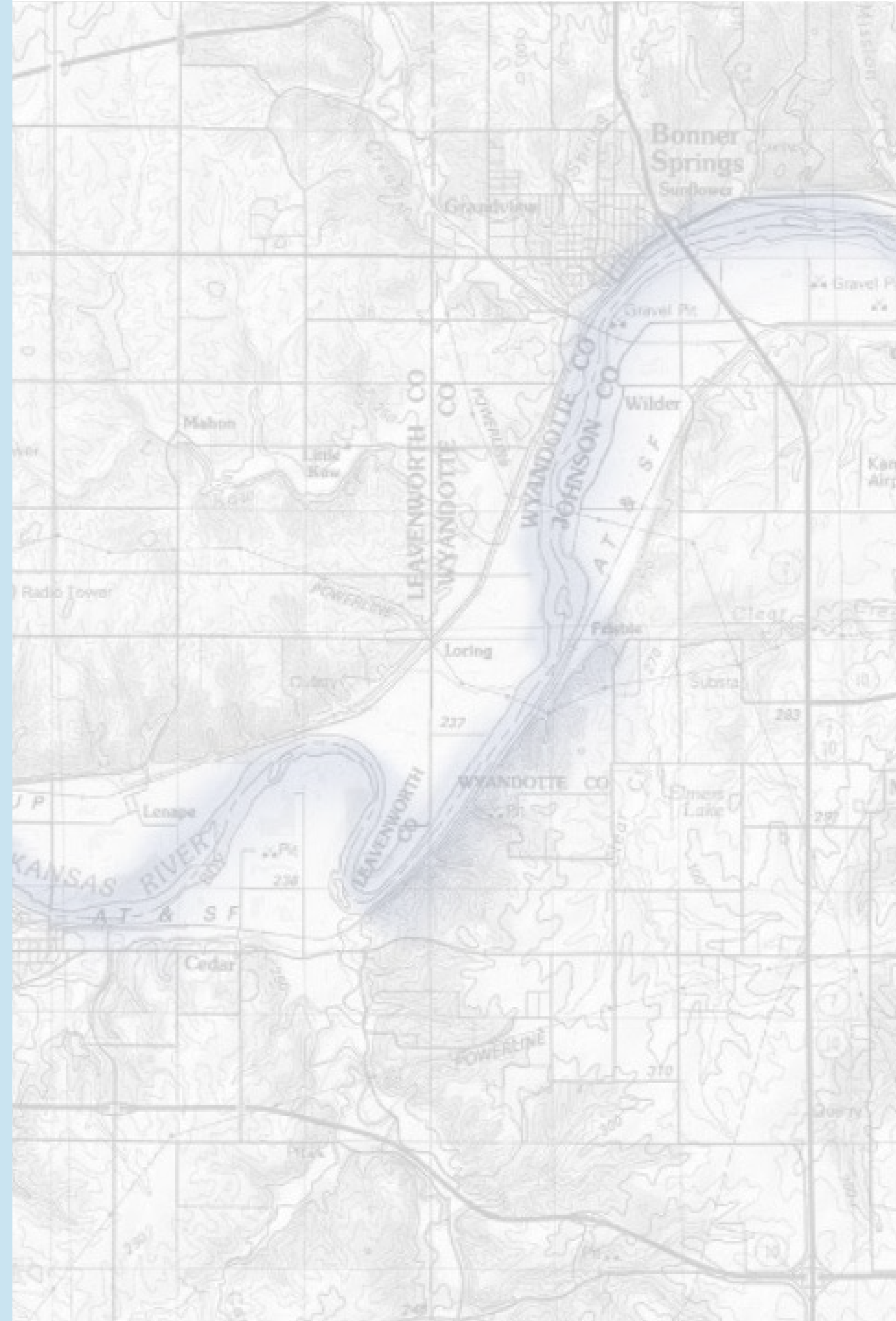

The case study analysis looks at four different renewable energy projects and their approach to site design, their energy output, and how well each site fits aesthetically within the community area. Understanding the character and aspects of each case study will help create the necessary design guidelines for shaping each of my sites. The analysis will also explain what policy measures were important in determining the outcome of each project. Certain design strategies used throughout these case studies demonstrate the need to create low impact designs that maximize energy potentials while minimizing visual interruptions. In The Renewable Energy Landscape by Dean Apostal (2017), he states the need for a proper framework to create an adequate visual impact assessment.

Renewable energy landscapes commonly undergo visual impact assessments (VIA) both before and after the completion of a renewable energy site. Usually, the VIAs look to understand four common criteria:

1) the magnitude of the impact,
2) the geographic extent of the impact,
3) the duration of the impact, and
4) the context of the impact (Apostal 2017, 214).

For this case study analysis, I will be using the above criteria for understanding how each of the renewable energy sites visually impacts the landscape and local communities around them. I will also consider the energy outputs of each site and how much land in acres was needed to achieve this level power. The case studies are examples of successfully implemented renewable energy systems and serve as inspiration for the proposed designs.

Case Study 1: Búrfell Wind Farm – Central Highlands, Iceland

This is a large regional wind farm found in the central highlands region of Iceland. Researchers wanted to understand to what degree this renewable energy system dominated the surrounding landscape and how people's subjective opinions ultimately shape perceptions and attitudes of landscapes. The central highlands of Iceland have been greatly affected by volcanism since the end of the last ice age (Ingólfsson 2015). Although Mount Búrfell has no erupted in some time, there are risks from other surroundings mountains such as Hekla volcano (Ingólfsson 2015). Iceland is home to various forms of renewable energy including geothermal, hydroelectric, and wind, but of the three, wind is still in the developing stages throughout the country (Frantál 2017). The Búrfell wind farm would be considered large, compared to the types of installations to be designed on the sites for pilot project, as it aims to create a wind farm that supports up to 80 turbines and a possible capacity size of 200 MW (Megawatts) and the turbine towers for this site stand at an impressive 488 feet tall (Mannvit Consulting Engineers 2020).

To ensure project viability, the designing engineers completed an environmental impact assessment, a landscape analysis, and a visual impact analysis. The project manager has said, "This is a new energy option which sits well with hydropower and supports the electrical energy system" (Mannvit Consulting Engineers 2020). The image in figure 13 shows the wind farm in its current state.

The research study conducted by the group of researchers from the Czech Academy of Sciences looked to understand how people perceived the turbines within the landscape and how compatible the wind farm is with the surrounding

Figure 13: *The Búrfell Wind Farm is found within a stunning landscape. Although the area is home to only a small number of human inhabitants, the landscape surrounding the wind farm is considered a scenic resource to Iceland (Google 2013).*

landscape. The results revealed that most people viewed the wind farm as incompatible while about only 1/3 of respondents view the wind farm as compatible with the surrounding landscape. Interestingly, regardless of opinion on compatibility, most respondents view the Búrfell landscape as “exposed, open, unfriendly, windy and kind of unique” (Frantál 2017, 241). These descriptions of the landscape shows that although opinions may vary when it comes to landscape compatibility, most respondents view the landscape in the same light. In general, the defining qualities of the landscape are agreed upon by and that the landscape is generally understood by most. The following charts in figure 14 show charts that display how the researchers analyzed the data about project approval and the differences/similarities in landscape perception of the wind farm.

Case Study 2: Avangrid Renewables Tule Wind Farm - McCain Valley, CA

The Avangrid Renewable Tule Wind Farm (seen in figure 15) is in McCain Valley, CA just east of San Diego. The plant is a 131 MW system with connections to the

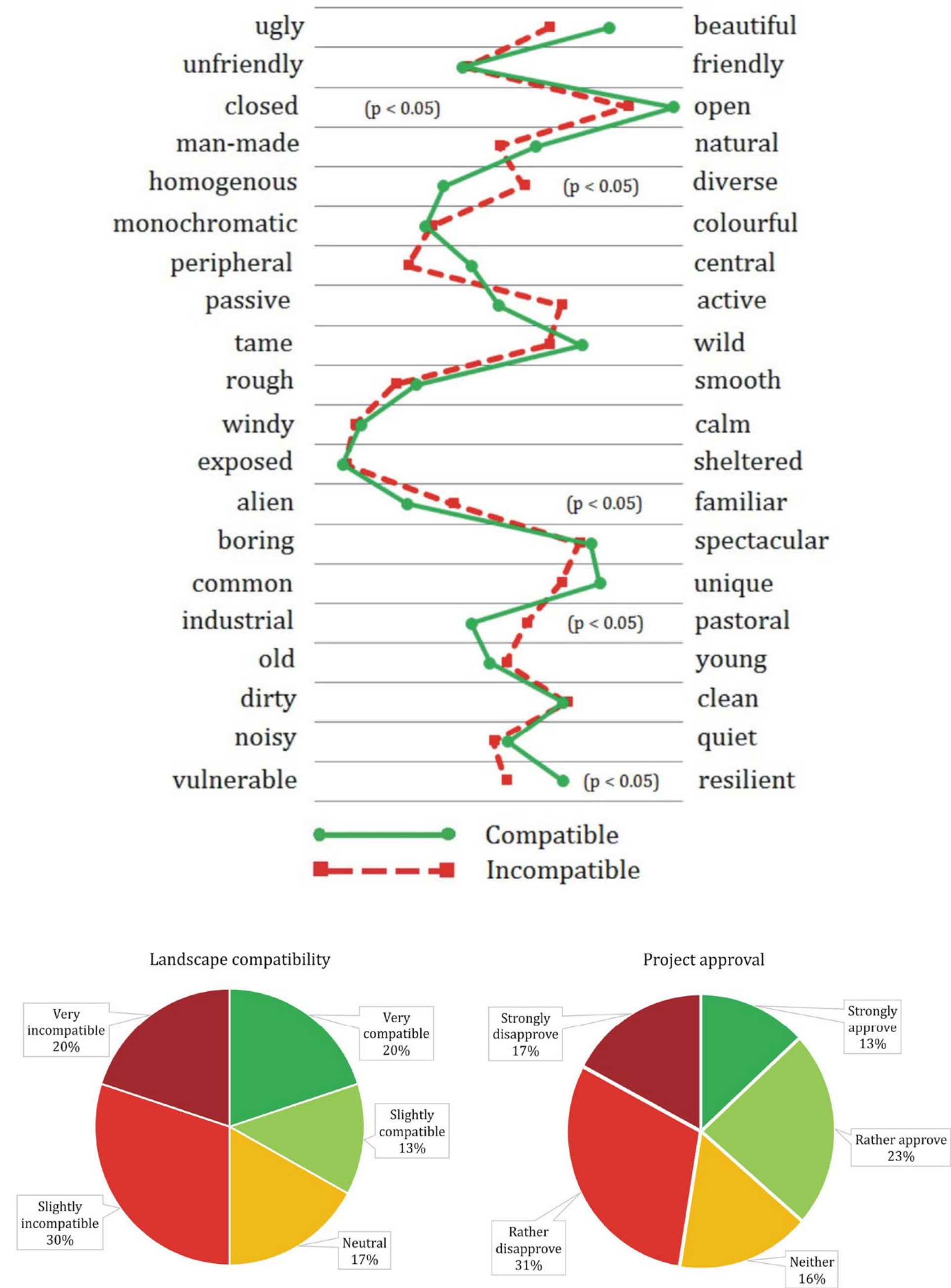

Figure 14: *The charts show that most respondents do not view the wind turbine project as compatible with the landscape and that most respondents have an unfavorable view of the project, however there are strong similarities in how people visually characterize the landscape of Búrfell (Frantál 2017).*

Figure 15: The Tule Wind Farm within McCain Valley is surrounded by a rugged landscape with rocky hills. This is an example of another Avangrid Renewables wind farm found within southern CA. Both wind farms are found within a similar arid and rocky landscape (Avangrid Renewables 2018).

energy grid via underground and some overhead electrical lines. The project was made possible in 2012 when the Bureau of Land Management (BLM) issued a right-of-way (ROW) grant to Tule Wind LLC to build, operate, and maintain a wind farm and necessary facilities on a 12,360-acre plot of land. To ensure the environmental safety of the site, the BLM and Tule Wind LLC established an Environmental and Construction Compliance Monitoring Plan to set certain mitigation measures and meet the terms of the BLM ROW grant (Sahagun 2017). Turbines at the wind farm were built by General Electric (GE) as well as many of the key components of the system such as the power plant controller (PPC). The PPC is unique in that it allows the entire wind farm to function as one single generator by regulating the real and reactive power outputs of the individual wind turbines (Loutan & Vahan 2020, 17). This means that the system is not limited like other wind farms that cannot precisely control their power outputs. The plant controller can easily manage power output just as a typical large scale fossil fuel powerful plant might and makes active power control and voltage regulation tasks easy to perform. This PPC is a closed-loop scheme and can distribute rapid commands to all components of the system (Loutan & Vahan 2020, 18). The system demonstrates that the overall power outputs were able to be regulated by the system. Figure 15 displays the landscape around the windfarm.

The Tule Wind Farm project is significant to the study for several reasons, but there are three main impacts that this project will have. Avangrid Renewables first reported the completion of this windfarm in 2018 along with two other renewable energy sites in southwestern U.S. adding to their already diverse renewable energy infrastructure fleet (West and Sasse 2018). Their recent projects demonstrate that the company is dedicated to expanding their operations and helping create cleaner energy for the growing number of communities throughout the region, thus helping to regionally reduce the amount fossil fuels necessary for the area. Second, the construction of the Tule Wind Farm was a great economic asset to the communities around it. The project quickly employed a wide range of people, contractors, and companies and promoted the further growth of economies throughout the southwest. In total, the project construction employed 21 local companies and was expected to provide $39 million in local and state tax revenue over the next 25 years (West and Sasse 2018). Avangrid Renewables President and CEO, Laura Beane had this to say:

"Bringing jobs and economic development dollars during construction is just the beginning of our long-term partnerships with these communities. While commercial operation marks the culmination of years of teamwork with landowners, local leaders, and so many supporters, we'll continue to work hard to build on these relationships, as our employees will live and work in these areas for years to come" (West and Sasse 2018).

Finally, the Tule Wind Farm project is a good example of how to work with federal, state, and local governments to ensure environmental standards are met during construction. The project was first granted approval in 2011 and was not completed until seven years later (Sahagun 2017). It demonstrates that renewable energy projects of any scale take time, effort, and much consideration before the actual construction and completion of these types of projects. Altogether, the Tule Wind Farm is a prime example of a complex renewable energy system and demonstrates renewable energy is a long-term investment that requires a steady approach but can also lead to fantastic economic and regional progress.

Case Study 3: Stanton Energy Center – Orange County FL

The Stanton Energy Center in Orange County Florida is a 5.9 MW PV system which can be seen in figure 16. This solar array is situated on a 3,280-acre site and works in conjunction with the already existing natural gas and coal energy generators which were first installed in 2003 (Orlando Utilities Commission 2020). The project was originally engineered and designed by Blue Oak Energy, which is a design and engineering company based in California that specializes creating PV systems throughout the country. In total, the solar array is made up of 25,000 PV panels and contributes a 30% increase to the overall effectiveness of the energy center (Orlando Utilities Commission 2020). The entire solar array is also conscious of potential inclement weather and can withstand hurricane force winds (Orlando Utilities Commission 2020). The

Figure 16: Stanton Energy Center can be seen from Innovation Way and is situated so as not to impact drivers (Orlando Utilities Commission 2020).

solar array can be seen in figure 16.

While the Stanton Energy Center is not entirely renewable energy, it is a strong step forward in the right direction as its focus is to shift from a predominately fossil fuel system to a renewable energy system. This project is significant as it is a good example of the plans that several energy companies throughout the nation are making. The phasing out fossil fuels and phasing in of renewable energy solutions is a process that takes both economic investment on the part of the energy supplier and time to implement. The OUC has given themselves a goal to eliminate the use of coal by 2027 and achieve 100% renewable energy by the year 2050 (Wilson and Parks 2020). OUC has implemented another solar energy field near the existing one which has a 13 MW capacity and occupies a total of 24 acres (Orlando Utilities Commission 2017). This project is also significant because it is an example of utilizing the best possible renewable energy form available given the region and its climate. Florida is one of the sunniest states in the country and in 2019 solar energy accounted for half of the state's renewable energy sources generation (U.S. Energy Information Administration 2020).

Case Study 4: Montgomery Solar - Biscoe, NC

The Montgomery Solar Array in Biscoe, NC is owned and operated by O2 EMC LLC, a company focusing on solar energy in the southeast of the U.S. The project was made possible thanks to a partnership between Duke Energy and O2 EMC. This 20 MW system was designed not only to provide energy to the surrounding area, but also to create jobs for the local community (Anderson 2016). Just to the west of the site is a local farm called the Montgomery Sheep Farm and as of 2018 part of the constructed solar array became solely dedicated to the farm which provides for 99% of the electricity the farm uses (Montgomery Sheep Farm 2018). The farm performs a variety of roles and acts as a vacation destination, a bed & breakfast, and as a venue for retreats and weddings. Tours of both the farm and the solar array are available upon request (Montgomery Sheep Farm 2018). Upon the completion of the solar array, U.S. Senator Richard Burr stated that, "Since opening in 2016 the system employs several people from the local area and contributes to the electrical powering of more than 3,500 homes within Montgomery County" (Anderson 2016). Joel Olsen, President of O2 EMC, expressed that although the project required much labor to get through the permitting and inspection processes at both the state and federal level, the hard work has paid off (Anderson 2016). As seen in figure 17, the solar array appears to take up a lot of space. The entire site is 123 acres, but only 50 of those acres are beneath the solar panels themselves (Anderson 2016).

Montgomery Solar is a good example of a smaller scale, yet very significant solar array. It is an independent site not tethered to a large fossil fuel facility and is able to make significant energy contributions to the local electrical grid. Additionally, the Montgomery Sheep farm, found just west of the site, is able to draw all of its power from the adjacent solar array (Montgomery Sheep Farm 2018). The Montgomery Solar project is a prime example of a private and public partnership acting together to do something that benefits both the community and the environment. The solar array was awarded a tax credit from the federal government which helped to stimulate the project and fund it during construction which helped turn a property with a $500 tax base into a $100,000 tax base (Anderson 2016). The Montgomery Solar array can be seen in figure 17.

Figure 17: Montgomery Solar Array is seen here in this birds eye view. In the upper left is the local Montgomery Sheep Farm and the site is flanked to the Northeast by I-74 (O2MEC 2016).

