CZECH UNIVERSITY OF LIFE SCIENCES

Faculty of Environmental Sciences

Wind Turbines and Recreational Landscapes: Visual Preference of Energy Generation within Tourism among Emerging Green Energy Demands

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DIPLOMA THESIS ASSIGNMENT

Olivia Andersen, BS

Geology

Environmental Geosciences

Thesis title

Wind Turbines and recreational landscapes: Visual preference of energy generation within tourism among emerging green energy demands

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Objectives of thesis

Research intends to determine user preferences for or against wind turbines in a variety of recreational landscapes. Specifically, do the presence of wind turbines, or photovoltaic arrays for that matter, cause a positive, negative, or neutral impact on both visitors and local inhabitants in landscapes with high scenic value that typically attract tourists (short-term visitors).

Methodology

• Review current published literature on the topic. Review survey methodologies.

• The main research location will be tourism landscapes in Guam, USA).

• Surveys will be conducted using 16 or more photographs of various scenic and recreational landscapes.

• Nearly all of the images will include different scenic landscapes with wind turbines simulated in each..

• Photos will be divided into different types of recreational landscapes, including those with hiking, trekking, parks and beaches, fishing with bodies of water, coastal areas, etc.

• Landscapes should depict an absence of other disturbances, such as utility polls, highways, logistical parks, smoke chimneys from power generation plants, etc.

• Respondents will rank the images on a scale from -5 to +5.

• Survey will also include some other questions, such as basic demographic profile of respondents; have they visited similar locations as those depicted in the images; would they be willing to return to such locations if wind turbines were now present, and why yes or no; etc.

• Surveys will be conducted using on-line web site where respondents will view and rank images.

• Surveys will be conducted and administered to university students at a number of EU and USA research universities to students in both design and natural sciences curriculum.

• Survey results will be evaluated, grouped and summarized without using elaborate statistical software because the number or responses are estimated to be approximately 100.

The proposed extent of the thesis

65+ pages

Keywords

Wind Turbines, visual impacts, recreation landscapes

Recommended information sources

Frantal, Bohumil and Josef Kunc. 2010. Wind turbines in tourism landscapes Czech Experience. Annals of Tourism Research, 38, 2, 499-519.

Landry, Craig, Tom Allen, Todd Cherry, and John Whitehead. 2012. Wind turbines and coastal recreation demand. Resource and Energy Economics. 34, 93-111.

Wrozynski, Rafal, Mariusz Sojka, and Krzysztof Pyszny. 2016. The application of GIS and 3D graphic software to visual impact assessment of wind turbines. Renewable Energy, 96, 625-635.

Expected date of thesis defence

2019/20 SS – FES

The Diploma Thesis Supervisor

doc. Peter Kumble, Ph.D.

Supervising department

Department of Land Use and Improvement

Electronic approval: 24. 3. 2020	Electronic approval: 24. 3. 2020
prof. Ing. Petr Sklenička, CSc.	**prof. RNDr. Vladimír Bejček, CSc.**
Head of department	Dean

Prague on 25. 03. 2020

DIPLOMA THESIS AUTHOR’S DECLARATION

I hereby declare that the work presented in this thesis, to the best of my knowledge, is my independent original work, under the supervision of Peter Kumble. I have listed all literature and publications from which I acquired information.

26th, June 2020

Olivia R Andersen

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ABSTRACT

Through expanding urbanization, emissions from the burning of fossil fuel in power plants and mineral extraction, this has led to global climate change. As a result, countries are investing more into renewable and sustainable (green) energy. Wind turbines are by far the most used alternative technology in practice today. However, a major drawback for viewers is their visual impact. Previous research has focused on the visual impact of wind turbines, specifically related to their overall height, blade length, distance between each wind turbine, and overall spatial layout and organization both onshore and offshore. This research examines the visual preference of wind turbines and how their presence might impact a viewer's attitude towards the landscape and overall experience. A variety of recreational and scenic landscapes were captured on the island of Guam, a popular tourist destination. Photographs were manipulated using Adobe Photoshop 2020 to digitally add wind turbines into each image. A total of 16 images were used as part of an online survey questionnaire that asked respondents to rank each image on a scale of -5 to +5, based on the negative, neutral or positive attitudes towards each image. The survey was distributed to universities across the European Union and the United States of America. Of the 116 completed surveys, some respondents expressed a strong negative attitude towards wind turbines, both onshore and offshore, due to their perceived visual disturbance upon a landscape. However, most of the respondents had positive attitudes towards each image, stating how they support wind turbines as they represent the effort to combat climate change and air pollution. These results are similar to previous research findings. This survey will undergo further revision and be distributed to locals and tourists in Guam, to further examine how wind turbines impact tourism, the island's main economic source.

KEY WORDS

Wind turbines, Visual impact, Recreational landscapes

Contents

1. INTRODUCTION

Wind power is a sustainable energy resource and is one of the leading forms of renewable energy within the global market energy sector. However, there are several factors to consider during the proposal and implementation of wind energy projects. Visual impact of wind turbines is the most prominent factor, creating much of the backlash against wind energy projects. There is an overall visual aesthetic judgment of what is considered appropriate and inappropriate locations for wind turbines (Broekel & Alfken, 2015), ranging from highways, country sides, coastal areas and recreational landscapes. The location and physical design of wind farms are also aesthetic indicators, based on the spatial distribution of each wind turbine and the visual pattern to the wind farm layout (Teisl et al., 2018). From multiple studies, the majority of the populace have a more positive attitude towards wind turbines, rather than negative attitudes. There has been discussion about changing the physical design of a wind turbine (Brittan, 2001), whether this be an attempt to better camouflage the turbines to match their environmental surroundings, or change the entire design of the basic three rotary blades. However, none have been successful enough to replace the standard design of wind turbines on a large global scale or one that is commercially successful.

Secondly, societal disruption is a factor that occurs during the erection and installation of wind turbines. Communities near wind energy project sites report some daily annoyance from the transportation of wind turbine parts and from the sound associated with infrastructural machinery (Kim & Chung, 2019). However, social acceptance of wind turbines follows a U-shaped curve, where the approval of wind turbines is higher during the before and after installation periods, but lowest during the installation period (Wüstenhagen et al., 2007). Wind energy project proposals also give rise to the common phenomenon “Not in My Back Yard” attitude. In this instance, residents disprove of the erection of wind turbines near their homes, but support wind energy projects in other locations. This phenomenon is a simple illustration of how communities or individuals oppose a service mostly for the selfish reason of not wanting to see a wind turbine (van der Horst, 2007).

The energy production from wind turbines has gradually begun replacing other forms of energy production in numerous countries including the United States, Spain, Germany, Denmark, Finland, India and more. China remains the leading country with the highest number of wind power facilities, producing the most electricity from wind energy (Liang, Yu, & Wang, 2019). Wind power is a huge economic sector as expanding wind energy projects create numerous job opportunities. The discussion of wind turbines and their environmental impact has risen, leading the conversation to determining what is safe green energy for both the people and the surrounding environment.

Environmental concerns include the disruption and collision of bird migration paths and other animal disturbances as well as terrain disruption both on and offshore. Cultural and historic values associated with land play a huge part in limiting social acceptance for wind turbines and can greatly influence the location of wind projects. Bird and bat collisions are one of the main ecological concerns with wind turbines. However, Aschwanden (2018) and Wang (2015) concluded that more birds collide with industrial buildings and are poisoned from pesticides on an annual average compared to the mortality rate of birds colliding with turbines. Only a small percentage of birds during a migration season are in the collision zone of wind turbines. There are other disruptions that occur from offshore installations, such as marine life disturbances and the eroded material from wind turbine parts, but no major impact has been reported from these concerns thus far.

Wind energy continues to gain global popularity as more countries strive to reduce their atmospheric pollution. Wind turbines produce zero carbon emissions once in operation while remaining the quickest and cheapest form of green energy. Locations that rely on tourism for their economy may experience positive or negative changes to the tourist industry if wind turbines are implemented in such areas. This research continues to address the general public's opinion of wind turbines, specifically in areas of high tourism. There is little research done on the impact of wind turbines in areas of high recreational or scenic value and whether wind turbines play a role in visitor preference.