Overview of Design Guidelines for Site Design:

All case studies discussed in this chapter are exemplars of renewable energy sites that demonstrate practical and thoughtful landscape design. These projects also show the significant planning and environmental mitigation challenges associated with the construction and implementation of wind farms and solar arrays regardless of location. Each case study exhibits that these installations are no minor projects that can be completed within the course of a year's time. Renewable energy projects are long term investments but can lead to positive impacts on communities, their economies, and their regional ability to create energy. For the pilot project, the design of the four prospective renewable energy sites should not only meet the local and state requirements but maintain the unique character and culture of the landscape. The following design guidelines will be used to design each site:

- Conduct initial site visits and make visual assessment
- Match existing aesthetic of the place and locality
- Meet construction requirements set forth by national, state, local governments
- Ensure that the project would be beneficial to local economic growth
- Reduce visual impacts of apparatuses and equipment so that sightlines and views are minimally interrupted
- Minimize possible negative impacts such as noise pollution or light reflection
- Connect proposed energy generating system to the overall electrical grid
- Provide security measures for all sensitive equipment
- Avoid disturbing established or potentially fragile environments

Pilot Project

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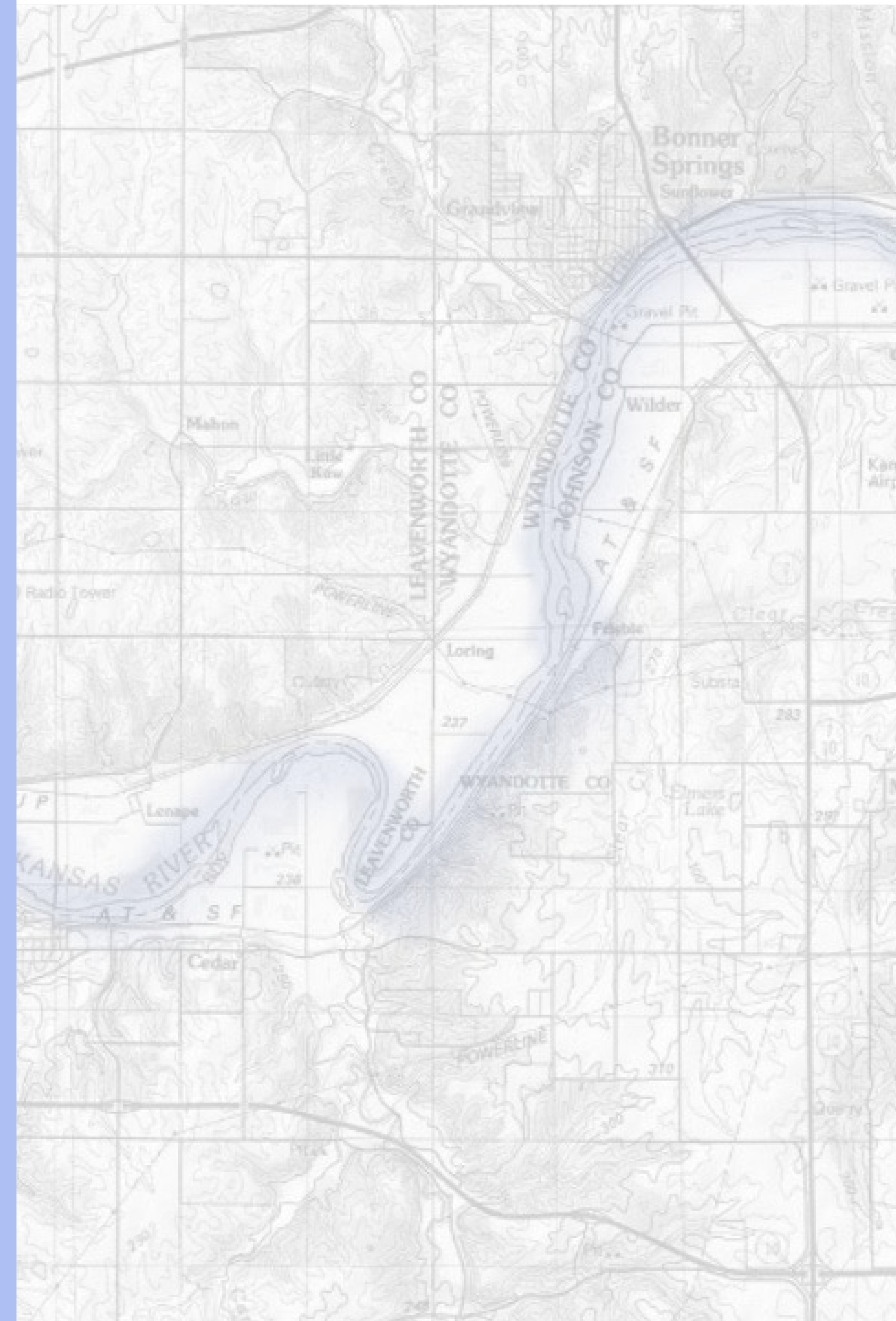


Renewable energy (RE) is one of the most pivotal tools designers, engineers, ecologists, planners, and policymakers must utilize if we are to curb the negative impacts of climate change. In the United States there is tremendous potential to reduce the amount of carbon we produce and invest in renewable energies as a safe, clean, and sustainable source of alternative energy. This project, based in the Eastern Kansas River Corridor, focuses on creating potential RE sites by reducing dependence upon fossil fuel energy sources, creating new employment opportunities for residents, and over time, lowering the cost of energy so that all people can comfortably afford the energy they need. Small-scale RE systems can help us to decrease dependence upon a national energy grid and lead to a society that works with nature and emulates its processes. The map in figure 18 shows the regional site where a renewable energy network can be created.

Current Energy Profile in Eastern Kansas:

As stated previously, Kansas is a major producer of renewable energy via wind, but a large majority of the power produced in Eastern Kansas is generated from Coal and Natural Gas powerplants. The only real source of RE in the region is the Bowersock and Mills Hydroelectric dam found in Lawrence, Kansas. While wind turbines are responsible for most of the RE produced in Kansas, most cities and communities in eastern Kansas rely heavily upon fossil fuels to generate electricity (U.S. Energy Information Administration 2020). The major energy plants within the immediate area of the region include the Lawrence Energy Center, the Nearman Creek Power Station (both coal-fired plants), and the Bowersock Mills & Power Company. The map in figure 19

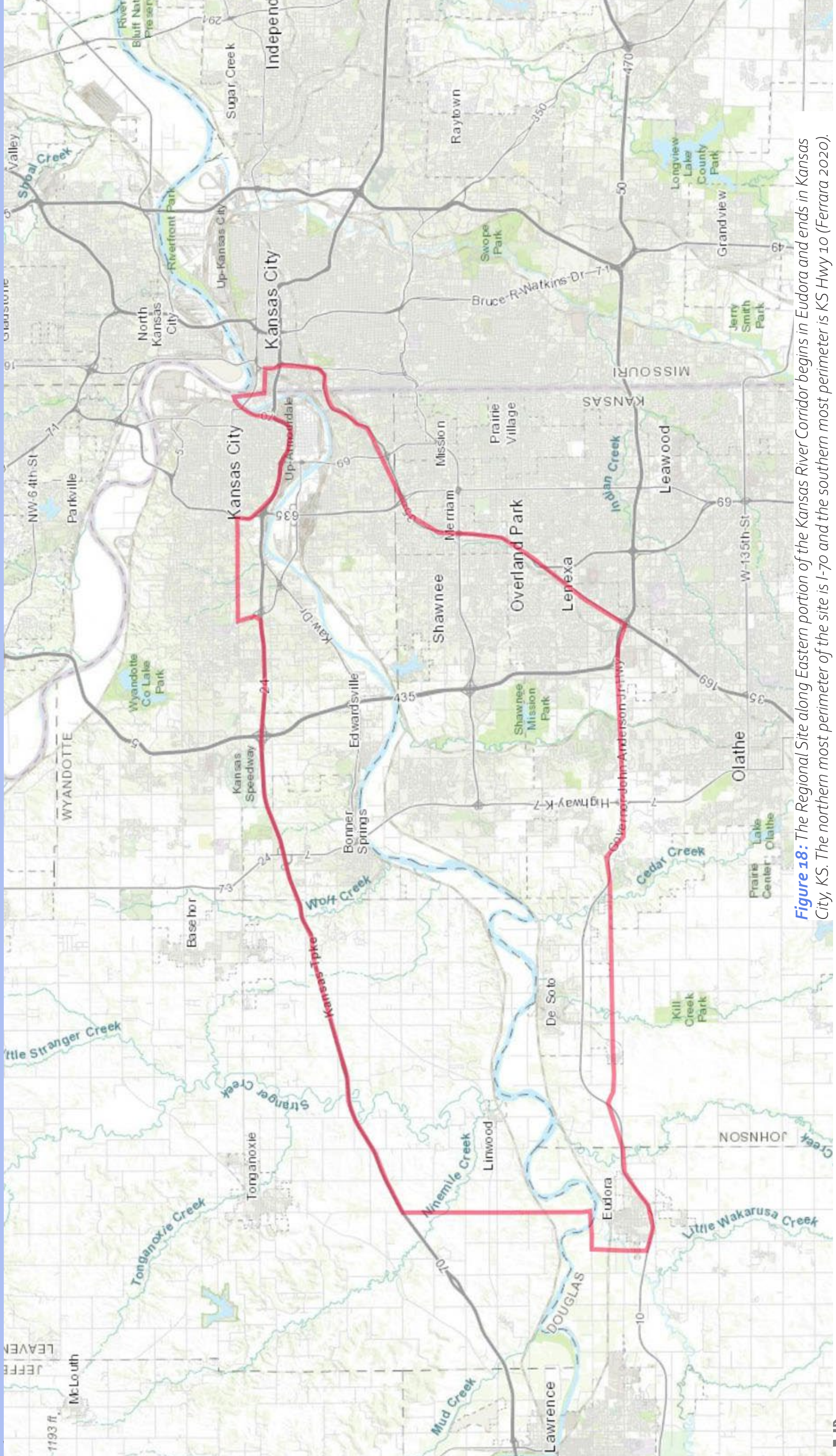


Figure 18: The Regional Site along Eastern portion of the Kansas River Corridor begins in Eudora and ends in Kansas City, KS. The northern most perimeter of the site is I-70 and the southern most perimeter is KS Hwy 10 (Ferrara 2020).

displays where the energy stations are located, and the fuel source used to power them.

Sites:

Within the region, four sites were selected for further study. Four sites were necessary to provide an adequate number of possible renewable energy site scenarios. The four sites are near and or within the towns of Eudora, De Soto, Lenexa, and Bonner Springs, KS and the sites can be seen in figure 20.

The sites were selected for their energy potentials, economic opportunities, and for the cities and towns where small to medium scale renewable energy installations are feasible. By examining the wind potentials, solar potentials, job creation potential, predicted labor force growth, and community proximities within the region, the areas of greatest opportunity were revealed. Four sites were selected for the development of small-scale

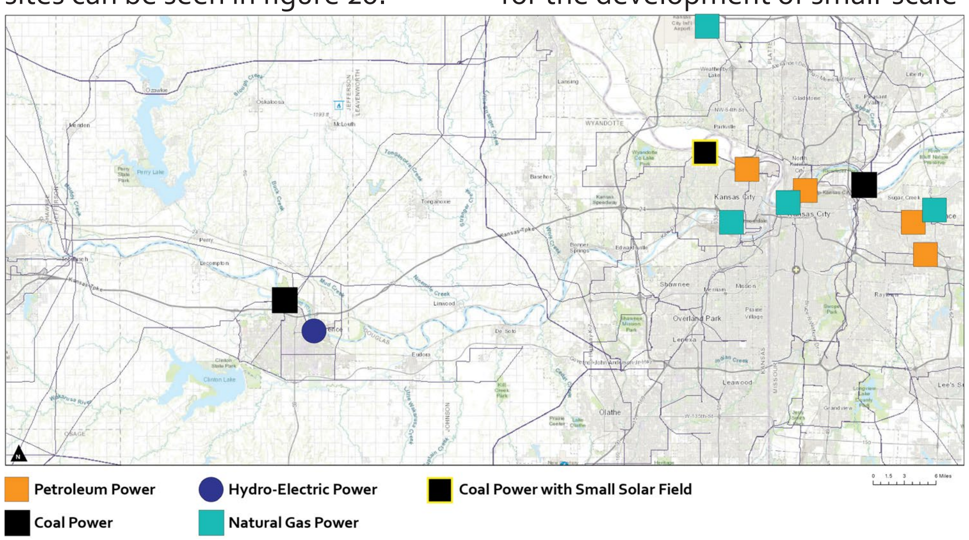


Figure 19: This map displays major energy stations and powerplants that generate power within Eastern Kansas. Most energy generation plants are found around the Kansas City metropolitan

renewable energy systems to come together and create a new renewable energy network for the region. The four sites are in Eudora, DeSoto, Lenexa, and Bonner Springs. The first two sites focus on developing a mixed energy approach utilizing space for both wind turbines and photovoltaic (PV) panels. Meanwhile, the Lenexa site explores an all-PV panel strategy with long weaving bands of solar arrays and the Bonner Springs site focuses on utilizing more space than any of the other sites to accommodate large grassland rings with turbine towers found at the center of each ring.

Project Goals and Objective:

The project goal is to demonstrate what small scale renewable energy sites would look like in proximity to the smaller towns and communities of the eastern Kansas River corridor. A secondary goal of the project is targeted at exploring how this idea of small-scale renewable energy might fit within the confines of the Green New Deal. Master's students studying landscape architecture in the Fall of 2020 at Kansas State University were tasked with participating in the national "Superstudio" sponsored by the Landscape Architecture Foundation (LAF). The following is an excerpt from the LAF:

"The Superstudio is an open call for designs that spatially manifest the principles and policy ideas of the Green New Deal with regional and local specificity. A national climate plan like the Green New Deal will be understood by most people through the landscapes, buildings, infrastructures, and public works agenda that it inspires. The Superstudio is a concerted effort to give form and visual clarity to the scale, scope, and pace of transformation that the Green New Deal implies." (Landscape Architecture Foundation 2020). Our class chose to emphasize

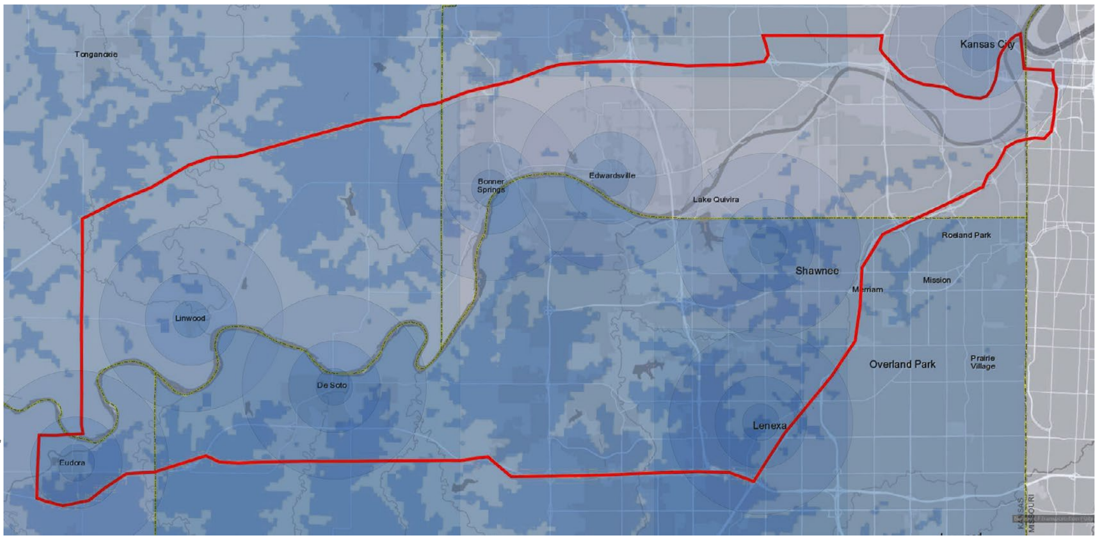


Figure 20: *The regional area was analyzed for its energy potentials, economic opportunities, and for the cities and towns where small to medium scale renewable energy installations are feasible.*

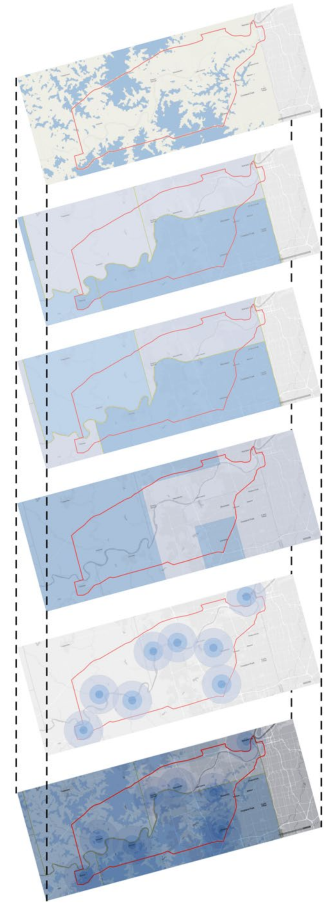


Figure 21: *The overlay diagram above shows how the different aspects of the site come together to reveal zones of greatest opportunity. In descending order, the maps reflect:*

- ***Wind Potential***
- ***Job Creation***
- ***Labor Force Growth***
- ***Solar Potential***
- ***and Community Proximity***

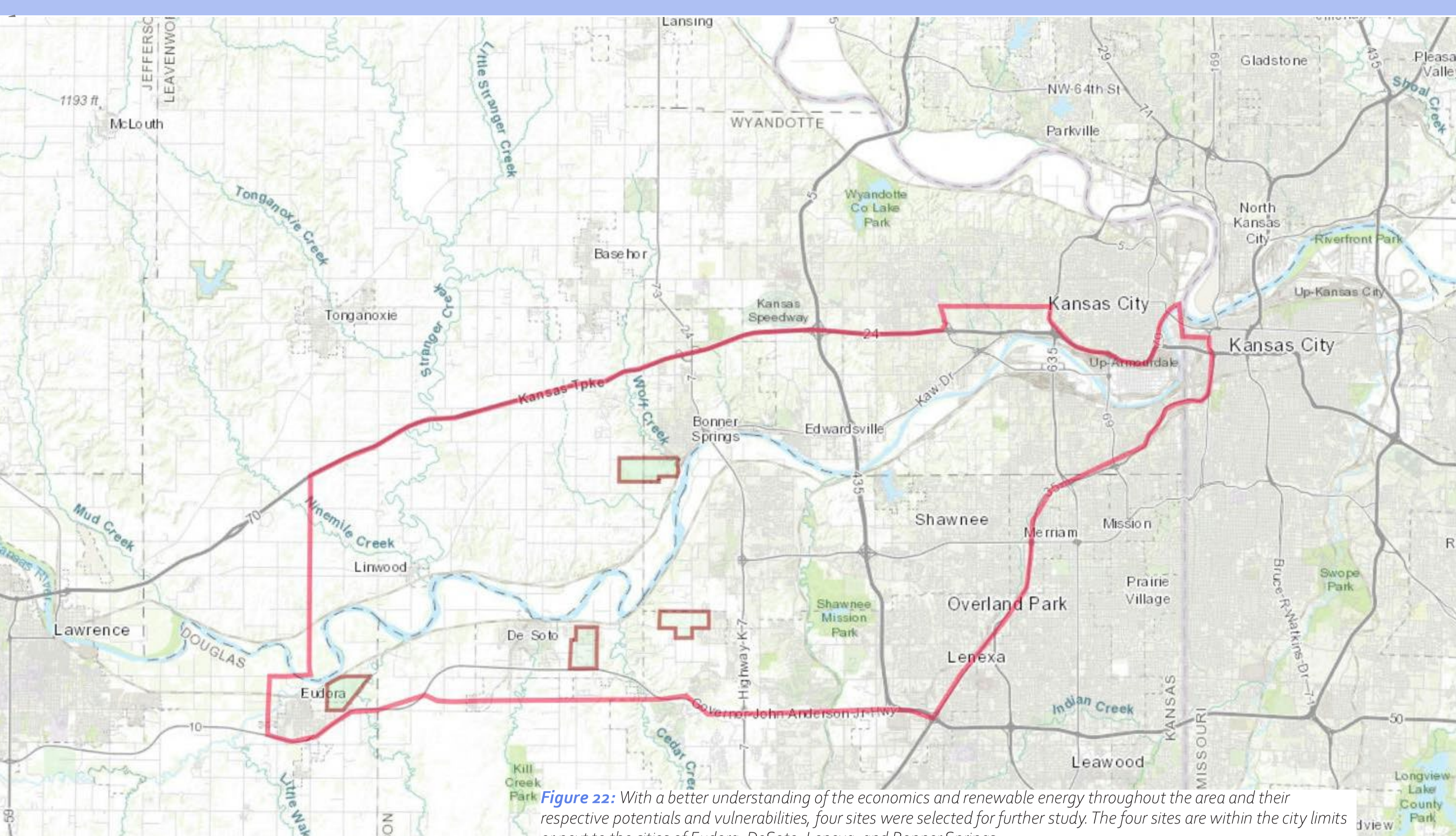


Figure 22: *With a better understanding of the economics and renewable energy throughout the area and their respective potentials and vulnerabilities, four sites were selected for further study. The four sites are within the city limits or next to the cities of Eudora, DeSoto, Lenexa, and Bonner Springs.*

the importance of understanding the Green New Deal and how a regional framework might be used to guide potential application.

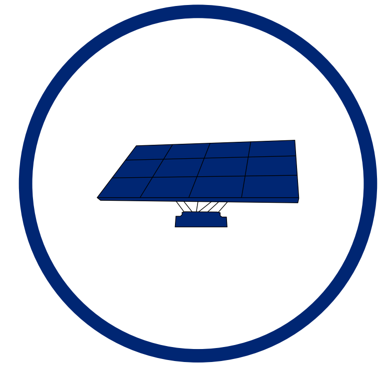
The project I conducted in the fall and spring semester master's studios demonstrates that small-scale renewable energy sites could be beneficial to communities. Renewable energy sites could lead to further decarbonization, new jobs for residents of the community both current and future, and decreased costs to produce energy which over time would lead to more affordable rates for all residents of the immediate and surrounding communities. The project shows that the design process and creation of renewable energy sites is more complex than placing turbines or PV panels upon the landscape. These renewable energy landscapes require skilled designers and engineers to carefully consider the capabilities and limitations of each designated site. Additionally, the project produced various graphics which were used in the subsequent preference study.

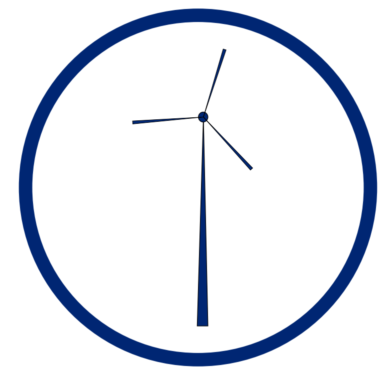
Discussion of Sites and Designs:

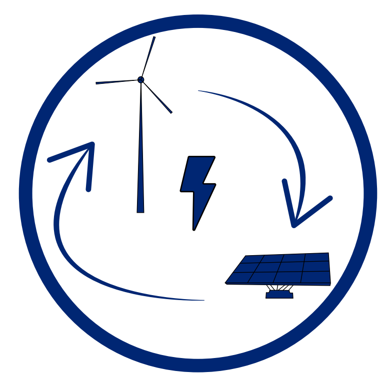
Sites are discussed in detail, explaining their setting (where they are within regards to the heart of their respective communities), their size, their power output, the site's current use, and the proposed renewable energy infrastructure. The context of each site is important for this study as it is necessary to understand how they fit into the regional landscape fabric. It is also important to consider how each of these sites will fit into existing energy grid. Knowing how and where each site connects to the grid is important because of the transmission lines required to deliver the power from site to consumer. Necessary changes to the grid will inevitably lead to more energy corridors which must space across roads, highways,

railroads, and through towns and neighborhoods. The goal in each of these projects is to connect each renewable energy hub to the nearest electrical substation thus minimizing impact.

Each site design features a different approach to the implementation of renewable energy. Some sites utilize a mix approach which feature both wind turbines and PV solar panels while others focus on either an all wind or an all-solar approach. All sites are centered upon the idea of creating small-scale realistic energy solutions that demonstrate how wind and solar energy can reduce dependence upon fossil fuels and how the generation of electricity can be made more efficient and cleaner for the global population. A variety of plan, section/elevation, and enhanced imagery graphics will be used to convey site designs and tell the story of each site.







Eudora:

The first site is near Eudora, Kansas. Eudora is a small town of about 6,500 residents about 10 minutes east of Lawrence, KS. The site focuses on utilizing both solar and wind renewable energy strategies and can be found near the Kansas River east of the town. Currently, much of the site is used for agricultural purposes with a few homes scattered throughout the site. It is approximately 550 acres in size and the proposed design features seven wind turbines and a solar field about 60 acres in size. The northern most and eastern most portions of the site are covered by woodlands which would need to be addressed in the actual implementation of the site to ensure no interference to the energy equipment. The total potential energy output of the site is around 29 MW. Site design for this particular site focused on organizing wind turbines along three diagonal axes which helps to visually align the turbines so that they appear in a sequence. All wind turbines on the site face a west to southwest direction. The solar array was situated to the south of all wind turbines on site and face directly south. This was done to maximize the effectiveness of the PV system and reduce direct solar disruption.

Figure 23: Wind and solar field at the Eudora site. The Eudora solar field is about 60 acres in size (Ferrara 2020).

Figure 24: Wind turbines on the eastern side of the Eudora site (Ferrara 2020).

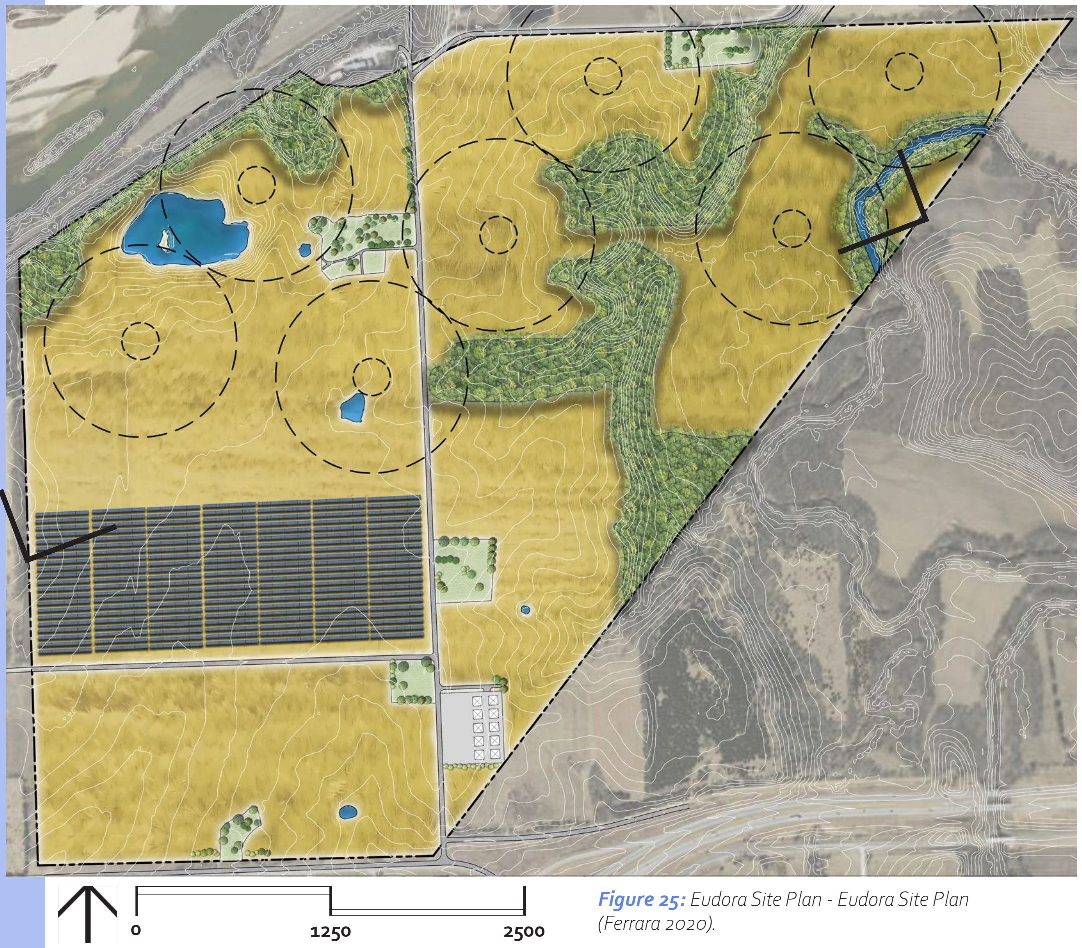


Figure 25: Eudora Site Plan - Eudora Site Plan (Ferrara 2020).

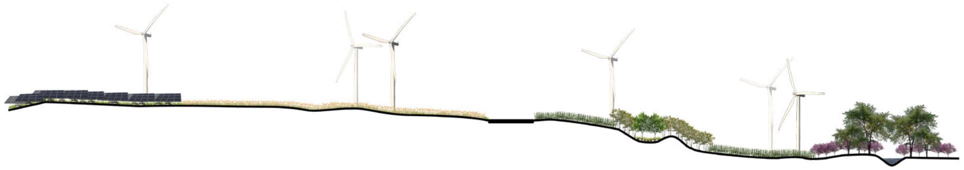


Figure 26: Eudora Site Section which cuts across the entire site shows that the site is relatively flat and is mostly made up of farmland (Ferrara 2020).

DeSoto:

The De Soto site also features both wind turbines and PV solar collectors. The site, which is approximately 575 acres, features a mix of uses ranging from residential areas to scattered agricultural land throughout with pockets of forested area in between. Area terrain is dominated by gently sloping hills with a few areas of steep gradation. Arrangement of renewable energy infrastructure on site was meant to reflect a more clustered pattern. Groups of wind turbines and solar arrays reflect the pre-existing arrangement of structures found on-site. Together the proposed wind and solar installations have an energy potential of about 19MW. The project would also employ local businesses within the area to assist with the clearing and pre-construction phases of the site implementation. This site is unique because it presents the opportunity to show how renewable energy can be implemented at the neighborhood level and demonstrating the possibilities of implementing these small-scale systems near these communities. The maintenance and upkeep of the infrastructure would contribute to the local economy and provide new career opportunities to both current and future residents.

Figure 27: De Soto Wind Turbine Installments

Figure 28: De Soto Wind Turbine Installments

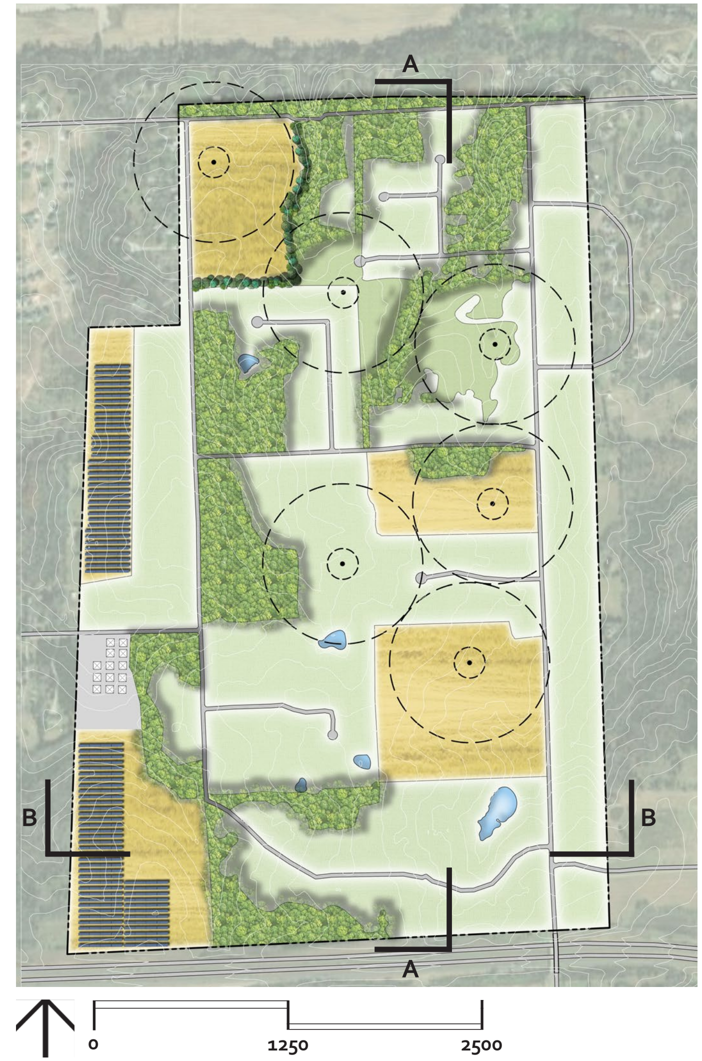


Figure 29: De Soto Site Plan - The plan is organized to work with the neighborhood around it, utilizing the open space available within the site boundary.

Figure 30: De Soto Section A

Figure 31: De Soto Section B

Lenexa:

The Lenexa site, which is on the western side of the city near De Soto, focuses on an all-solar approach to a small-scale renewable energy system. As it exists, the site is mostly made up of open agricultural land with scattered woodland space found throughout the site and there are a few private properties found throughout the site as well. The concept for the layout of the site is different than most solar arrays in that they are not all massed together to appear as one massive solar array. Solar arrays were organized into four solar ribbons and are separated by forested areas. The sectioned ribbons of solar fields are framed on the northern side and southern side of each by native grass and wildflower planting mixes. An existing transmission station is located at the southeast corner of the site and a large electrical transmission line cuts across the site, so the design needed to work around this preexisting piece of infrastructure. In total, the site is covered by nearly 180 acres of solar arrays of the 560-acre site. This site is also unique in that it contains a local school, Mill Creek Middle School. It provided a unique opportunity to demonstrate that renewable energy infrastructure can be incorporated into the fabric of the community without interfering with its existing components. The whole solar array can produce and estimated 45 MW of power.

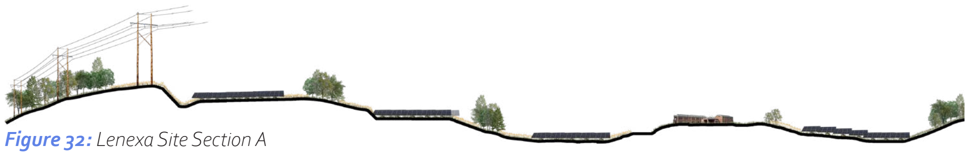


Figure 32: Lenexa Site Section A

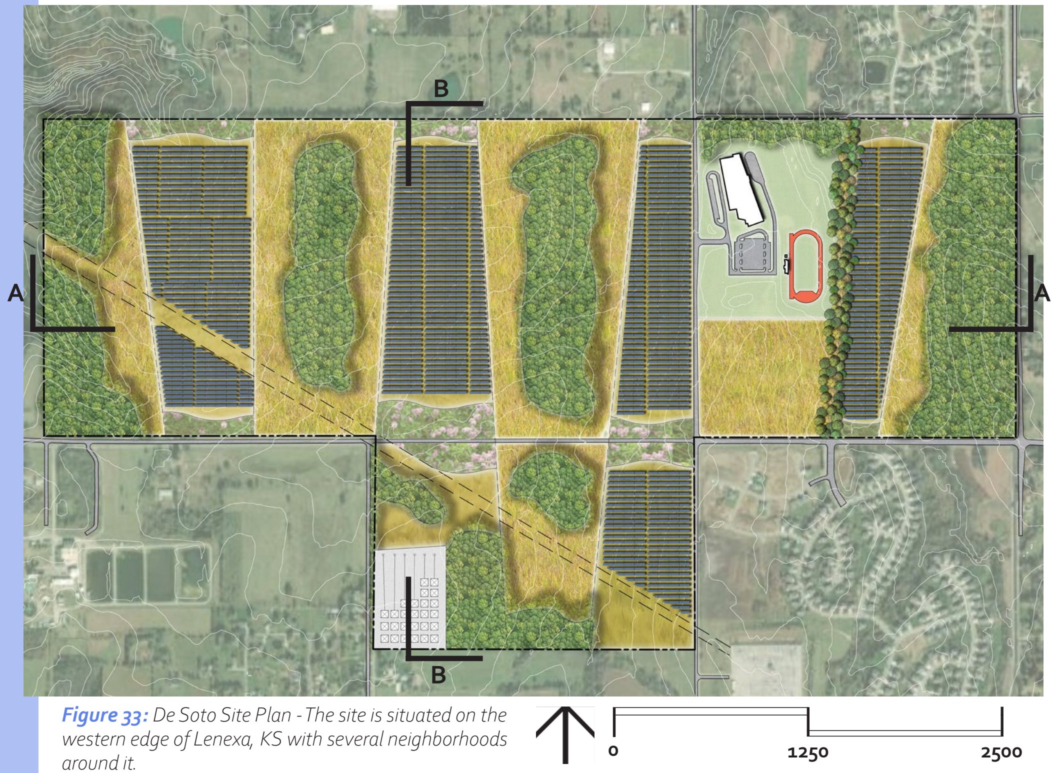


Figure 33: De Soto Site Plan - The site is situated on the western edge of Lenexa, KS with several neighborhoods around it.

Figure 34: Lexexa Solar Field West of School

Figure 35: Lexexa Solar Field East of School

Figure 36: Lenexa Site Section B

Bonner Springs:

The final site in Bonner Springs entirely utilizes wind energy as the site hosts 13 wind turbines and has a 13 MW capacity. In terms of size, the site is slightly larger than any of the other sites. It is about 730 acres in area and is located along the river bluffs of the Kansas River just southwest of downtown Bonner Springs. Much of the site is made up of various residential properties with a lot of forest space and more open farm fields. The wooded portions of the site, especially along Wolf Creek which can be found in the northeastern corner of the site, are particularly dense and feature multiple streambank plant species. The site was designed to present and show how much space wind turbines need. The small inner rings on the plan are indicative of the width of the turbine blade and each outer ring represents the recommended spacing needed between each wind turbine (generally about 300ft). To demonstrate this space, each of the rings contain a mix of native shortgrass and wildflower plantings to show the amount of clearance needed between each turbine and the space outside the rings is made up of native tallgrass plantings. The result is two groups of planting circles that nest the wind turbines themselves. The design is meant to emphasize how plantings can help frame the renewable energy around it.

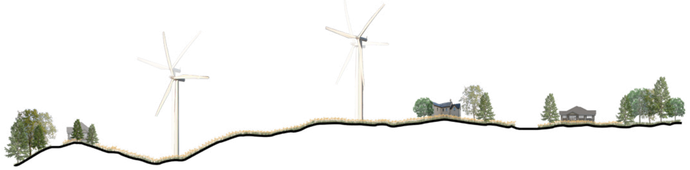


Figure 37: Bonner Springs Site Section A

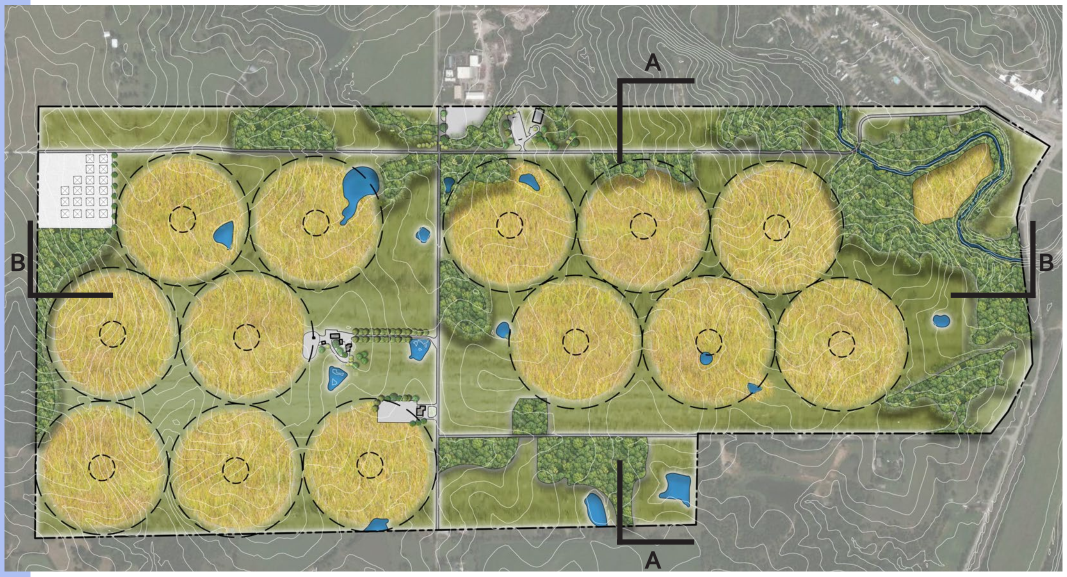


Figure 38: Bonner Springs Site Plan - The site is found just west of historic downtown Bonner Springs. It is made up of mostly farm land and sits just above the bluffs of the river.

Figure 39: Bonner Springs Wind Turbines

Figure 40: Bonner Springs Wind Turbines

Figure 41: Bonner Springs Site Section B

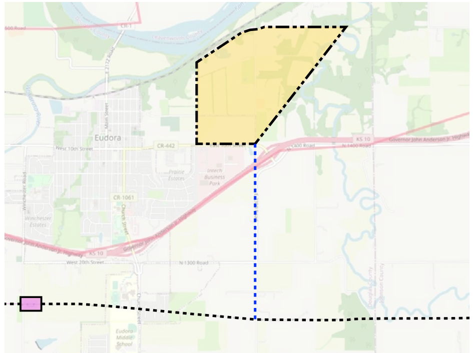


Figure 42: Eudora Grid Connectivity (Ferrara 2021).

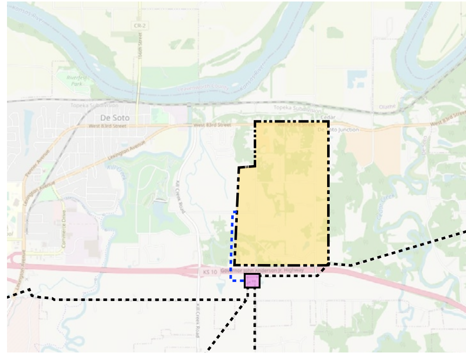


Figure 43: De Soto Grid Connectivity (Ferrara 2021).

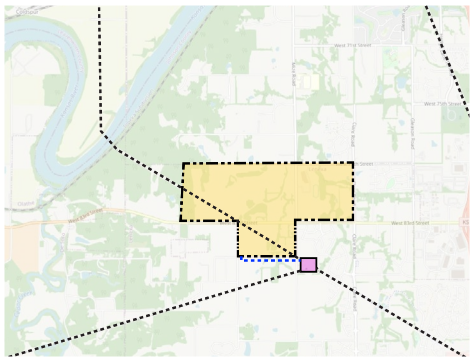


Figure 44: Lenexa Grid Connectivity (Ferrara 2021).

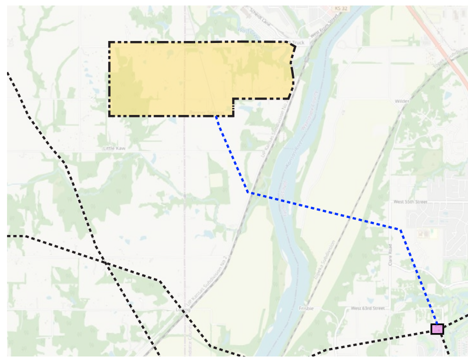


Figure 45: Bonner Springs Grid Connectivity (Ferrara 2021).