2. AIMS

The aim of this study is to assess the visual preference of wind turbines in various recreational and scenic landscapes, specifically in areas of high tourism. Our survey is used to evaluate the negative, neutral or positive visual impact of wind turbines, contributing to future work, which will take place on the tropical island of Guam.

3. REVIEW OF LITERATURE

The goal of the literature review is to discuss the existing research focused on wind turbines as a form of efficient environmentally green forms of energy production and provide background on the visual pollution associated with wind energy project sites. Through the evaluation of previous case studies, the literature review examines various methodological approaches on the numerous techniques used to gather data of public opinion on the social, visual, economic, and environmental aspects of wind energy. Published literature was sourced from multiple databases such as Science Direct, municipality websites and other scholarly publications.

3.1 VISUAL DISTURBANCE

Broekel and Afken (2015) point out how the visual consumption and aesthetic judgment of landscapes attribute to the notion that there are appropriate and inappropriate locations for specific designs. As such, public opinion is often a driving factor behind the development and design of building complexes, highways, wind farms, and city monuments. Renewable energy installations require both economic and spatial resources (Kipperberg et al., 2019). Often these structures are considered visually unpleasing; however, proponents are likely to point to the potential economic benefit (Wolsink, 2010). For example, developers of wind turbines and the associated infrastructures are tasked with developing structures that fit in with the nature that surrounds them (Broekel & Alfken, 2015). Visual impairments of wind turbines based on the physical design and spatial distribution often impact both scenic viewpoints and recreational landscapes (e.g., beaches, golf courses).

3.1.1 SCENIC BEAUTY

Natural landscapes are often viewed as less beautiful when anthropogenic influences are visibly present, specifically with tall man-made structures like wind turbines (de Vries et al., 2012). The perception of wind turbines in nature significantly differs among cultural regions. In the Czech Republic, wind turbines create high levels of visual disturbances (Frantál & Kunc, 2011; Klouček, et al., 2015) and there are few regions within the Czech Republic where you can find them. Meanwhile, countries like Denmark, Germany and Portugal have the largest number of wind turbines installed worldwide, though this does not disbar the theme of local resistance of new energy projects (Wüstenhagen et al., 2007). In other global regions like China and the United States, wind turbines are sometimes viewed as tourist attractions. At these sites, instead of making landscapes less beautiful and devaluing the natural landscape, wind turbines have the opposite effect, adding beauty and meaning to the otherwise boring natural landscape (Smith et al., 2018).

Visual and public impact assessments have been carried out through numerous studies, addressing the visual impact of wind turbines using Geographic Information System (GIS) viewsheds, 3D graphics software, photo simulations and survey questionnaires. A wind turbine study conducted in Maine, USA used both photo simulation and survey methodologies. Using the paired t-test, they statistically illustrated the acceptability of scenic impacts of ten wind energy project sites. (Palmer, 2015). They reveal on average, a more positive attitude towards pre-existing wind turbines and a more negative attitude towards the proposal of future wind turbine infrastructure. However, Palmer addresses the variation among the negative attitudes as they are primarily based on the frequency and spatial distribution of the wind turbines.

3.1.2 AESTHETIC INDICATORS

The visibility of an element is a critical factor that determines a viewer's overall attitude. Distance between the viewer to the element of impact influences the viewer's overall perception of the landscape and inevitably, the viewer's acceptance towards the element of impact (de Vries et al., 2012). The visibility of an element includes parameters such as wind turbine height, blade length, color, silhouette design, frequency and density of wind turbines and wind turbine alignment and topography. All indicators have been used and manipulated among various research surveys to better determine their impact on viewer acceptance towards wind energy.

3.1.2.1 TOPOGRAPHY

Landscapes and seascapes are visual features containing vast amounts of space. If there are consistent winds, they can be subject to potential wind energy project sites. Coastal wind turbine aesthetic indicators differ from landscape indicators, predominately by the distance the turbines are placed from the coast and horizon, all influencing how much the viewer can see of the wind turbine (Teisl et al., 2018). Topography is an indicator that drives viewer consumption, defined as terrain elevation (Kazak et al., 2017). Landscape topography can vary substantially, meaning specific areas can hide wind turbines and can create blind spots to viewers (Hevia-Koch & Ladenburg, 2019; Smith et al., 2018). These areas can include mountainous regions with valleys and hills. However, along the coast looking at offshore wind turbines, the topography will not differ much to the human eye. When the topography appears relatively constant, such as a coastline, wind turbines have no chance of being hidden, further influencing the viewer's opinion of both the surrounding nature and of wind turbines.

3.1.2.2 SPATIAL DISTRIBUTION

The visual impact from wind turbines are generally attributed to the spatial distribution. In one case study, Maslov et al. (2017) used photo simulations to analyze the dependency of wind farm layout and the different viewing points, to measure the wind turbine visual impact. Depending on the viewpoint, the alignment of wind turbines may be perceived as persistent rows evenly spaced and organized (Figure 3.1). On the other hand, the alignment of wind turbines may also be perceived as diagonally scattered and or chaotic from different viewpoint locations. The most aesthetically pleasing alignment from this case study is when there is an organized distribution of wind turbines, meaning the viewer sees parallel rows of turbines and equal spacing (Maslov et al., 2017). This case study also indicates a more positive view on offshore wind turbines when the turbines are in deeper waters, as opposed to shallower waters. This is because deeper waters give the illusion that the turbines are farther away (Maslov et al., 2017).

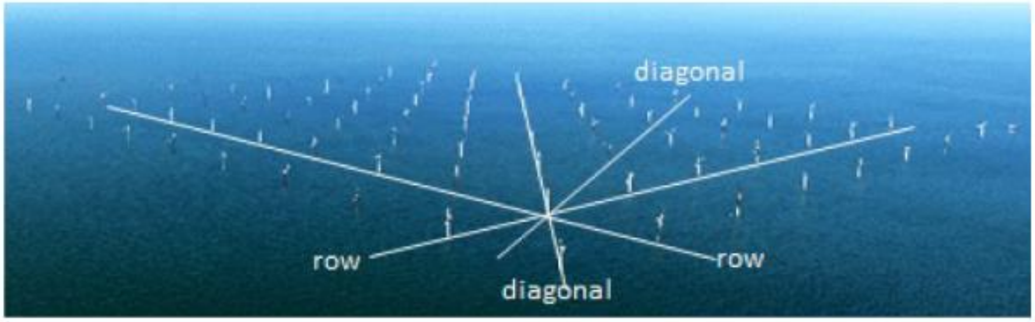

Figure 3.1
Offshore wind farm layout configuration of organized and evenly spaced rows. Source: (Maslov et al., 2017)

The space between turbines and overall perceived density also contributes to overall perception of wind turbines as a whole object. If wind turbines appear close in distance, viewers perceive the turbines as one object rather than multiple individual turbines. This leads to the general perception of one cluster of wind turbines. When there appears to be a considerable distance between each turbine, the viewer identifies each turbine as one separate object rather than a cluster. The human eye is most responsive when it can identify multiple moving objects (Hevia-Koch & Ladenburg, 2019), further influencing a viewer's perception of wind turbines in a given area (Figure 3.2).

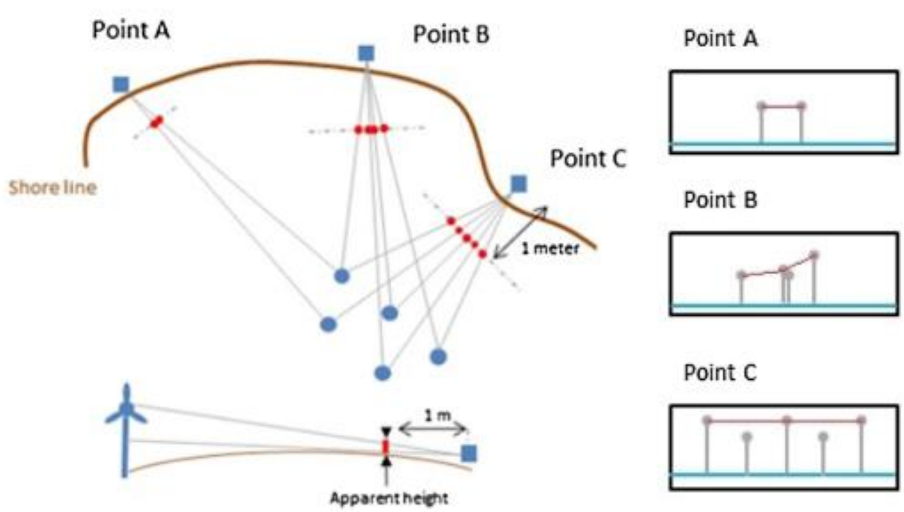

Figure 3.2
Wind Turbine perception based off horizon occupation and apparent height from various viewpoints. Source: (Maslov et al., 2017)