Local Energy Grid and Connectivity of Sites

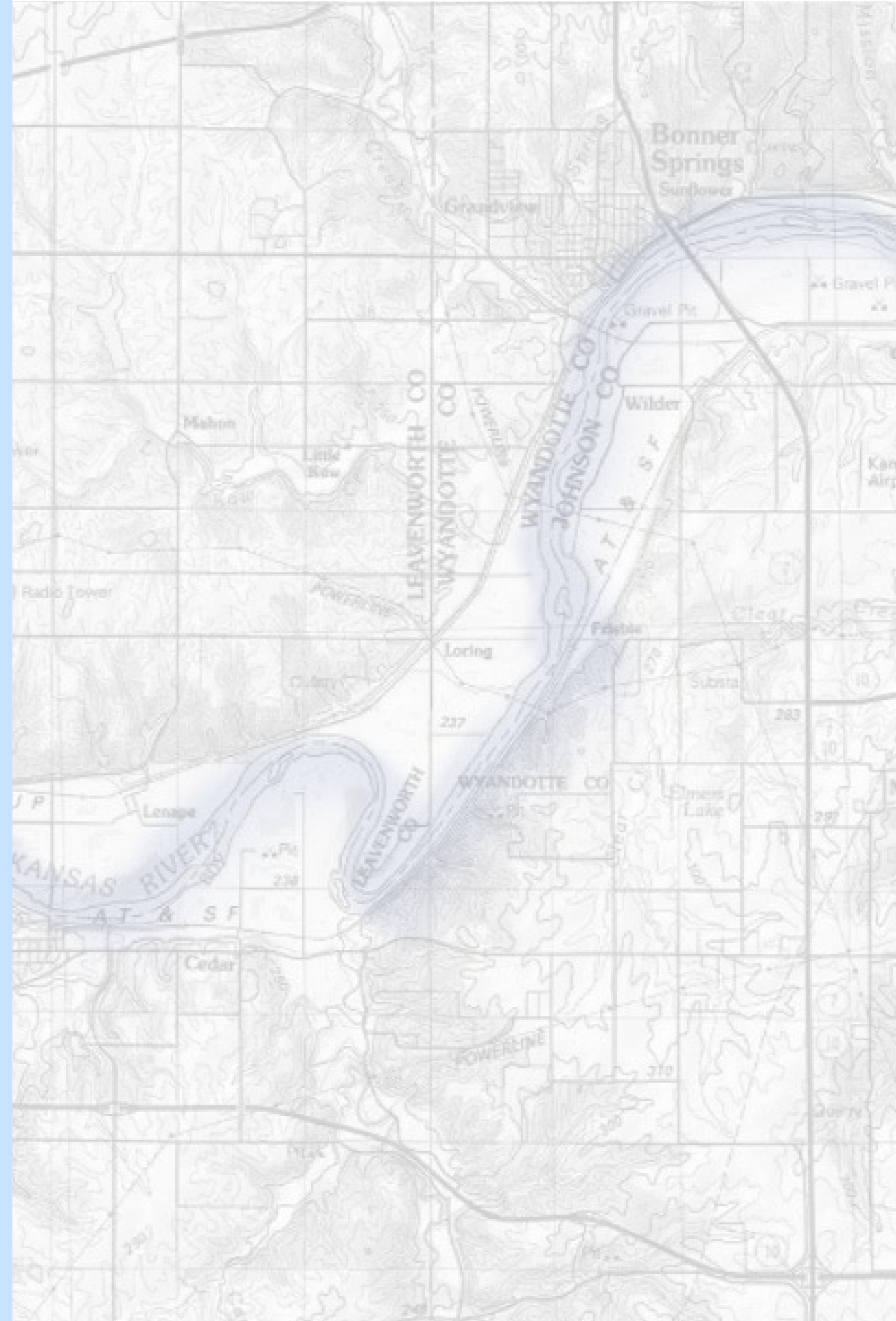
It is important to understand how the local energy grid functions within the regional site and how it would impact the individual sites themselves. The transmission of the energy that would be produced at the new sites must delivered to the existing electrical grid if the sites are to contribute to energy generation within the area. The U.S. Energy Information Administration holds information on the location of electrical substations throughout the entire country and using their online mapping service, the nearest substation to each site was found. Figures XX through XX display maps of the nearest substation to each site and they also display the surrounding large overhead powerlines. The sites are in yellow and nearest energy substations are in purple. The blue dashed lines represent the proposed connection to the grid and the black dashed lines are the existing overhead power corridors.

How the Pilot Project is Significant

The four sites were chosen for their energy potentials, economic opportunities, and the cities and towns where small-medium scale renewable energy installations are feasible. The goal of choosing four sites was to create unique renewable energy systems that could help form a small-scale renewable energy network. This network would help to shift the way our society thinks about renewable energy by demonstrating that wind turbine and photovoltaic panel installations can be thoughtfully designed to minimize aesthetic impacts. Small-scale renewable energy systems can help us to decrease dependence upon a national energy grid and lead to a society that works with nature and emulate its processes. The graphics produced during this pilot project were used in a follow up renewable energy preference study. Two sites from the project (the Eudora and DeSoto sites) were further examined by surveying the townspeople from each of the respective cities. The following chapter discusses how the preference study was conducted and what its results were.

Preference Study

6



Overview

The renewable energy (RE) preference study set out to answer the key research questions mentioned in the methodologies section of this report:

- *How does renewable energy fit aesthetically within the fabric of our landscapes, especially those in eastern Kansas?*
- *Can renewable energy provide the power needed for entire regions?*
- *What impacts would occur if we implemented more renewable energy within our communities?*
- *What are the strategies and guidelines we use to design and implement renewable energy landscapes?*

These questions play an important role in understanding how designers, engineers, planners, and energy experts alike can promote RE and understand how the wind turbines and PV panels are aesthetically perceived by those who live near and or around them. To explore these questions further, a renewable energy preference study, in the form of a survey questionnaire, was necessary to ascertain the aesthetic acceptance of RE. Participants for the preference study were selected from residents of two cities which featured sites from the pilot project (described in chapter 5), one in Eudora and other in De Soto, KS.

The two sites and their respective cities were selected based upon the following. First, both cities have similar population sizes (both being around 6,000 residents). Secondly, both cities have a similar landscape character in that they both contain neighborhoods and small-town centers, but maintain a sense of the countryside. Finally, the cities are similar in that they are both towns found just outside larger metropolitan areas (De Soto being just outside the Kansas City metro area and Eudora being just outside

the Lawrence Metropolitan area). De Soto and Eudora, Kansas are good examples of what smaller towns and communities throughout this region look like. Smaller communities are often rich in character and tight knit. Most people know their neighbors and are familiar with the issues and challenges the community faces each day.

The first part of the survey was designed to understand people's preferences when it comes to renewable energy. For both cities, respondents viewed two series of four images. Respondents from Eudora were shown Eudora site imagery and respondents from De Soto were shown De Soto site imagery. The visualizations produced were created using photographs taken during site visits to the respective cities and utilize photographic alterations to display what RE apparatuses might look like on site. Each series of four images display the following conditions: one that displays no RE equipment, one that displays only wind turbines, one that displays only PV panels, and one that displays both wind turbines and PV panels (it should be noted that these images were not placed in any particular order). An example of what participants viewed can be seen in figure 46. Respondents ranked images using a "drag and drop" question format which allowed them to place the images in the order they desired. In the second part of the survey, respondents were asked a variety of demographic questions to gauge their environmental attitudes and setting preferences. The second part is aimed at understanding the settings people come from (urban, suburban, small town, or rural), how scenic they see eastern KS landscapes, how concerned they are with the environment, and how important they believe RE to be.

Figure 46: *The images above are a one of the series of four images used in the first part of the preference survey. These were made by taking one image taken during a site visit and altering it to display the various necessary conditions (wind, solar, wind & solar, and no site change). This process was performed several times for a variety of images from both he Eudora and the De Soto sites.*

Survey Distribution:

Preference surveys were distributed to the respective populations of De Soto and Eudora via the popular social media website: Facebook. Facebook was the most logical way of getting the survey out to the proper towns' populations in a timely fashion. Each city has their own Facebook community group which is led by local community leaders. The De Soto group is composed of about 5,000 members and the Eudora group has about 4,300 members. A brief explanation of the survey and its contents were given to the community members and they were advised on the amount of time it would take to complete the survey.

The survey was available for response for a total of three weeks. In addition to the first post which introduced the survey to both the Eudora and De Soto Facebook groups, two reminders were sent out over the following weeks. The final reminder was sent out on February 24 which meant the

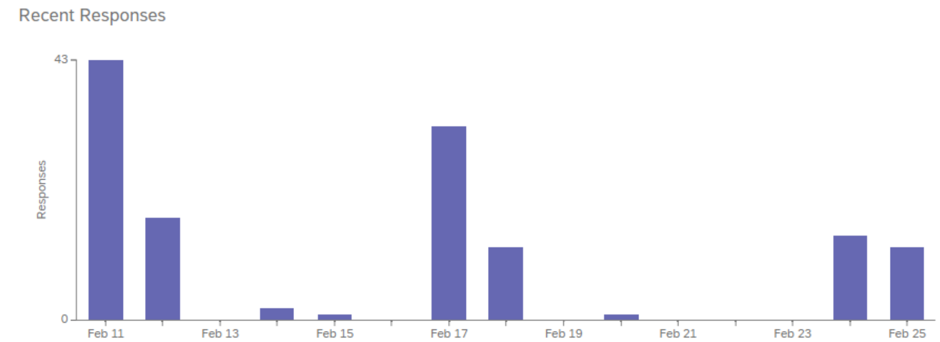


Figure 47: *The above bar graph displays the number of surveys taken each day for the duration of the survey. Most of the responses were collected during the first 24 hours the survey was available. Survey reminders correspond with the other increases of participants (Ferrara 2021).*

survey was available from February 11 until February 28, 2021. In total, more responses were collected from De Soto than Eudora. Figure 47 displays the amount of time the survey was available and the level of response across that time.

Survey Results:

The preference survey was taken by people from each city and respondents' background included a diverse range of age, gender, and education (more specific information about respondents demographics can be found in Appendix B, pages 177-179). Initial survey results reveal that groups from both cities have a range of perceptions regarding renewable energy equipment within the landscape. Results also indicate that there are interesting correlations between how people view renewable energy within their own landscapes and their attitudes about scenic value, environmental protection, and renewable energy in general.

Regarding survey respondents from De Soto, the majority of respondents found that they most preferred images of the sites that demonstrated no change. The least favored images were those that featured the mixed approach strategy to renewable energy with both wind turbines and PV panels. However, examining the second and third most preferred images revealed some interesting insights about the preferences of people from De Soto. Most of the De Soto respondents said that the second most appealing image in both image series were those that featured only wind turbines

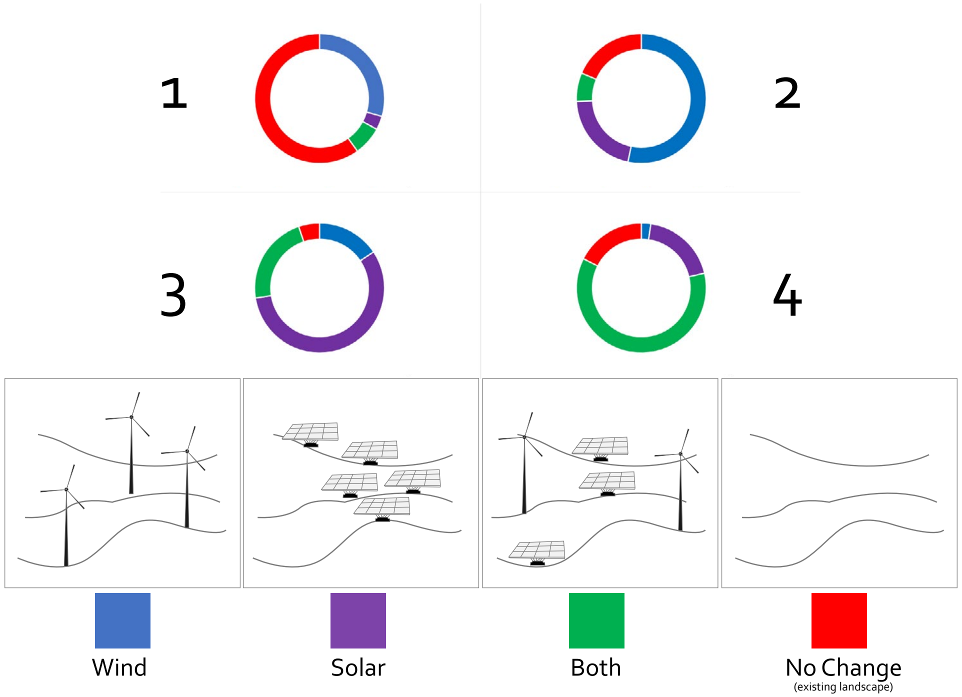


Figure 48: The pie charts above display the image preference results for the entire region. The pie chart with #1 above it is indicative of respondent's most preferred image following to the chart with the #2 above it which indicates respondents 2nd most preferred image and so on. Overall images with no change were most preferred, however most respondents indicated they prefer wind turbines within the landscape as opposed to PV (solar) panels (Ferrara 2021).

and that the third most appealing images were those that only featured PV (solar) panels. Figure 48 displays the overall results of the image preference tests.

The respondents that answered the survey from Eudora provided similar survey results to those that answered form De Soto. The least preferred image for both Eudora image series were the ones that featured both PV panels and wind turbines. The images with only PV panels were also the third choice for most respondents and wind turbines were once again, the second most preferred option. The most preferred images for Eudora yielded some interesting results. From both series of images, most respondents indicated they preferred images of the sites that demonstrated no change, however when examining individual results of each series, the second series of images for Eudora reveal a key difference. For the second image set, the most preferred image was the one that featured only wind turbines within view.

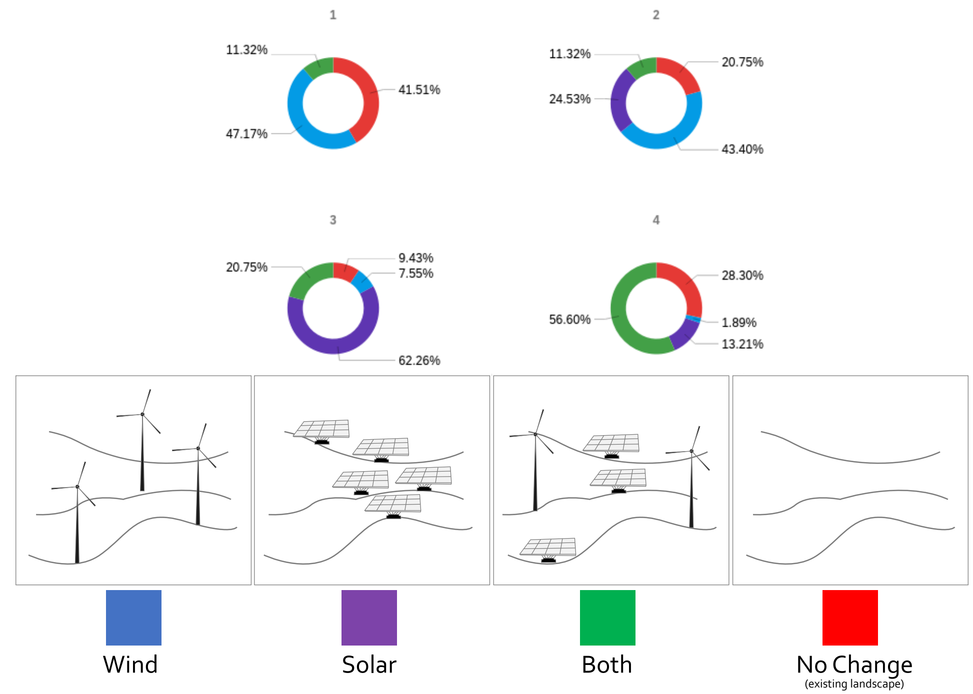
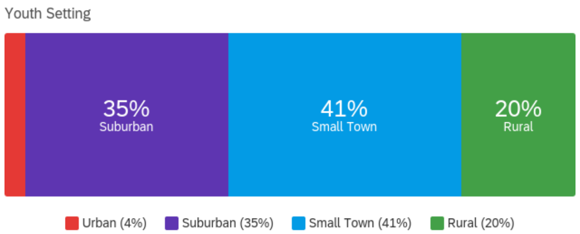


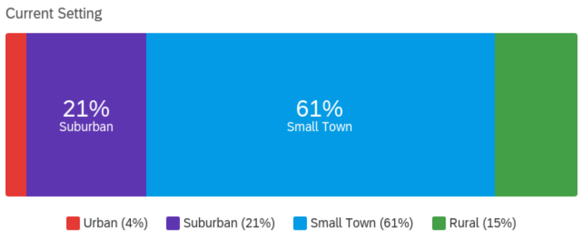
Figure 49: These pie chart represents the result of the 2nd image preference question for Eudora. The 2nd image series revealed that the image with wind turbines in view was the most preferred image with 48% of respondents claiming it was the most appealing image in the set (Ferrara 2021).

46% of respondents from Eudora indicating this was their preferred image. In figure 49, the key difference for the most preferred choice can be seen can be seen.

The image preference test section of the survey did reveal one major factor overall which contributes to the understanding of renewable energy landscapes. For every image series in the preference survey, the least appealing or least favored image were the ones that had both wind turbines and solar panels within view. The fact that images with both strategies were least preferred could potentially indicate that within renewable energy landscapes, most people prefer that only one type of renewable energy apparatuses or equipment be used.

The next group of questions revealed interesting perspectives and attitudes about people from both cities. One of the intentions of the survey was to examine how some people see their own life within the towns of Eudora





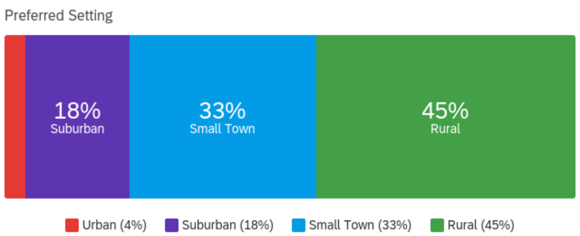


Figure 50: The Breakdown Bars show how respondents described the settings they come from, the settings they currently reside in, and the settings they would choose if given the opportunity (Ferrara 2021).

and De Soto. Respondents were asked three questions regarding setting which were 1) the setting they grew up in, 2) their current setting, and 3) the setting they would choose to be in. For all three questions they were able to choose from urban, suburban, small-town, and rural. For the first question, most respondents seemed to be from suburban or small-town areas with both settings yielding 38% of respondents. Others saw themselves as being from rural areas (20%) and even fewer from urban settings (4%). In second question, about where the respondents currently reside, it was found that 56% of respondents see the areas in and around Eudora and De Soto as smalls towns while others see the area as more suburban (25%) or rural (15%) with very few viewing it as urban (4%). When asked about which setting, they would prefer to live in if they could choose, rural was the most favored option with 46% saying they would prefer a rural setting followed by others saying they would prefer to live in a small-town (32%) or suburbia (19%). Only 4% of respondents

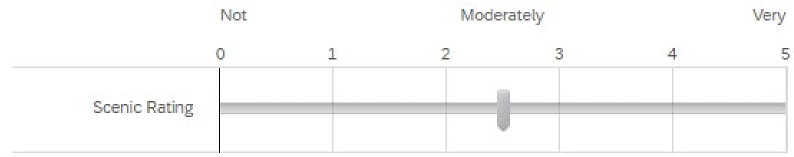


Figure 51: Example of the scale used by participants to indicate scenic rating, level of concern, and level of importance for some of the questions in the survey.

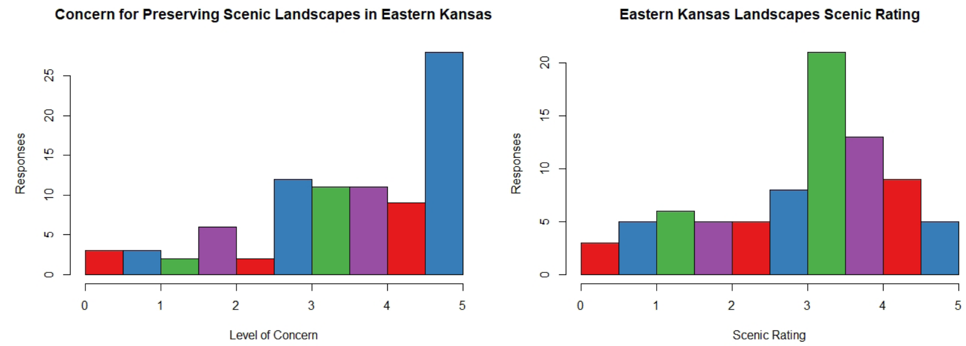


Figure 52 & 53: The histograms indicate that respondents have mixed opinions on how scenic eastern KS landscapes are, but several indicate that they see the landscape as being more moderately scenic. When it comes to scenic preservation however, more respondents indicated they are more than moderately concerned about the preservation of landscapes throughout eastern KS (Ferrara 2021).

said they would prefer an urban area as their setting of choice. The following results can be seen in figure 50 in the breakdown charts .

Respondents were also asked two questions about the scenery in the eastern KS landscape. First, participants were asked to give landscapes of eastern KS a scenic rating on a scale of 0 being not scenic at all to five 5 being very scenic (example of scale seen in figure 51). Many respondents found that eastern KS landscapes were somewhere in the range of moderately scenic (2.5) to very scenic (5) with more than half of respondents giving eastern KS landscapes a rating of 2.5 or higher. The next question asked respondents how concerned they were about preserving the scenic attributes of eastern KS landscapes on a scale of [0-5]. Most respondents indicated that there were higher levels of concern for wanting to preserve the scenic value that their home landscapes offered with more than 80% of respondents indicating they had

#	Field	Minimum	Maximum	Mean	Count
1	Air, Water, and Waste Pollution	0.00	5.00	4.03	99
2	Endangered and/or Threatened Native Species	0.00	5.00	3.79	100
3	Global Environment	0.30	5.00	3.66	97

Table 01: The table shows how concerned respondents are with the following environmental issues. On average most respondents have higher levels of concern for every issue listed with Air, Water, and Waste Pollution as the greatest concern (Ferrara 2021).

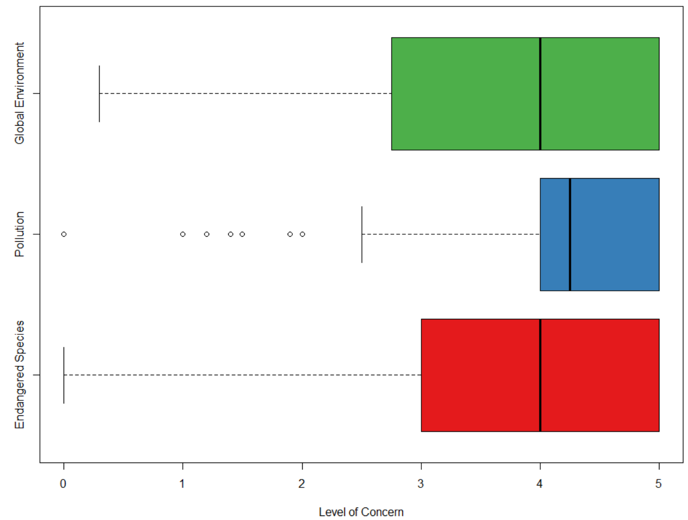


Figure 54: As further demonstrated, the boxplots indicate there are high levels of concern for all the issues with many people indicating the maximum level of concern for all of the issues (Ferrara 2021).

higher levels of concern (3.0 or higher). The histograms in figures 52 & 53 display the results of both questions.

The final two groups of questions asked in the survey were used to help understand the attitudes of respondents toward some of the key environmental issues and the more general aspects and benefits of renewable energy. The first question was aimed at understanding how concerned respondents were with key environmental issues such as air, water, and waste pollution, endangered and/or threatened native species, and the global environment. The second question asked about renewable energy and how important respondents feel it is within regards to the production of energy, local economies, and sustainability. Responses to both questions revealed similar trends. Most respondents feel more than moderate levels of concern when it comes to pollution, endangered

#	Field	Minimum	Maximum	Mean
1	Energy Production	0.40	5.00	3.91
2	Local Economies	0.00	5.00	3.55
3	Sustainability	0.10	5.00	3.95

Table 02: The table shows how important respondents feel the following items are within relation to renewable energy. On average, most respondents feel all the items to be pertinent to renewable energy (Ferrara 2021).

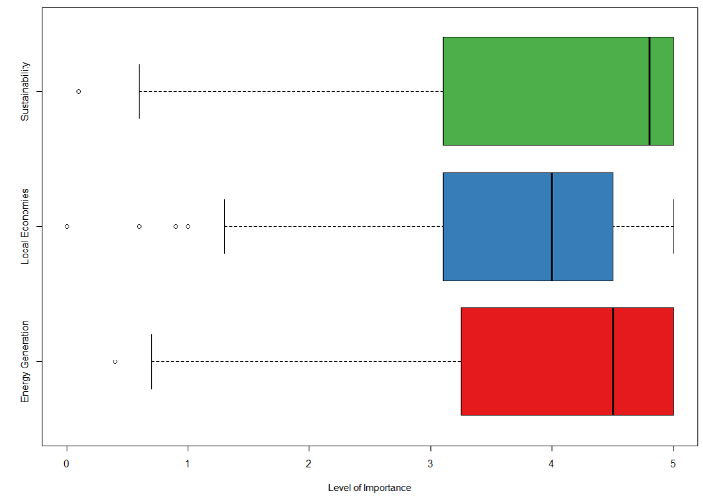


Figure 55: The box plot shows that many of the respondents feel that both sustainability and energy production are extremely important to renewable energy, but level of importance to local economies is seen as a lesser yet still significant importance (Ferrara 2021).

species, and global environment while similarly respondents feel that renewable energy is more than moderately important to support energy production, local economies, and sustainability. The results of the two questions can be seen in tables 01 & 02 and in figures 54 & 55.

Summary:

The key takeaways from the renewable energy preference study are that participants of the study from the Eudora and De Soto communities feel that renewable energy installations of any kind within the landscape are less appealing than the current unimpaired landscape. However, participant responses would also indicate that wind turbines within view are more appealing than that of PV (solar) panels or some combination of both. Participants who answered the survey see that their communities are more likely small towns, yet some do feel that they are in suburban area while others would consider their communities to be rural. Additionally, many of the participants also feel that the landscapes of eastern Kansas do hold some scenic value and that the scenic attributes of the landscape should be protected. Concurrently, most, but not all, participants feel that they are to some degree concerned about key environmental issues in our society and that renewable energy is in some way significant to communities.

Reformed Design Guidelines & Project Adjustments

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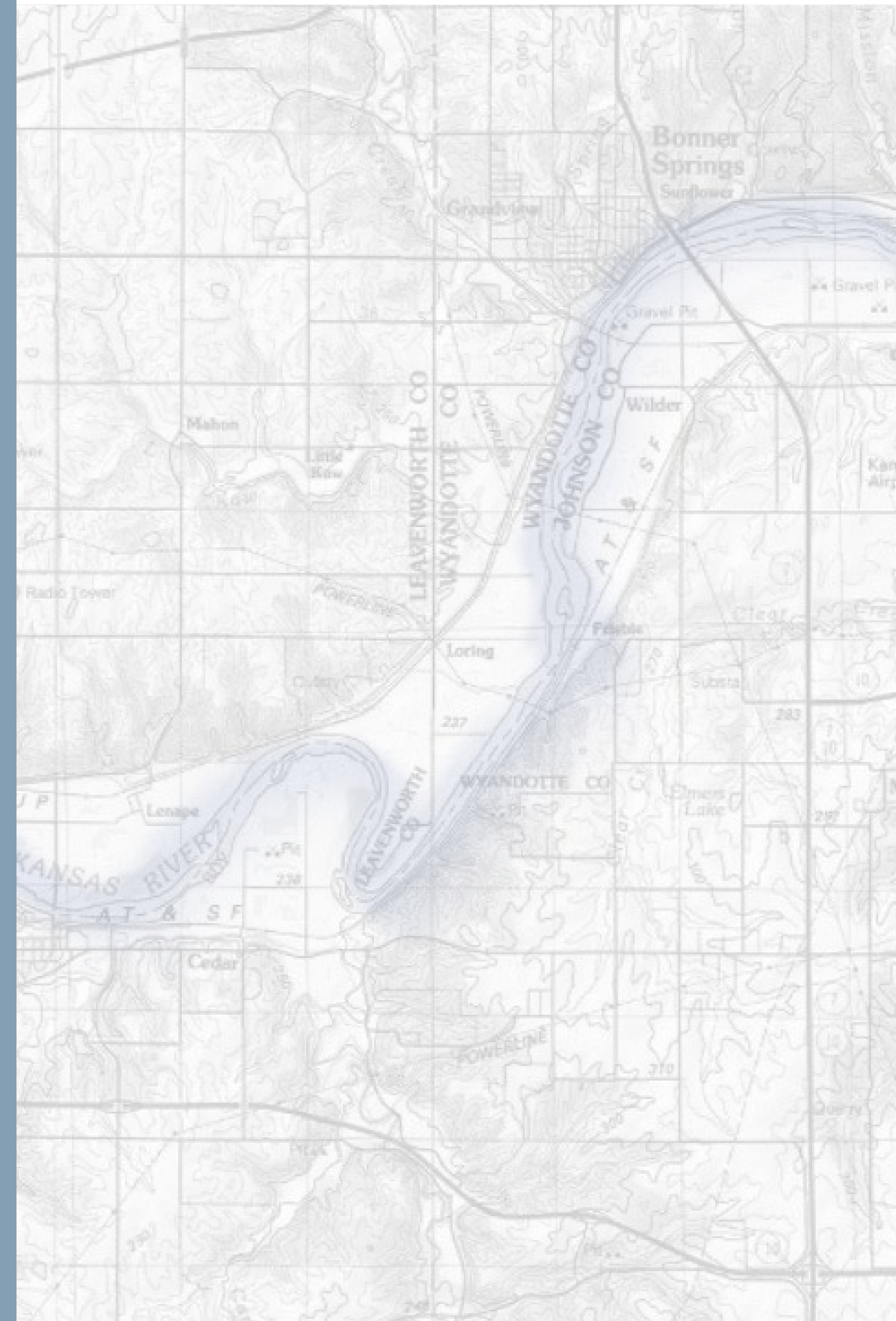


Application of Preference Study

The renewable energy preference study revealed what method of renewable energy generation is most appealing to participants. The image preference section found that wind turbines and imagery that featured turbines within view, were preferred to those which featured solar arrays or some combination of both. Based on responses from participants in the study, it is necessary to adjust the initial design guidelines and policy recommendations that were first mentioned in Chapter 4 – Case Study Analysis. Changes will reflect ideas and attitudes derived from responses to the preference study. The goal of adapting the design guidelines is to restructure the layout of pilot project sites discussed in Chapter 5 to reflect the RE preferences of people from eastern KS based responses from the preference study.

Limitations of Previous Design Guidelines

The previous set of guidelines were based on general findings from the four sites examined in the case study analysis. Guidelines were also shaped using common siting principles and visual assessment processes from renewable energy authorities. However, the initial guidelines did not accurately reflect the desired preferences of the local population and the regions ecological needs. In "Social Barriers to Renewable Energy Landscapes," author Martin Pasqualetti states that as technological advancements make renewable energy more attainable; the number of social barriers increase and they are often complex challenges to overcome (Pasqualetti 2011, 219). There are legitimate concerns about renewable energy related to the public perception, alterations to the landscape, and established lifestyles that designers, engineers, policymakers, and energy experts alike must address if renewable energy landscapes are to be successful (Pasqualetti 2011, 2019). To add to his point, it is also important to consider that the lifestyles, public perceptions, and landscape perceptions of people differ from location to location. In other words, there is no single set of guidelines or rules to be used when creating renewable energy landscapes because they vary from place to place and from region to region. Dean Apostal affirms this in his book The Renewable Energy Landscape by conveying it is important to analyze both landscape values and uses on a place-to-place basis when considering renewable energy development (Apostal 2017, 131).

Reformed Design Guidelines & Recommendations

The revisions to the design guidelines and recommendations below are meant to assist with changes and revisions to pilot project designs. New revisions to the guidelines will also further demonstrate why knowing the local communities preferences is key to the success of any renewable energy development. While renewable energy may affect the lives of many people across several communities, those that live near or around renewable energy landscapes will undoubtedly experience the greatest impacts due to these installations. The following are the reformed design guidelines & recommendations for renewable energy landscapes within Kansas.

- Conduct initial site visits & note key viewpoints in and around the area
- Conduct a visual assessment and assure quality of scenic views
- Emulate local area's landscape character
- Meet construction requirements set forth by national, state, local governments
- Ensure that the project would be beneficial to local economic growth and communicate the projected benefits with the community
- Reduce visual impacts of apparatuses and equipment so that sightlines and views are minimally interrupted
- Minimize possible negative impacts such as noise pollution or light reflection
- Make community aware of possible audio and visual impacts the renewable energy installations might have

- Connect proposed energy generating system to the local electrical grid and limit the transmission distance by ensuring substation is within close proximity
- Provide security measures for all sensitive equipment
- Avoid disturbing established or potentially fragile environments by coordinating with local and state environmental governing bodies

The changes to the design guidelines reflect the preferences and attitudes of ideas found in participants of the preference study. New design guidelines and recommendations are more attentive to the needs of the region and are aimed at meeting both the technical needs of the site and the public's needs surrounding issues of perception and visualization. Furthermore, the new design guidelines focus on the sites and communities they

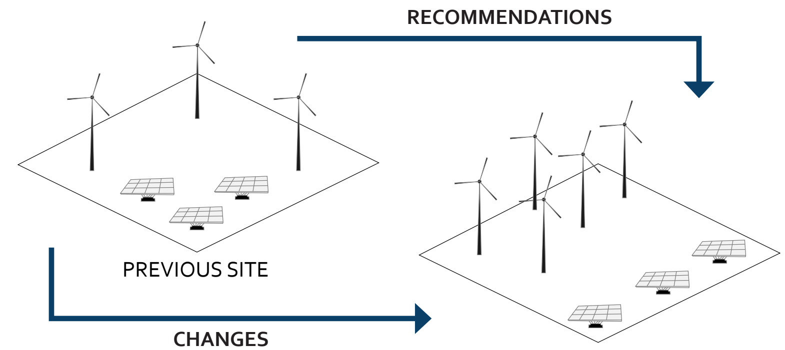


Figure 56: *The diagram above displays the reforming process used for each site. Similar orthographic diagrams will be used to demonstrate the necessary changes to each site. (Ferrara 2021).*

are within, or near, as places. While the intent is to design a renewable energy landscape, Eudora and De Soto are more than just small towns or suburban areas. Each city is a place with their own group of community members and their own individual character. The new design guidelines and recommendations place an emphasis on place-based design, and they focus on addressing social issues of public perception.

Project Adjustments and Reformations

The new design guidelines and recommendations will require various changes for each of the four sites from the initial pilot project. The sites within or near to Eudora, De Soto, Lenexa, and Bonner Springs will all need to be adjusted to reflect preferences of people within the region. Discussions for each site will examine the previous design strategy, how the strategy may have been limited, and what changes are necessary to meet the design guidelines and standards. Changes to sites include new arrangement of equipment and components, additional features to the site, and better cohesion with surrounding environment to maintain a sense of place. Overall, the reformed site designs should demonstrate that although the design process for renewable energy landscapes is lengthy, it leads to more thoughtful, publicly conscious designs that aesthetically fit well into the communities they were designed for.

Eudora

Site reformations for the Eudora site were much needed. The first rendition of the site design had some good elements and interesting approaches, but they lacked cohesion. The site features a mix of wind and solar energy generating equipment but the two were not working together with the flat farm, countryside landscape. The two were acting individually as separate entities, but the site reformations correct the issues. With the new design, both PV panels and wind turbine towers are placed along the diagonal axes keeping all apparatuses placed on the landscape organized. It was also necessary to move the energy transmission area from its previous locations near the middle of the site to the southern border of the site. This would ensure the shortest route to an existing electrical transmission corridor. Additionally, the site design is much more conscious of on-site views and sightlines and thus utilizes more planting screens to mask certain elements within the landscape, such as the PV panels and the transmission area. The planting screens fit well with the overall rural character of the landscape acting as windbreaks. Overall, the reformed design does not completely remove all semblance of the former design. Rather, the reformed design amplifies the design language by making the most of the diagonal axes and utilizing the planting screens to mask less preferred elements from view. Together, the turbines and PV panels are capable of a 23 MW capacity.

Figure 57: *Eudora Wind Field - Wind Turbine and Solar Field - the reformed site uses less solar arrays than before and utilizes more of the existing site features, such as fence lines and windbreaks, to mask and partition the RE equipment found on site (Ferrara 2021).*

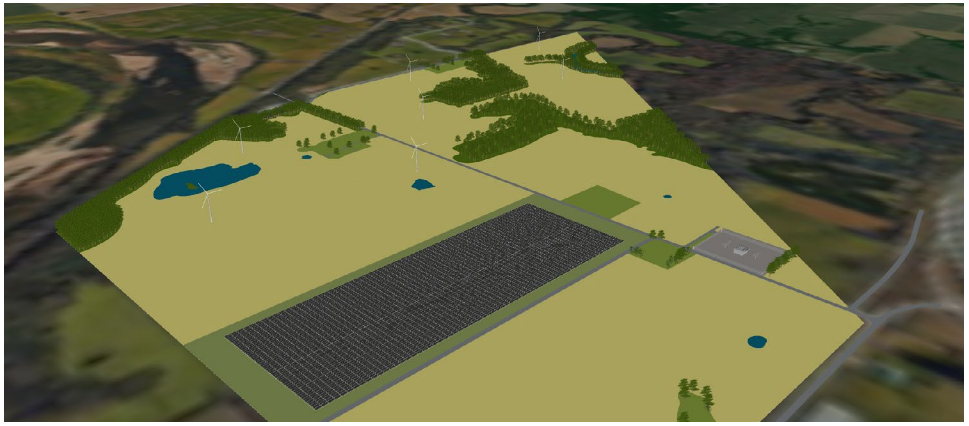


Figure 58: *Initial Eudora Site (Ferrara 2021).*

- Optimize for energy transmission
- Reinforce design language of strong diagonal axes
- Use planting screens and wind breaks whenever possible to screen equipment from view

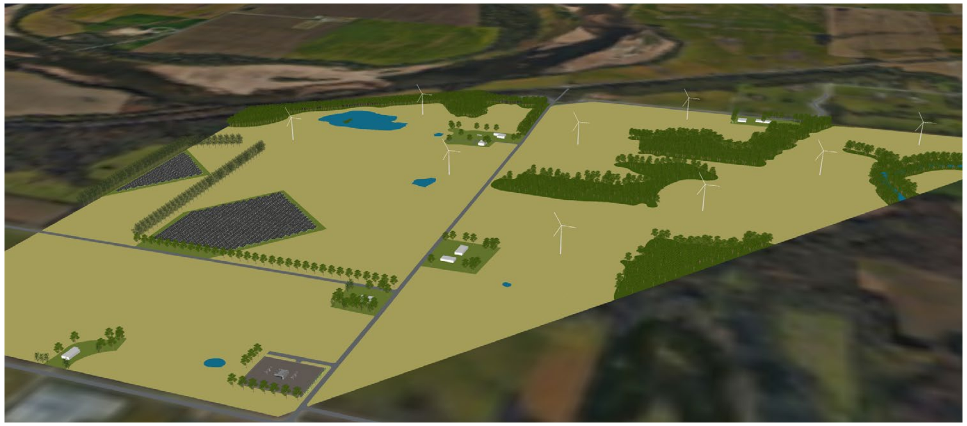


Figure 59: *Reformed Eudora Site (Ferrara 2021).*

- **Energy collection area transitioned further south on site**
- **All renewable energy equipment focus along diagonal axes**
- **Existing planting screens were maintained and new planting screens added to reduce visual hazards**

De Soto

The De Soto site had various challenges when creating the initial design and the reformed designed. The area is made up of a mix of farm fields and averaged sized residential lots organized around winding streets to create contemporary neighborhoods. Site topography also presents several challenges for the siting of PV panels and energy transmission areas (uneven landscape surfaces make the placing of multiple solar arrays more difficult). The former site design strategy sought to maximize the available space for solar arrays and group wind turbines together in clustered formations but ensure that the towers themselves were only found within the farm fields. The new strategy is more focused on using the available space and is more conscious of how much equipment can "fit" within the site. Turbine towers were more closely grouped in triangular

Figure 60: *De Soto Northern Wind Field - The reformed design grouped turbines more closely together (while maintaining distance recommendations) and more toward the center of the site (Ferrara 2021).*

clustered formations within the site so that the groupings appear deliberate and intentional and less random within the landscape. Additionally, the design features less solar arrays than before. A group of PV panels can be found in the southwest corner of the site and a linear column of panels are along the eastern edge of the site where a new public amenity installation has been envisioned. The new public space would act as a site of education and community engagement about the renewable energy installations within the area. The reformed design also shifted the location of the energy transmission area to the southeastern corner of the site. Overall, the renewable energy equipment on-site is capable of an 18 MW capacity.