Wind turbine frequency, ranging from a few turbines out in the country to an extensive industrial wind farm, influences a viewer's outlook based on the number of wind turbine encounters. In the Czech Republic, where wind energy development is slow to grow (Frantál & Kunc, 2011) a viewer will encounter few single wind turbines or small wind farms (smallest group including one and larger groups including around ten turbines) as opposed to large developed wind farms seen throughout parts of Germany (Molnarova et al., 2012). Generally speaking, wind turbines have a higher approval rate and a lower visual disturbance effect when limited in number (Ladenburg et al., 2013; Molnarova et al., 2012).

3.1.2.3 PHYSICAL DESIGN

Visual analyses using 3D graphics and GIS viewshed tools have mapped the visual impairment of wind turbines, based on the turbine height while factoring in the blade length. Turbines that are 70-95 meters (m) tall have a visibility factor of roughly 25-30 km. This visibility factor is defined as spatial extent and "the area from which the wind turbine is visible" (Wróżyński et al., 2016). The taller the wind turbine, the greater the spatial extent is. Wróżyński also models the visibility of a 90 m tall wind turbine with a total height of 150 m including blade range, and how the visibility changes based on observer location within a landscape (Figure 3.3). With increasing size and height of wind turbines, obstruction lights become necessary for flight safety, expanding the wind turbine visibility into the night (Rudolph, et al., 2017).

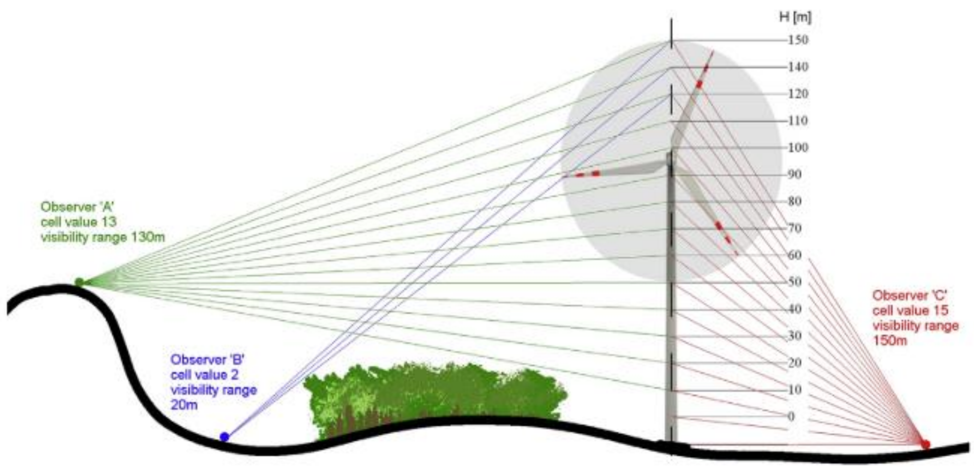

Figure 3.3
Schematic representation of wind turbine visibility at different observer position. Source: (Wróżyński et al., 2016)

The rotor blade length, typically 30 m, contributes to the increasing visibility factor as well as to noise pollution, sun ray reflection and an annoyance of shadow flickering (Hübner et al., 2019). There is a swishing sound associated with wind turbines; however, this annoyance has been reported to disturb a minority of residents in previous studies. Occasionally these sounds are being found to disrupt sleep patterns for locals (Firestone, Bates, & Knapp, 2015). The length of turbine blades have also increased animal awareness as bats and bird flight paths may be in direct line with wind turbines (Ólafsdóttir & Sæþórsdóttir, 2019; Thomson & Kempton, 2018).