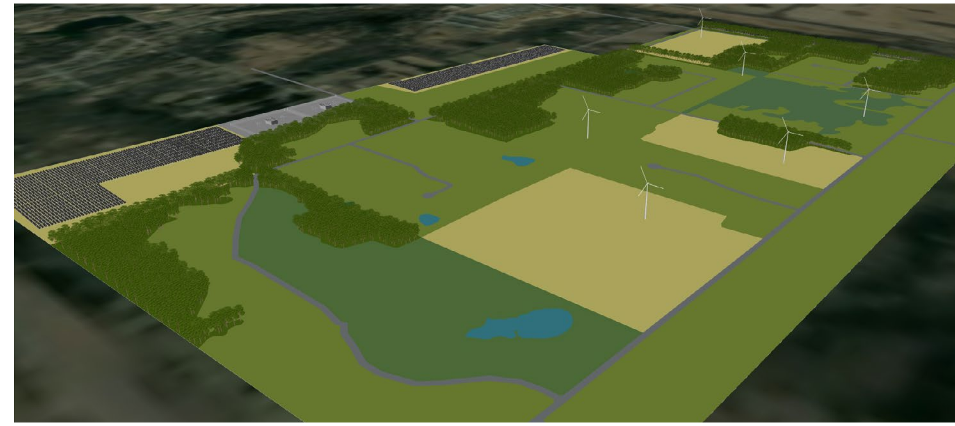


Figure 61: *Initial De Soto Site (Ferrara 2021).*

- Transmission area must be made easily accessible
- Screen transmission area from surrounding area
- Reduce solar field size
- Reorganize turbines to be centrally oriented within site
- Engage public to demonstrate benefits of renewables

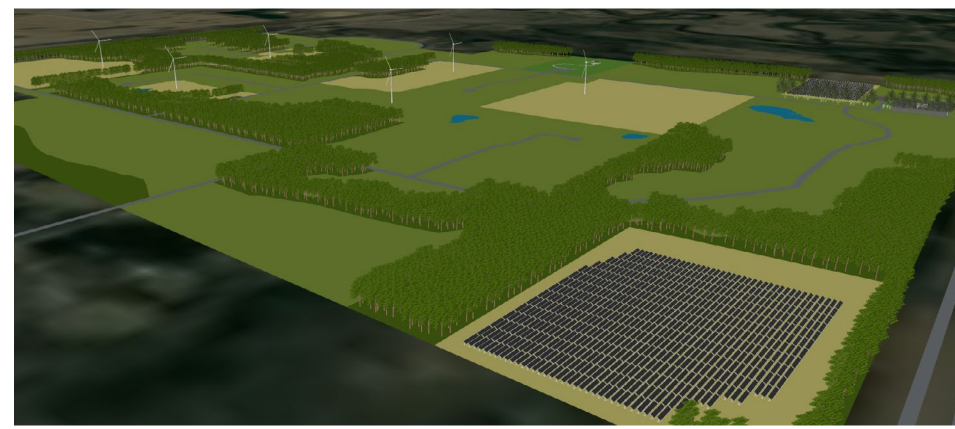


Figure 62: *Reformed De Soto Site (Ferrara 2021).*

- **Shifted transmission area to easily access grid substation just south of site**
- **Transmission area hidden from public view**
- **Turbines clustered in tighter triangular groups**
- **Solar array reorganized in smaller groups**
- **New community space created to inform public of site benefits**

Lenexa

Site adjustments at the Lenexa site reflect one of the major lessons learned from the preference study, namely that people within the eastern Kansas region prefer wind turbines to solar panels. This is challenging considering that the Lenexa site utilizes an entirely solar strategy. However, it does not mean that all solar arrays will be removed from the site and replaced with the wind turbines. Rather, a more careful approach to masking and screening the PV panels from general view is required. The old design featured several ribbons of solar arrays stretching across the site dividing it into various sections. While the approach was interesting, it created various fragments within the landscape and the panels were not easily screened from view (a column of panels could be seen across the street from the school). The redesign of the site, while keeping with the ribboning design idea, focuses more on utilizing the space as an opportunity for energy generation and recreation. While some PV panels were removed, additional screening schemes were implemented and a system of trails throughout the site brings an additional amenity to the community. The "park-like" setting demonstrates that solar arrays or "solar fields" are not singular in purpose and that they are beneficial to communities in more ways than one. The energy transmission area was also shifted to the eastern side of the heel of the site, so it is near the electrical grid substation. In total, the 135 acres of PV panels means the site has a 35 MW capacity.

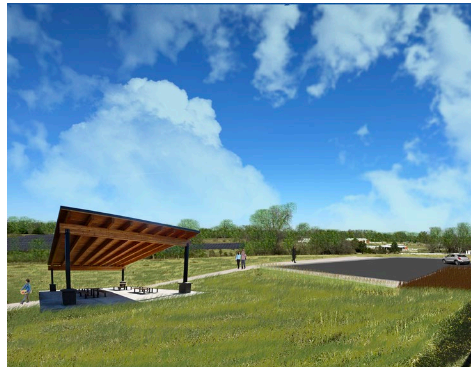


Figure 63: *Lenexa Solar Array Community Area - The new design for the solar arrays takes into account the need to show how RE landscapes can be multifunctional. The new design features a system of trails making the site a new type of "park" (Ferrara 2021).*

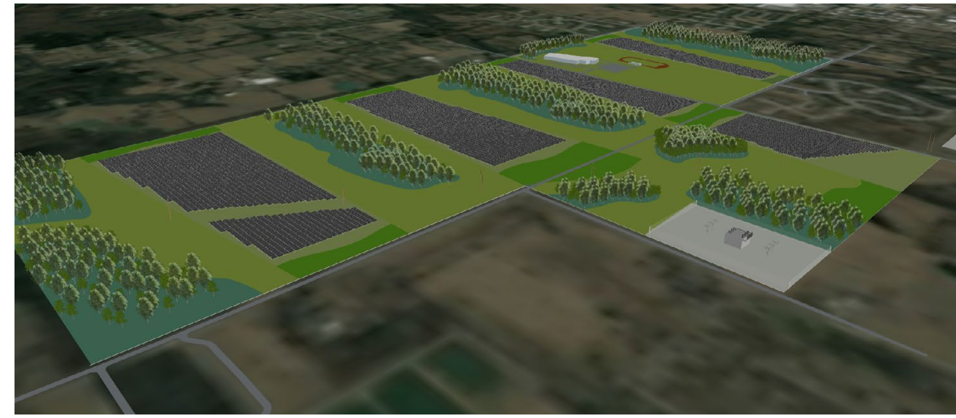


Figure 64: *Initial Lenexa Site (Ferrara 2021).*

- Reduce solar bands
- Further screen solar band boundaries along roads
- Make site more accessible and understandable
- Shift transmission area to be close to existing substation

Figure 65: *Reformed Lenexa Site (Ferrara 2021).*

- Solar array band just west of school removed; solar array east of school screened from view
- Boundaries of solar bands enhanced with upper and lower canopy plantings
- Overall number of PV panels reduced
- Transmission area shifted to easily connect to electrical grid
- Site made more interactive with trails and park features

Bonner Springs

The all-wind approach at the Bonner Springs site required several site adjustments. The previous site design did not consider the energy corridor going through site due to an oversight during the initial design. Previously, the design of the site sought to work around the various residential and commercial buildings scattered throughout the site and simply focused on maximizing the amount of wind turbines to be implemented. The reformed design of the site considers the existing energy corridor and utilizes it as the connection point for the energy transmission area. The transmission area was also shifted from the northwestern corner of the site to corner of 142nd street and Woodend Road, just west of the energy corridor. It also utilizes a planting screening strategy (featuring ranging heights of plant material) along both streets to prevent visual interruptions. To prevent overcrowding of wind turbines on site, the number of wind turbines has been reduced from 13 to 11. This also helps to reduce the chance of any one turbine being too close to roadways or homes, thus avoiding potential problems with noise pollution. To highlight the views of and around the site, the northwest corner of the site (which is the highest elevation of anywhere on site) is designed as a scenic overlook area which would feature an elevated viewing area that includes information about the renewable energy apparatuses on-site. Overall, the site is capable of a 22 MW capacity.

Figure 66: *Bonner Springs Wind Farm - The reformed Bonner Springs site shifts the arragement of wind turbines so they are further from existing residences. A scenic overlook was also incorporated in the northwestern corner of the site to exhibit and display the benefits of the wind farm (Ferrara 2021).*

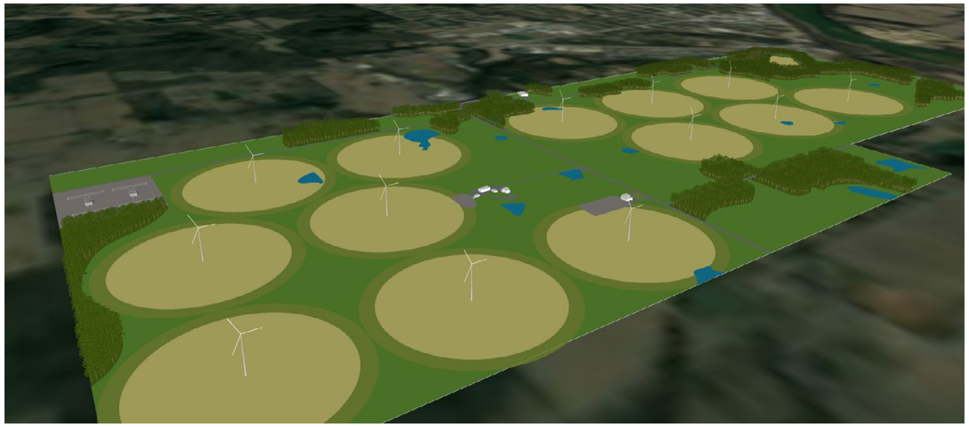


Figure 67: *Initial Bonner Springs Site (Ferrara 2021).*

- Energy transmission corridor not accounted for in initial design
- Turbines should be away from existing residences
- Site should inform and engage the public

Figure 68: *Reformed Bonner Springs Site (Ferrara 2021).*

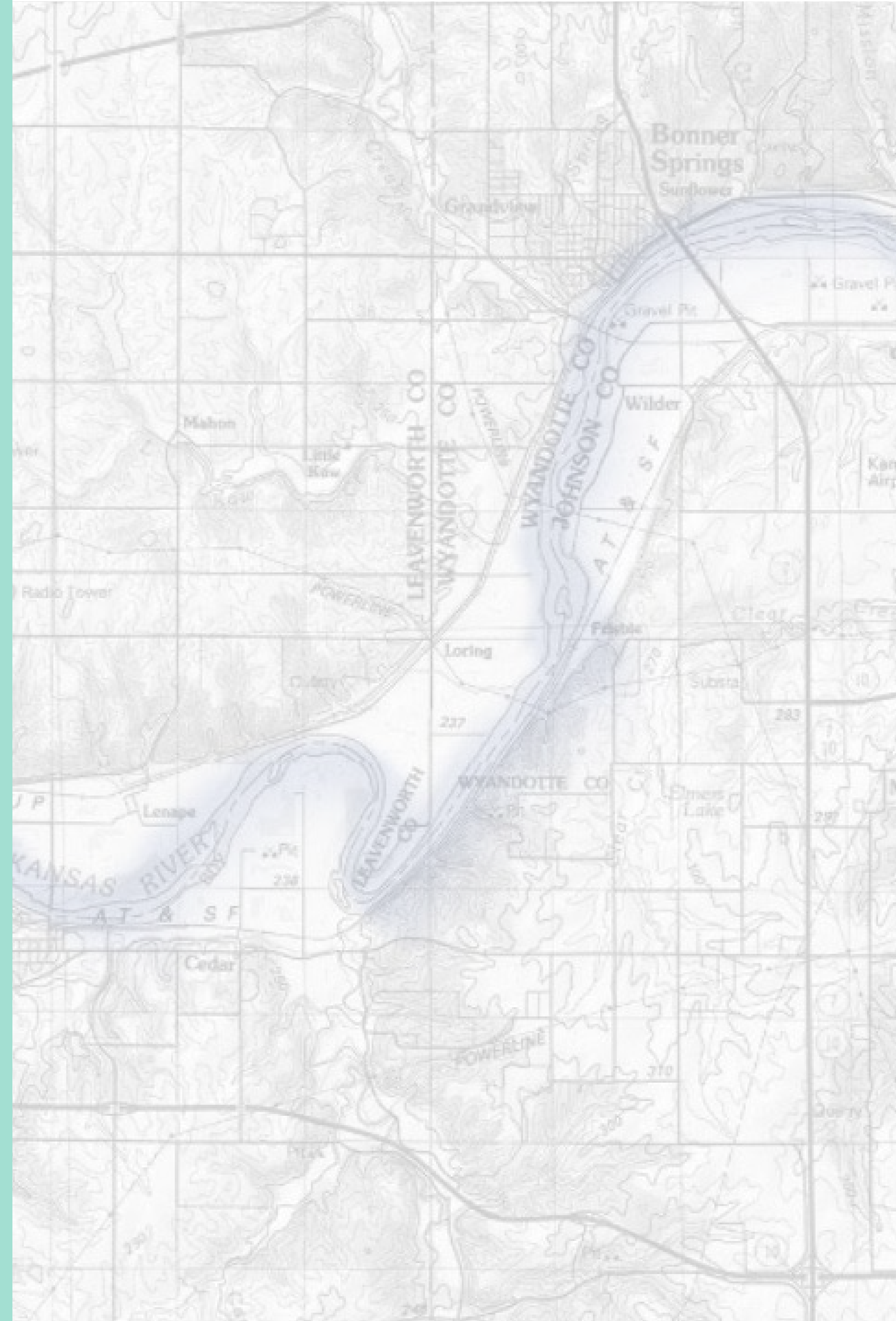
- Transmission area was moved for easier access to existing energy grid
- Energy transmission corridor was accounted for
- Number of wind turbines reduced and were pulled away from as many existing residences as possible
- Overlook created in the NW corner of the site and provide community with overlook of the wind farm

Overview:

The site reformations helped to strengthen the design of each “pilot” or hypothetical renewable energy landscape within the region. Adjusting the sites so that they align with the preferences of the public was a key part of the process as many of the barriers to integration of renewable energy involve peoples preferences and public perception. If public support is not garnered for such renewable energy projects, people are less likely to look upon them favorably and approve of their implementation. The reformed designs are aimed at respecting the preferences of people within eastern Kansas and overall, the project is intended to serve as an exemplar of how one might understand the particular public perceptions of renewable energy within a given area or region.

Conclusions

8



In order to create energy more sustainably and curb the effects of climate change, societies must seek opportunities to implement renewable energy equipment within our various communities, neighborhoods, and towns. Renewable energy (RE) and the equipment associated with it is often viewed as unsightly within the landscape, but many also see large electric powerlines, grid substations, powerplants, and pipelines as equally intrusive and controversial. It is important to consider the various impacts RE has upon people, communities, and societies. Often, the visual impacts of RE bring forth several social difficulties and can delay the development of RE within specific areas and regions. These issues of visual perception are linked to how individuals and communities see their own immediate and familiar landscapes. Understanding that no one landscape is the same and that all landscapes have innate defining qualities, can help landscape architects, planners, energy experts, and engineers understand the need to reduce the visual impacts of RE equipment.

The Importance of Aesthetics

Many people throughout the U.S. are accustomed to the way their home looks, whether it be a city, a town, a suburban area, or a rural farm. The familiarity of the scenery and views are what makes a home familiar and recognizable. Often the implementation of renewable energy can alter how the public perceives the landscapes that are most familiar to them. The careful addressing of public perception issues can lead to a more cohesive and less visually impactful renewable energy designs. Implementing renewable energy where we can also play a major role in reducing atmospheric carbon (CO_2) and contribute to curbing the effect climate change is having on the planet. The decarbonization

of our atmosphere is a lengthy process, but by generating energy in more clean and efficient ways, we can slow the rate at which our climate is changing. This would also lead to a fundamental shift in how people, especially in the U.S., use and consume energy. The success of renewable energy is dependent upon how well our society transitions from systems of luxury energy to systems of subsistence energy. We must learn to use energy more conservatively and adopt practices that teach electricity efficiency. If our societies adopt renewable energy and the functional changes it brings to our lives, then it is key that we perfect the design of renewable energy landscapes (Apostal 2017, 137).

The way humans perceive landscapes greatly impacts our attitudes and notions of what we find aesthetically pleasing in our surroundings. People are impacted by the type of environments where they grew up and the places where they currently reside. Familiar environments form indelible images in minds of people, but when these familiar images change, people become apprehensive. Renewable energy and the equipment associated with it, can have a similar impact upon entire communities and regions. In general, people throughout the U.S. are prone to support renewable energy, until the proposals for renewable energy landscapes come close or near home. NIMBY or the “not in my back-yard” syndrome is commonly adopted by people nearest the renewable energy developments. There is no denying that the implementation of RE equipment changes the look of landscapes and while landscape architects cannot completely mask the equipment from view, we can organize the landscapes in such a way that they minimally impact the greater contextual landscape.

Survey Results

What the Results Showed

The aim of the renewable energy preference study was to understand the general preferences of people within the region when it comes to renewable energy infrastructure within the landscape. Two of the four towns examined in the masters project were chosen for further study because of their general location, population size, and potential opportunity to host renewable energy landscapes by conducting a RE preference study in the form of a survey. The RE preference study, described in chapter 6, revealed that most people within the eastern KS region would rather not see renewable energy within the areas around their communities, as anticipated. While people feel that renewable energy is important and that they are concerned about the environment, they also feel that preserving the scenic attributes of eastern KS is of high concern. Interestingly, respondents of the preference study indicated wind energy to be their preferred renewable energy generation mode within landscapes of eastern KS when compared to solar energy or some combination of the two. Overall, the study revealed people prefer wind energy or wind turbines within the landscape as opposed to solar and that generally, people feel concerned with preserving their most familiar landscapes.

How the Results Impact Renewable Energy Landscape Design

The results of the preference study demonstrate the need for sensitive renewable energy landscape design. It is imperative for landscape architects to be part of the RE conversation. Everything landscapes architects do, from site inventory and analysis to conceptual design to construction documentation, can greatly change the way renewable energy sites are implemented and affect the public perception of renewable energy. The goal with any RE site should not be to completely hide or mask the apparatuses and equipment from view, but to blend the equipment more harmoniously within the fabric of the landscape. By understanding the local language of the land and its unique attributes, landscape architects can create RE designs that work to retain the local character of the landscapes around them thus emulating the landscapes symbiotic processes. Every region and its unique landscapes, cultural character, and environmental attributes would require a well-crafted, distinct strategy for renewable energy landscape design.

Limitations of the Study

The study contains limitations which were due in part to the time and contextual constraints of the study. Contextually, the pilot project section of the study only examined the four towns within the eastern KS region. Specifically, the region along the Kansas River from Lawrence to Kansas City, KS. From the four selected cities for site design, Eudora and De Soto Kansas were chosen for further study because of similar landscape character and similar population sizes. By examining four cities within the region and two cities for further study, only so much data could be gathered. A larger study, which falls outside the confines and purposes of this document, might have examined several (8-10) communities and towns within the eastern KS River corridor and their ability to host renewable energy landscapes. Examining more sites and towns within the region could have led to an even more detailed understanding of peoples renewable energy preferences within the region.

Additionally, the study

also only examines issues pertaining to the visual impacts of renewable energy equipment and its perception within the landscape. The study did not examine the visual ramifications that energy corridors and large electrical power lines have upon people and the environment. Large electrical energy corridors often span hundreds to even thousands of miles to deliver electricity over long distances to maintain nationally connected energy grids. The policy of interconnecting energy grids has led to vast and complex energy transmission infrastructure that presents several challenges to modern day societies. The study does not examine the visual complications of energy corridors for several reasons, but primarily because to examine the issue thoroughly would require an entirely separate study. The focus of this study remained centered around understanding the visual impacts of renewable energy within a regionally specific landscape.

Final Discussion & Study Contributions

Overall, this report demonstrates the necessity to examine renewable energy sites and how the ways RE landscapes are implemented could change the way people perceive the landscapes around them. If renewable energy is to play a significant role in energy generation in the future, then the challenges associated with it must be addressed. While some of these challenges are technological, many are more closely associated with aesthetic challenges brought on by society. The public's general perception is that RE is good and beneficial to economies, the environment, and the efficient generation of electricity. However, when a proposal or the development of renewable energy comes close to or within a familiar landscape, the public's perception within the area tends to change (Gipe et al. 2002, 177).

As designers, we strive to create solutions that work for everyone. We must tune the design of renewable energy landscapes to the regional public's preferences so that a creative and appealing resolution can be achieved. While this study is limited and examines only one regional area, the methods could be applied in other regions. Further studies might examine how people within ecoregions perceive renewable energy and how they might fit within the visual context of the region. Understanding the perceived scenic value of specific regions would lead to more informed placement of renewable energy installations and would play an important role in protecting those landscapes deemed by the public to have high levels of scenic value. However, it should be noted that this report is not intended to serve a guidebook to implementing renewable energy landscapes. Rather, the report offers a framework for understanding how renewable energy equipment might aesthetically fit within the context of a given place or region. The results of the preference study from this report are extrapolated to understand the preferences of a much larger area. However, future studies might gather data from more locations within a geographical or contextual region to gain a more complete picture of regional inhabitants renewable energy aesthetic preferences.