The future of wind energy acceptance and development may entail a redesign, as the physical design of wind turbines is continuously met with visual impact complaints. Although, there is an increasingly positive attitude towards wind energy, as wind energy is viewed as environmentally friendly and is considered green energy (Firestone et al., 2015; Frantál & Kunc, 2011; Liu et al., 2016). If physical appearance is the number one reoccurring issue among viewers, then perhaps this primary concern should become a more prominent focus for developers and designers. By examining different shapes, curvatures and overall appearances of wind turbines, there is a possibility to find a design that is less obvious or fits in more naturally (Brittan, 2001).

3.2 SOCIAL IMPACT

The implementation of wind turbine installation has continued to receive both positive and negative responses from the general public. As climate change becomes a dominant topic of global discussion, countries are responding by transitioning to green energy as well as the reduction of greenhouse gases (Fredianelli et al., 2019). Several research surveys have demonstrated there is an overall acceptance of renewable energy technologies and policies, yet there is a disconnect between global and local demands (Wilson & Dyke, 2016; Wüstenhagen et al., 2007). Green energy is seen as highly favorable from a global stance, yet there are specific elements that disrupt a nearby community (Boyle et al., 2019). These elements include auditory disturbances from construction and the mechanical rotating blades, visual disturbances from the machine as well as light disruption, and financial burdens. These disturbances have a social impact on nearby communities, ranging from socio-economic impacts and daily annoyances to possible health effects (Fredianelli et al., 2019).

3.2.1 COMMUNITY DISRUPTION

Communities affected by wind turbines can be described as those who live near wind turbine project sites and more dispersed stakeholders (Firestone et al., 2015). Locals residing near wind energy construction sites suffer from higher annoyance, only due to the proximity, as opposed to residents living a greater distance from the construction site (Hübner et al., 2019). Nearby locals will deal with possible roadblocks, disturbing odors, noise associated with trucks and the installation process, and the overall visual displeasure from construction projects (Kim & Chung, 2019). Although, there are potential community benefits. In one survey study (Figure 3.4), locals living near wind turbines had a more positive reaction than those living near coal plants, with only 6% of residents disliking the wind turbines (Thomson & Kempton, 2018). Wind turbine projects create the possibility of higher employment and potential economic and environmental benefits with green energy consumption (Boyle et al., 2019; Firestone et al., 2015; Rudolph et al., 2017). The installation process is less disturbing if it takes place in areas of high noise pollution, near highways or airports (Pedersen et al., 2010). The location of project proposals may influence the housing market by increasing or decreasing housing costs, based on the proximity or view of the wind turbines (Carr-Harris & Lang, 2019). Businesses may also experience some type of impact after wind turbines are erected, possibly from tourism or agricultural disturbances (Kipperberg et al., 2019).

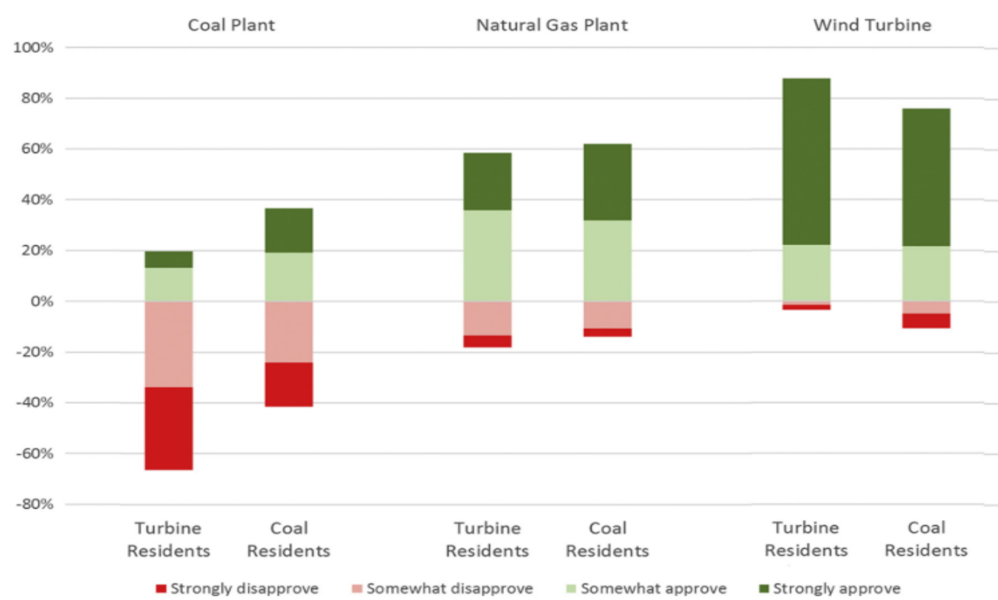

Figure 3.4
Resident survey based on approval and disproval of different forms of generated electricity. Neutral responses not included. Source: (Thomson & Kempton, 2018)

3.2.1.1 INSTALLATION

Wind energy is becoming more prevalent worldwide as it is replacing greenhouse gas intensive power plants. However, the continuous visual and noise complaints have not diminished, regardless of wind energy acceptance as it symbolizes the effort to combat climate change and air pollution (Westerberg et al., 2015). The noise pollution is not only from the wind turbine itself but also from the installation process. Noise from wind turbine installation is a local consequence and short-term daily annoyance. The average resident will have sparse encounters with such noise annoyances, as adults leave their home to go to work and young adults leave for school during installation work hours (de Vries et al., 2012; Walker et al., 2015). After installation, noise is still a reported annoyance either from the mechanics of the wind turbines, or from the air movement through the blades. Although, from a previous survey study conducted in 2014, 60% of residents indicated they did not hear the wind turbine while 22% of residents heard noise from the wind turbine, but did not find it bothersome (Firestone et al., 2015). Installation locations also have an impact on nearby businesses and property values (Ryberg et al., 2019; Wilson & Dyke, 2016). However, declining property values due to noise (Landry et al., 2012) have not overshadowed the societal opportunities of wind energy development.

3.2.1.2 LOCATION

With the introduction and construction of wind turbines, the financial consequences vary depending on the location of the wind project site. If turbines are installed near a small community, sale prices during the project construction phase will decrease, due to noise pollution, visual displeasure of the construction, and overall disproval of the infrastructural phase of the project (Boyle et al., 2019). Onshore wind turbines (within 3 km) negatively impact housing prices during the construction phase, reducing trade prices by 3-6%, and this impact increases with the number of turbines (Jensen et al., 2018). However, from a dense community study done in Rhode Island USA, researchers reported that there are no statistically significant negative impacts on housing prices, in either “post public announcement phase or post construction phase.” The statistical possible impacts of wind energy is still overshadowed by the negative consequences of high emissions of CO_2 and other greenhouse gasses (Lang, Opaluch, & Sfinarolakis, 2014). Researchers at the Lawrence Berkeley National Laboratory released a study done on property values and wind farms in 2013, noting there was no impact on nearby homes and property values. The study analyzed more than 50,000 household sales near 67 wind project sights across the United States (Hoen et al., 2014).

Expanding tourism and rising green energy demands have opened up the opportunity for tourism, as visitors can tour energy power plants, both for renewable and non-renewable energy (Ólafsdóttir & Sæþórsdóttir, 2019). Wind projects are also believed to improve the economic sector by expanding the tourism industry, agricultural upkeep, jobs and electricity rates (Boyle et al., 2019). Although the agricultural sector is not only associated with the economy, but also with social and environmental issues, as infrastructure expansion is at a constant battle with agricultural lands (Jochen Markarda, Rob Ravenb, 2012).

3.2.2 SOCIAL ACCEPTANCE

Social acceptance of wind energy can result in the continual support of wind energy installation. The proposal process of such renewable energies is where community consumers, policy makers, and stakeholders can express their demands. Local acceptance typically follows a U-shaped curve of acceptance, resulting in high acceptance during the wind project proposal, low acceptance during the construction period, and back to high approval once the project is up and running (Aitken, 2010; Wüstenhagen et al., 2007). Renewable energy is a heavily discussed topic, with some of the highest number of publications regarding renewable energy resources (Jochen Markarda, Rob Ravenb, 2012). However, the most common form of renewable energy, wind energy, is met with the strongest backlash (Teisl et al., 2018), largely due to the concerns of visual impact (Molnarova et al., 2012). Renewable energy also brings out some of the more extreme Not in My Back Yard beliefs (Boyle et al., 2019). Despite of public resistance towards wind energy projects, increasing the awareness of environmental issues and sustainability options through promotion and marketing, have positively impacted the publics' overall attitude towards wind energy.