Finally, the overall study contributes to landscape architecture by conveying the necessity to understand the attitudes and preferences of the people we design for. Renewable energy landscapes are different than other types of developments as they often take up hundreds of acres and change how the land and space around and within them is seen by the public. It is our duty as designers to reach out to the public and understand their various reservations towards renewable energy and attempt to design solutions that ease concerns. Through proper implementation of renewable energy, landscape architects, along with planners, engineers, and energy experts, have the opportunity to ensure the success of renewable energy because it is a key factor in leading our society to a more energy independent and sustainable future.

Figure 69: *Idealized Conception of a renewable energy landscape within eastern Kansas (Ferrara 2021).*

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Appendices

Appendix A - Survey & Questionnaire

Intro

This research project is focused on understanding the aesthetic and visual impacts of renewable energy upon the landscape and people's perceptions of renewable energy within familiar landscapes. Participants will be asked a series of questions regarding their personal preferences toward renewable energy and will be shown four sets of four images with different conditions and will be asked to rank each image according to their preference. This type of survey is called a preference test survey. The survey should take no more than __8-12__ minutes to complete.

Informed Consent Form for "Functionality and Aesthetics of Small-Scale Renewable Energy Networks: The Need to Shift to Sustainable Resources and Designed Green Energy Systems"

PURPOSE
You are invited to participate in a web-based online survey about the individual perception of renewable energy within familiar landscapes for the research project: Functionality and Aesthetics of Small-Scale Renewable Energy Networks: The Need to Shift to Sustainable Resources and Designed Green Energy Systems. This is a research project being conducted by Nicholas Ferrara, a graduate student at Kansas State University. It should take approximately __10-15__ minutes to complete.

PARTICIPATION
Your participation in this survey is voluntary. You may exit the survey at any time without penalty. You are free to decline to answer any particular question you do not wish to answer for any reason.

BENEFITS
The benefit of the survey is that it would help people and the researchers understand how the local populations view or perceive renewable energy and the general attitudes that people from smaller communities might have within regards to renewable energy.

RISKS
There are no foreseeable risks involved in participating in this study other than those encountered in day-to-day life.

CONFIDENTIALITY
Your survey answers will be sent to a link at kstate.qualtrics.com where data will be stored in a password protected electronic format. Qualtrics and Kansas State University do not collect identifying information such as your name, email address, or IP address. Therefore, your responses will remain anonymous. No one will be able to identify you or your answers, and no one will know whether or not you participated in the study. All information gathered as a result of the survey will not be distributed or used in any future study.

At the end of the survey, you will be asked if you are interested in receiving the results of the survey and the research project once complete. If you would like to be informed of the results, a follow up email may be sent to you. However, no names or identifying information would be included in any publications or presentations based on collected data, and your responses to this survey will remain completely confidential.

CONTACT
If you have questions at any time about the study or the procedures, you may contact the research supervisor, Professor Tim Keane via phone at 785-532-2439 or via email at whisker@ksu.edu or you may contact the responsible graduate student Nicholas Ferrara via phone at 816-914-0264 or via email at njferrar@ksu.edu.

If you feel you have not been treated according to the descriptions in this form, or that your rights as a participant in research have not been honored during the course of this project, or you have any questions, concerns, or complaints that you wish to address to someone other than the investigator, you may contact the Kansas State University Institutional Review Board at the University Research Compliance Office at 203 Fairchild Hall 1601 Vattier Street Manhattan, KS, or email comply@ksu.edu.

ELECTRONIC CONSENT: Please select your choice below. You may print a copy of this consent form for your records. Clicking on the “Agree” button indicates that

- You have read the above information
- You voluntarily agree to participate
- You are 18 years of age or older

○ Agree
○ Disagree

Which city do you live in (if you do not live within the city limits which would you consider to be your most immediate community)?

○ De Soto, KS
○ Eudora, KS
○ Neither of these cities

Preference Images DeSoto

In this section of the survey, you will be asked to rank the images from most appealing to least appealing (where the number 1 spot represents the most appealing image, and the #4 spot represents the least appealing image). A series

of 2 sets of images will be shown relating to potential renewable energy landscape within Eastern Kansas. Please rank images honestly.

Please rank the images in order of most appealing (1) to least appealing (4). This question allows you to drag and drop the images in order of preference. The top image would represent the number 1 spot in your preference order and the bottom image would represent the number 4 spot in your preference order. Please rank images honestly.

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Please rank the images in order of most appealing (1) to least appealing (4). This question allows you to drag and drop the images in order of preference. The top image would represent the number 1 spot in your preference order and the bottom image would represent the number 4 spot in your preference order. Please rank images honestly.

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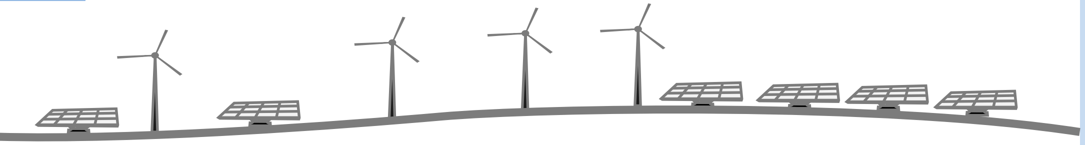
Preference Images Eudora

In this section of the survey, you will be asked to rank the images from most appealing to least appealing (where the number 1 spot represents the most appealing image, and the #4 spot represents the least appealing image). A series of 2 sets of images will be shown relating to potential renewable energy landscape within Eastern Kansas. Please rank images honestly.

Please rank the images in order of most appealing (1) to least appealing (4). This question allows you to drag and drop the images in order of preference. The top image would represent the number 1 spot in your preference order and the bottom image would represent the number 4 spot in your preference order. Please rank images honestly.



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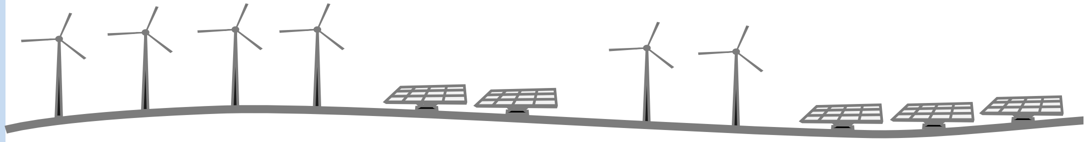

-

Please rank the images in order of most appealing (1) to least appealing (4). This question allows you to drag and drop the images in order of preference. The top image would represent the number 1 spot in your preference order and the bottom image would represent the number 4 spot in your preference order. Please rank images honestly.

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Outdoor Time Block

The following questions will help gauge the environmental and setting preferenc of respondents. As stated before, these questions are voluntary. You may exit th survey at any time without penalty. You are free to decline to answer any questic you do not wish to answer for any reason.

How many hours do you spend outside?
(If more than 10 please select 10)

	0	1	2	3	4	5	6	7	8	9	10
Typical Week Day											
Typical Weekend Day											

Setting Block

The next group of questions will ask you about setting. As stated before, these questions are voluntary. You may exit the survey at any time without penalty. Yo are free to decline to answer any question you do not wish to answer for any reason.

How would you describe the setting in which you grew up?

- ○ Urban
- ○ Suburban
- ○ Small Town
- ○ Rural

What type of setting would you say you currently reside in?

- ○ Urban
- ○ Suburban
- ○ Small Town
- ○ Rural

If you could live in any setting which would you choose?

- ○ Urban
- ○ Suburban
- ○ Small Town
- ○ Rural

Environmental Block

The next group of questions will ask you about scenery, environmental concerns, and renewable energy. As stated before, these questions are voluntary. You may exit the survey at any time without penalty. You are free to decline to answer any question you do not wish to answer for any reason.

How scenic are the landscapes of Eastern, KS?

	Not		Moderately			Very
	0	1	2	3	4	5
Scenic Rating						

How concerned are you with preserving the scenic attributes of Eastern, KS landscapes?

	Not		Moderately			Very
	0	1	2	3	4	5
Level of Concern						

How concerned are you about the following issues in today's society?

	Not		Moderately			Very
	0	1	2	3	4	5
Air, Water, and Waste Pollution						
Endangered and/or Threatened Native Species						
Global Environment						

Please indicate how important you think renewable energy is in relation to the following topics.

	Not		Moderately			Very
	0	1	2	3	4	5
Energy Production						
Local Economies						
Sustainability						

Demographic Block

The following questions are related to specific demographics. As stated previously, these questions are voluntary.

What year were you born?

What is your gender identification?

- ◯ Male
- ◯ Female
- ◯ Non-binary / third gender
- ◯ Prefer not to say

What is the highest degree/level of education you have completed?

- ◯ High School
- ◯ Trade School
- ◯ Undergraduate Degree
- ◯ Graduate Degree
- ◯ Prefer not to say

Appendix B - Survey Results

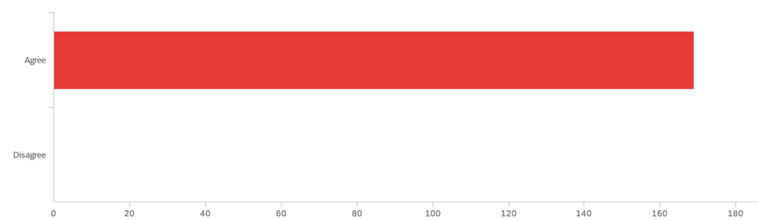
Renewable Energy in Eastern Kansas: Preference Study
March 22, 2021 12:56 PM MDT

Consent Form - Informed Consent Form for “Functionality and Aesthetics of Small-Scale Renewable Energy Networks: The Need to Shift to Sustainable Resources and Designed Green Energy Systems” PURPOSEYou are invited to participate in a web-based online survey about the individual perception of renewable energy within familiar landscapes for the research project: Functionality and Aesthetics of Small-Scale Renewable Energy Networks: The Need to Shift to Sustainable Resources and Designed Green Energy Systems. This is a research project being conducted by Nicholas Ferrara, a graduate student at Kansas State University. It should take approximately __10-15__ minutes to complete. PARTICIPATIONYour participation in this survey is voluntary. You may exit the survey at any time without penalty. You are free to decline to answer any particular question you do not wish to answer for any reason. BENEFITSThe benefit of the survey is that it would help people and the researchers understand how the local populations view or perceive renewable energy and the general attitudes that people from smaller communities might have within regards to renewable energy. RISKSThere are no foreseeable risks involved in participating in this study other than those encountered in day-to-day life. CONFIDENTIALITYYour survey answers will be sent to a link at

kstate.qualtrics.com where data will be stored in a password protected electronic format. Qualtrics and Kansas State University do not collect identifying information such as your name, email address, or IP address. Therefore, your responses will remain anonymous. No one will be able to identify you or your answers, and no one will know whether or not you participated in the study. All information gathered as a result of the survey will not be distributed or used in any future study. At the end of the survey, you will be asked if you are interested in receiving the results of the survey and the research project once complete. If you would like to be informed of the results, a follow up email may be sent to you. However, no names or identifying information would be included in any publications or presentations based on collected data, and your responses to this survey will remain completely confidential. CONTACTIf you have questions at any time about the study or the procedures, you may contact the research supervisor, Professor Tim Keane via phone at 785-532-2439 or via email at whisker@ksu.edu or you may contact the responsible graduate student Nicholas Ferrara via phone at 816-914-0264 or via email at njferrar@ksu.edu. If you feel you have not been treated according to the descriptions in this form, or that your rights as a participant in research have not been honored during the course of this project, or you have any questions, concerns, or complaints that you wish to address to someone other than the investigator, you may contact the Kansas State

University Institutional Review Board at the University Research Compliance Office at 203 Fairchild Hall 1601 Vattier Street Manhattan, KS, or email comply@ksu.edu.

ELECTRONIC CONSENT: Please select your choice below. You may print a copy of this consent form for your records. Clicking on the “Agree” button indicates that • You have read the above information• You voluntarily agree to participate• You are 18 years of age or older



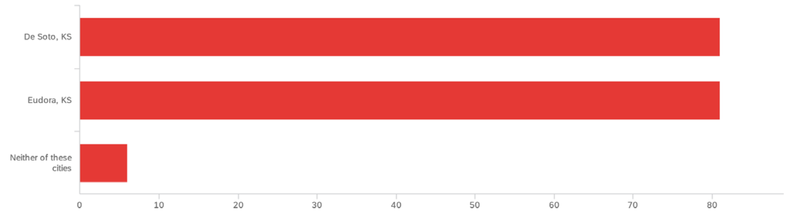
#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Informed Consent Form for “Functionality and Aesthetics of Small-Scale Renewable Energy Networks: The Need to Shift to Sustainable Resources and Designed Green Energy Systems” PURPOSEYou are invited to participate in a web-based online survey about the individual perception of renewable energy within familiar landscapes for the research project: Functionality and Aesthetics of Small-Scale Renewable Energy Networks: The Need to Shift to Sustainable Resources and Designed Green Energy Systems. This is a research project being conducted by Nicholas Ferrara, a graduate student at Kansas State University. It should take approximately __10-15__ minutes to complete. PARTICIPATIONYour participation in this survey is voluntary. You may exit the survey at any time without penalty. You are free to decline to answer any particular question you do not wish to answer for any reason. BENEFITSThe benefit of the survey is that it would help people and the researchers understand how the local populations view or perceive renewable energy and the general attitudes that people from smaller communities might have within regards to renewable energy. RISKSThere are no foreseeable risks involved in participating in this study other than those encountered in day-to-day life. CONFIDENTIALITYYour survey answers will be sent to a link at kstate.qualtrics.com where data will be stored in a password protected electronic format. Qualtrics and Kansas State University do not collect identifying information such as your name, email address, or IP address. Therefore, your responses will remain anonymous. No one will be able to identify you or your answers, and no one will know whether or not you participated in the study. All information gathered as a result of the survey will not be distributed or used in any future study. At the end of the survey, you will be asked if you are interested in receiving the results of the survey and the research project once complete. If you would like to be informed of the results, a follow up email may be sent to you. However, no names or identifying information would be included in any publications or presentations based on collected data, and your responses to this survey will remain completely confidential. CONTACTIf you have questions at any time about the study or the procedures, you may contact the research supervisor, Professor Tim Keane via phone at 785-532-2439 or via email at whisker@ksu.edu or you may contact the responsible graduate student Nicholas Ferrara via phone at 816-914-0264 or via email at njferrar@ksu.edu. If you feel you have not been treated according to the descriptions in this form, or that your rights as a participant in research have not been honored during the course of this project, or you have any questions, concerns, or complaints that you wish to address to someone other than the investigator, you may contact the Kansas State University Institutional Review Board at the University Research Compliance Office at 203 Fairchild Hall 1601 Vattier Street Manhattan, KS, or email comply@ksu.edu. ELECTRONIC CONSENT: Please select your choice below. You may print a copy of this consent form for your records. Clicking on the “Agree” button indicates that • You have read the above information• You voluntarily agree to participate• You are 18 years of age or older	1.00	1.00	1.00	0.00	0.00	169

#	Field	Choice Count	
1	Agree	100.00%	169
2	Disagree	0.00%	0
			169

Showing rows 1 - 3 of 3

City - Which city do you live in (if you do not live within the city limits which would you consider to be your most immediate community)?

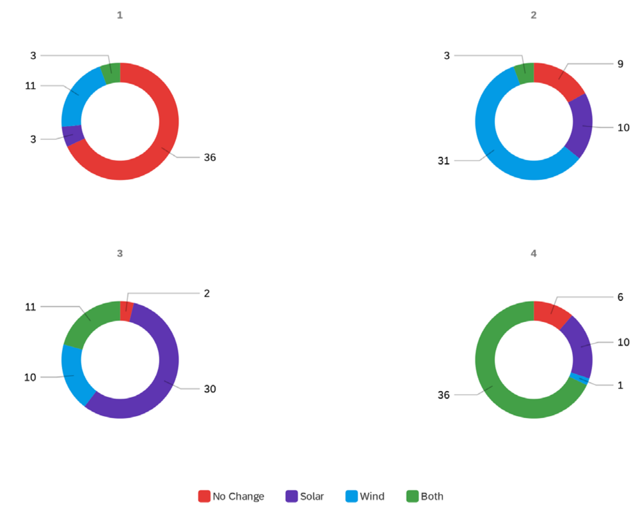


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Which city do you live in (if you do not live within the city limits which would you consider to be your most immediate community)?	1.00	3.00	1.55	0.56	0.32	168

#	Field		Choice Count
1	De Soto, KS	48.21%	81
2	Eudora, KS	48.21%	81
3	Neither of these cities	3.57%	6
			168

Showing rows 1 - 4 of 4

DeSoto Pref #1 - Please rank the images in order of most appealing (1) to least appealing (4). This question allows you to drag and drop the images in order of preference. The top image would represent the number 1 spot in your preference order and the bottom image would represent the number 4 spot in your preference order. Please rank images honestly.

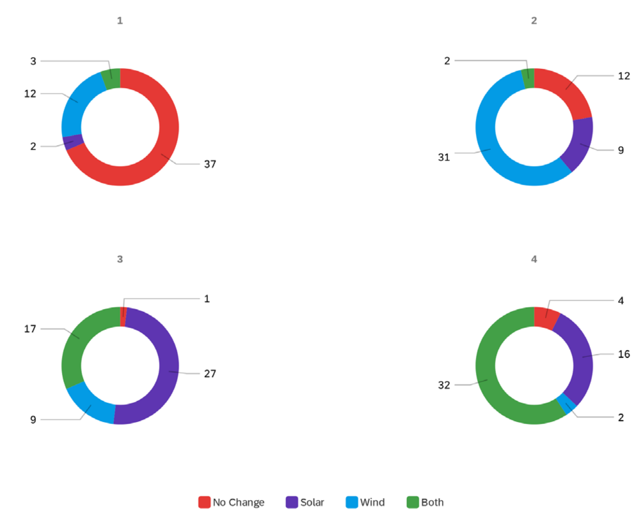


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	-	1.00	4.00	1.58	1.00	1.00	53
2	-	1.00	4.00	2.89	0.77	0.59	53
3	-	1.00	4.00	2.02	0.69	0.47	53
4	-	1.00	4.00	3.51	0.84	0.70	53

#	Field	1		2		3		4		Total
1	-	67.92%	36	16.98%	9	3.77%	2	11.32%	6	53
2	-	5.66%	3	18.87%	10	56.60%	30	18.87%	10	53
3	-	20.75%	11	58.49%	31	18.87%	10	1.89%	1	53
4	-	5.66%	3	5.66%	3	20.75%	11	67.92%	36	53

Showing rows 1 - 4 of 4

DeSoto Pref #2 - Please rank the images in order of most appealing (1) to least appealing (4). This question allows you to drag and drop the images in order of preference. The top image would represent the number 1 spot in your preference order and the bottom image would represent the number 4 spot in your preference order. Please rank images honestly.

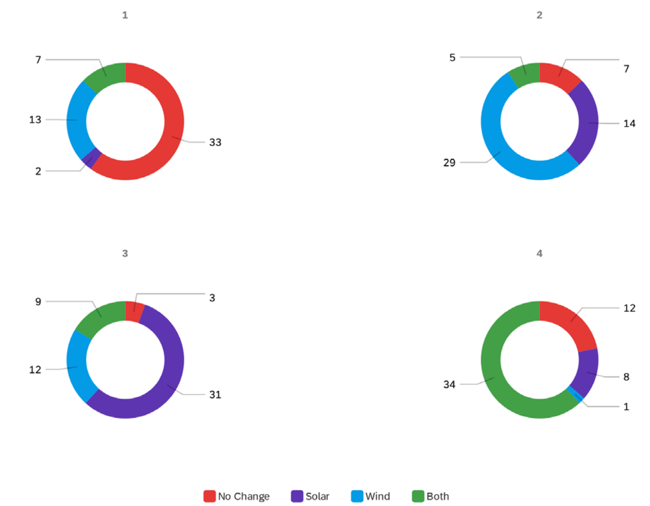


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
3	-	1.00	4.00	1.48	0.86	0.73	54
1	-	1.00	4.00	3.44	0.81	0.65	54
4	-	1.00	4.00	3.06	0.78	0.61	54
2	-	1.00	4.00	2.02	0.73	0.54	54

#	Field	1		2		3		4		Total
1	-	5.56%	3	3.70%	2	31.48%	17	59.26%	32	54
2	-	22.22%	12	57.41%	31	16.67%	9	3.70%	2	54
3	-	68.52%	37	22.22%	12	1.85%	1	7.41%	4	54
4	-	3.70%	2	16.67%	9	50.00%	27	29.63%	16	54

Showing rows 1 - 4 of 4

Eudora Pref #1 - Please rank the images in order of most appealing (1) to least appealing (4). This question allows you to drag and drop the images in order of preference. The top image would represent the number 1 spot in your preference order and the bottom image would represent the number 4 spot in your preference order. Please rank images honestly.

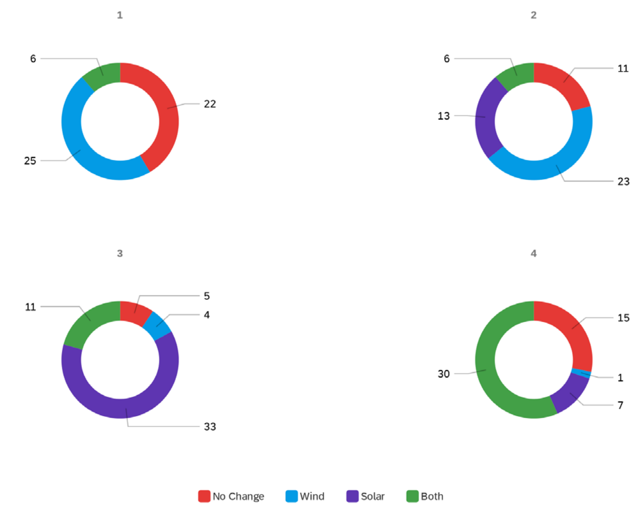


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
4	-	1.00	4.00	1.89	1.23	1.52	55
3	-	1.00	4.00	3.27	1.07	1.14	55
2	-	1.00	4.00	2.02	0.73	0.53	55
1	-	1.00	4.00	2.82	0.72	0.51	55

#	Field	1		2		3		4		Total
1	-	3.64%	2	25.45%	14	56.36%	31	14.55%	8	55
2	-	23.64%	13	52.73%	29	21.82%	12	1.82%	1	55
3	-	12.73%	7	9.09%	5	16.36%	9	61.82%	34	55
4	-	60.00%	33	12.73%	7	5.45%	3	21.82%	12	55

Showing rows 1 - 4 of 4

Eudora Pref #2 - Please rank the images in order of most appealing (1) to least appealing (4). This question allows you to drag and drop the images in order of preference. The top image would represent the number 1 spot in your preference order and the bottom image would represent the number 4 spot in your preference order. Please rank images honestly.



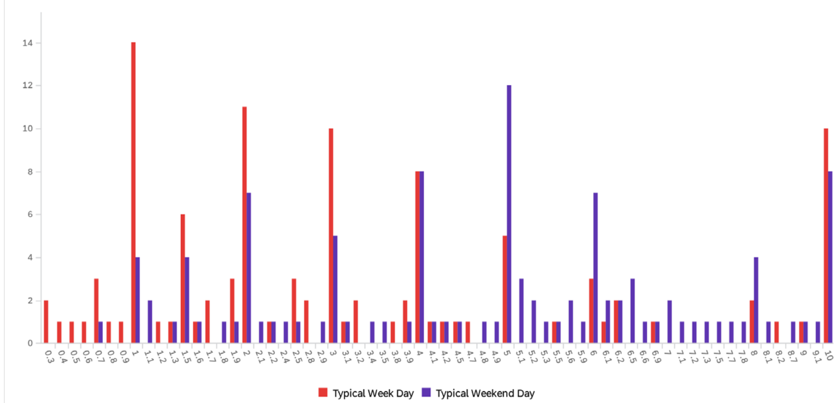
#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	-	1.00	4.00	1.64	0.70	0.49	53
2	-	1.00	4.00	2.25	1.26	1.58	53
3	-	2.00	4.00	2.89	0.60	0.36	53
4	-	1.00	4.00	3.23	1.04	1.08	53

#	Field	1		2		3		4		Total
1	-	47.17%	25	43.40%	23	7.55%	4	1.89%	1	53
2	-	41.51%	22	20.75%	11	9.43%	5	28.30%	15	53
3	-	0.00%	0	24.53%	13	62.26%	33	13.21%	7	53
4	-	11.32%	6	11.32%	6	20.75%	11	56.60%	30	53

Showing rows 1 - 4 of 4

Time - How many hours do you spend outside? (If more than 10 please select 10)

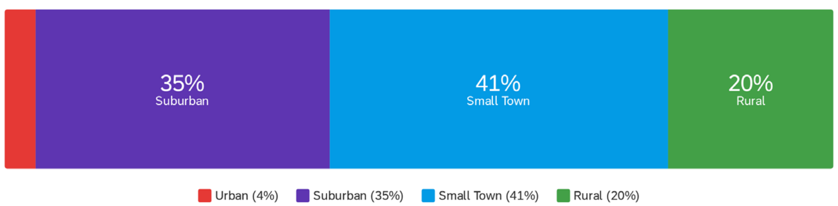
#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Typical Week Day	0.30	10.00	3.52	2.77	7.69	110
2	Typical Weekend Day	0.70	10.00	4.93	2.52	6.36	111



Youth Setting - How would you describe the setting in which you grew up?

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	How would you describe the setting in which you grew up?	1.00	4.00	2.77	0.81	0.65	110

Youth Setting

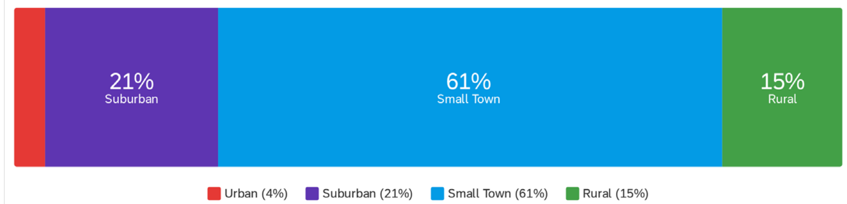


#	Field		Choice Count
1	Urban	3.64%	4
2	Suburban	35.45%	39
3	Small Town	40.91%	45
4	Rural	20.00%	22
			110

Showing rows 1 - 5 of 5

Current Setting - What type of setting would you say you currently reside in?

Current Setting



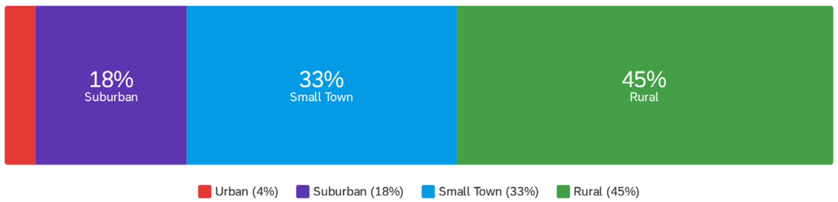
#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	What type of setting would you say you currently reside in?	1.00	4.00	2.86	0.69	0.48	110

#	Field		Choice Count
1	Urban	3.64%	4
2	Suburban	20.91%	23
3	Small Town	60.91%	67
4	Rural	14.55%	16
			110

Showing rows 1 - 5 of 5

Preferred Setting - If you could live in any setting which would you choose?

Preferred Setting



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	If you could live in any setting which would you choose?	1.00	4.00	3.20	0.86	0.74	110

#	Field		Choice Count
1	Urban	3.64%	4
2	Suburban	18.18%	20
3	Small Town	32.73%	36
4	Rural	45.45%	50
			110

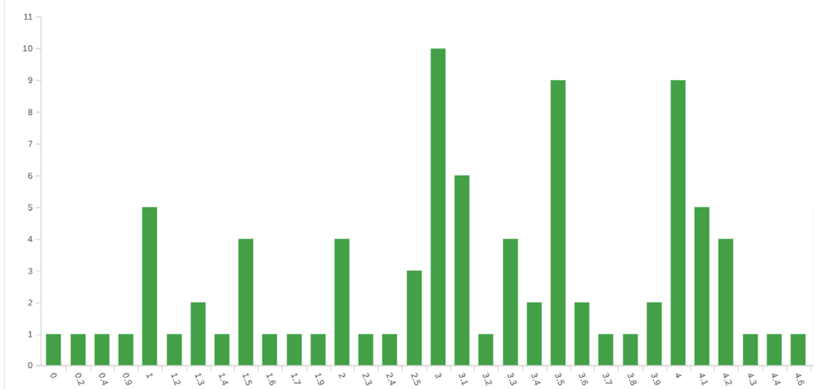
Showing rows 1 - 5 of 5

Scenic Rating - How scenic are the landscapes of Eastern, KS?

Eastern, KS Landscapes Scenic Rating

#	Field	Minimum	Maximum	Mean	Count
1	Scenic Rating	0.00	5.00	3.02	93

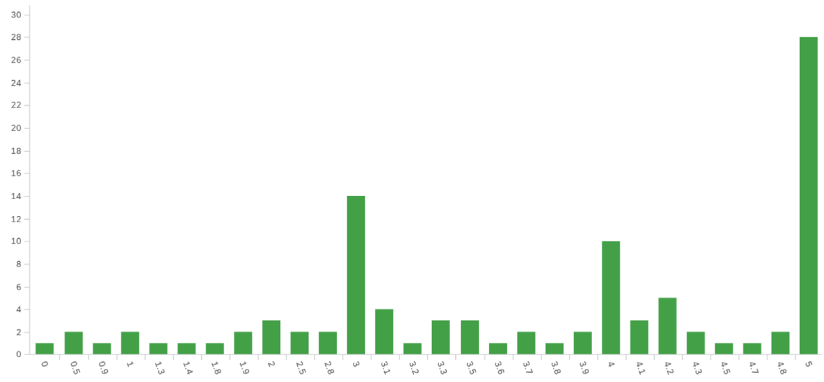
Eastern, KS Landscapes Scenic Rating



Scenic Preservation - How concerned are you with preserving the scenic attributes of Eastern, KS landscapes?

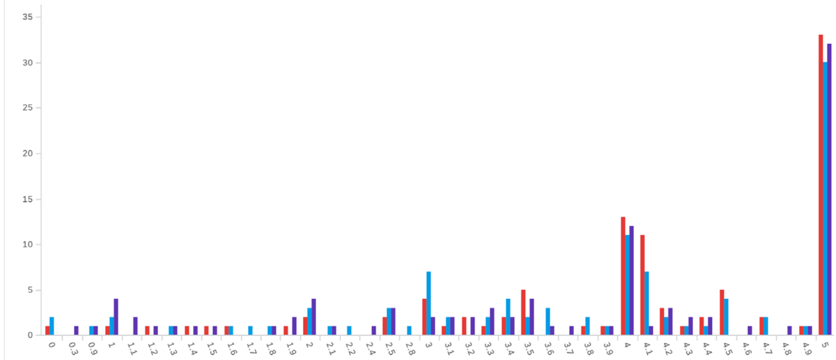
#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Level of Concern	0.00	5.00	3.66	1.24	1.53	101

Scenic Preservation of Eastern KS Landscapes



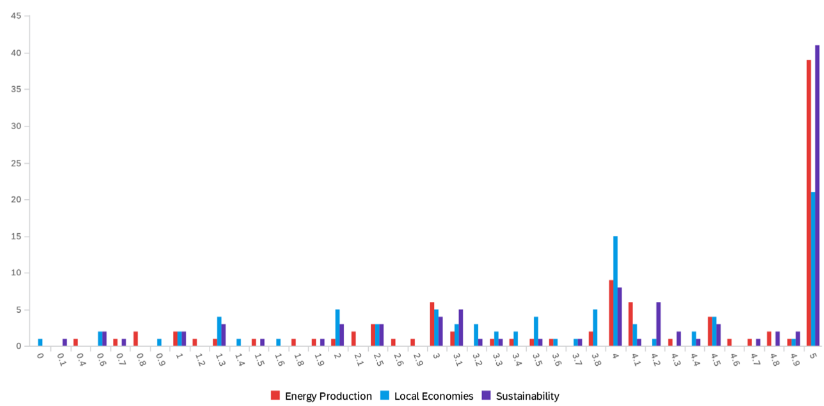
Environmental Issues - How concerned are you about the following issues in today's society?

#	Field	Minimum	Maximum	Mean	Count
1	Air, Water, and Waste Pollution	0.00	5.00	4.03	99
2	Endangered and/or Threatened Native Species	0.00	5.00	3.79	100
3	Global Environment	0.30	5.00	3.66	97

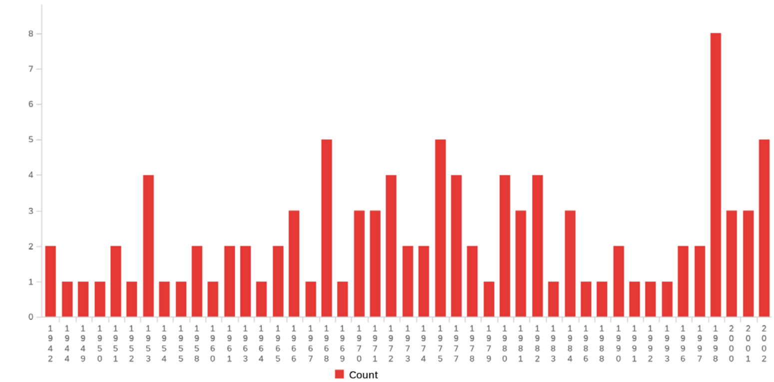


Renewable Energy - Please indicate how important you think renewable energy is in relation to the following topics.

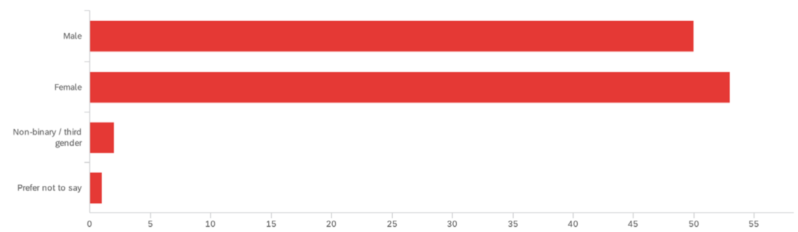
#	Field	Minimum	Maximum	Mean
1	Energy Production	0.40	5.00	3.91
2	Local Economies	0.00	5.00	3.55
3	Sustainability	0.10	5.00	3.95



Age - What year were you born?



Gender - What is your gender identification?

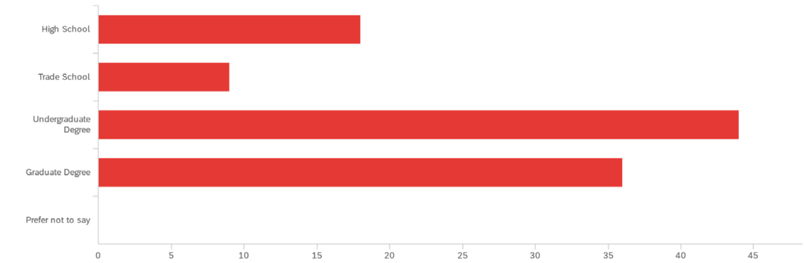


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	What is your gender identification?	1.00	4.00	1.57	0.58	0.34	106

#	Field		Choice Count
1	Male	47.17%	50
2	Female	50.00%	53
3	Non-binary / third gender	1.89%	2
4	Prefer not to say	0.94%	1
			106

Showing rows 1 - 5 of 5

Education - What is the highest degree/level of education you have completed?



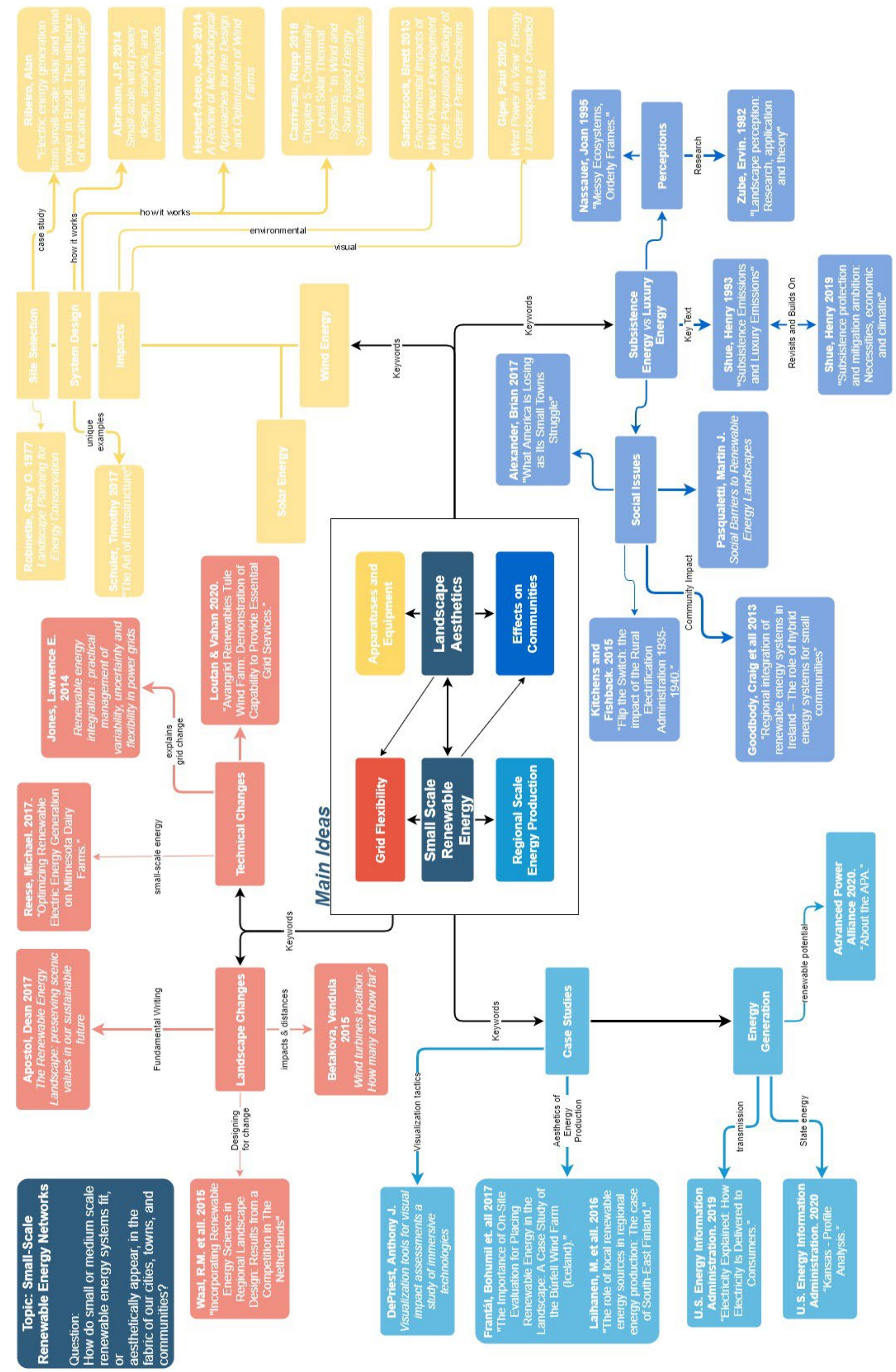
#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	What is the highest degree/level of education you have completed?	1.00	7.00	2.95	1.11	1.23	108

#	Field		Choice Count
1	High School	16.82%	18
2	Trade School	8.41%	9
3	Undergraduate Degree	41.12%	44
4	Graduate Degree	33.64%	36
5	Prefer not to say	0.00%	0
			107

Showing rows 1 - 6 of 6

End of Report

Appendix C - Literature Map



Appendix D - IRB Approval

Kansas State University | University Research Compliance Office

TO: Dr. Timothy Keane
Landscape Architecture/Regional and Community Planning
Seaton Hall

FROM: Rick Scheidt, Chair
Committee on Research Involving Human Subjects

DATE: 02/11/2021

RE: Proposal #10343.1, entitled "Functionality and Aesthetics of Small-Scale Renewable Energy Networks: The Need to Shift to Sustainable Resources and Designed Green Energy Systems."

A MINOR MODIFICATION OF PREVIOUSLY APPROVED PROPOSAL #10343, ENTITLED, "Functionality and Aesthetics of Small-Scale Renewable Energy Networks: The Need to Shift to Sustainable Resources and Designed Green Energy Systems"

The Committee on Research Involving Human Subjects at Kansas State University has approved the proposal identified above as a minor modification of a previously approved proposal, and has determined that it is exempt from further review. This exemption applies only to the most recent proposal currently on file with the IRB. Any additional changes affecting human subjects must be approved by the IRB prior to implementation and may disqualify the proposal from exemption.

Unanticipated adverse events or problems involving risk to subjects or to others must be reported immediately to the IRB Chair, and / or the URCO.

It is important that your human subjects project is consistent with submissions to funding/contract entities. It is your responsibility to initiate notification procedures to any funding/contract entity of changes in your project that affects the use of human subjects.