3.2.2.1 AWARENESS OF RENEWABLE ENERGY

As climate change gains traction in local and global coverage, countries like Sweden, Germany, Denmark and the United States have begun to implement new green energy policies, such as increasing renewable energy facilities as well as reducing their emissions to air pollution and greenhouse gases. Renewable energy is an energy resource that will not be depleted over time. It is also important these renewable energy resources are sustainable, to ensure future use of the energy resource. Countries like the Czech Republic, Slovakia and Poland are becoming more western, yet lack the renewable energy facilities as well as a positive perspective towards such energy developments (Kazak et al., 2017). The growth of major cities is leading to higher green energy demands from the energy sector. This type of pressure can cause dysfunctional investments into renewable energy, like poor site locations and project scale decisions (Kazak et al., 2017). Overall awareness and approval of renewable energy is also dependent on the respondent's educational background (Klick & Smith, 2010). Those who are highly educated tend to be more aware of climate change and committed to making change. The less educated are less aware of the climate change issues and alternative energy reducing options, and are less open to committing to change (Hui et al., 2018; Liu et al., 2016). Wind energy is a reliable, cost and energy efficient option (Klick & Smith, 2010). Even with global awareness of climate change and the growing acceptance of renewable energy, the implementation of change will always be met with self-motivated actions even though it serves a greater purpose.

3.2.2.2 NIMBY

The Not in My Back Yard (NIMBY) phenomenon simply illustrates how a general public may be in favor of a certain service, and in principle this service is beneficial for the majority of the population, but local opposition, whether this is by communities or on an individual scale, oppose such services mostly for selfish reasons (van der Horst, 2007). In other words, wind power is considered acceptable as long as it is not generated in my back yard (Westerberg et al., 2015). This is the "Not in My Back Yard" effect. Public opinion polls state that most Americans support wind energy, yet wind energy development at specific locations encounter local community backlash (Boyle et al., 2019). Boyle discusses the term volunteer's dilemma, which describes the situation where the public majority benefits from a collective good or service, while a minority group suffers from local personal costs. Wind farms are believed to create negative externalities nearby residents must bear, while the benefits of energy security and air pollution reduction are widely experienced by the larger community (Boyle et al., 2019). Such psychological attitudes and stresses can result in huge local movements against wind turbine installation and possibly deter future installment of renewable energy resources in nearby communities (Walker et al., 2015).

3.2.2.3 RENEWABLE ENERGY ACCEPTANCE

Renewable energy resources have become an expanding industry as a way to combat climate change and reduce greenhouse gas emissions and air pollution (Lang et al., 2014; Sardaro et al., 2019). Wind turbine development symbolizes an effort to combat climate change, yet it is also seen as an environmental disruptor, introducing the Green vs Green debate (Westerberg et al., 2015). Some studies suggest renewable power like wind power, has high acceptability based on resident's daily exposure, proximity, and familiarity. Research conducted in Ireland and Scotland in 2005, suggest there is a positive attitude toward wind power from those living near wind turbines. This type of support is "inverse NIMBYism," meaning there is a positive perception of wind turbines the closer the residents live to them (Wilson & Dyke, 2016). Another study based in the United States (US), took 1000 residents in various locations, living closest to wind farms and other power plants (operating at least for four consecutive years) to collect their opinion and viewpoint on living near such facilities. Those living near wind turbines have positive attitudes towards the facility and reported more positive than negative auditory and visual impacts. Those living near a fossil fuel plant had reported significantly more negative attitudes, both visually and auditory. Neither demographic characteristics nor distance from the facility had a significant impact on the results (Thomson & Kempton, 2018). Another study done in the Czech Republic (Figure 3.5) found that more residents have negative attitudes towards industrial buildings and mines, and more neutral or positive attitudes towards wind or hydraulic energy (Frantál & Kunc, 2011). Under green energy development, global acceptance to renewable energy methods is being met with the expectations to reduce carbon dioxide emissions as one way to address climate change (Biresselioglu et al., 2016).

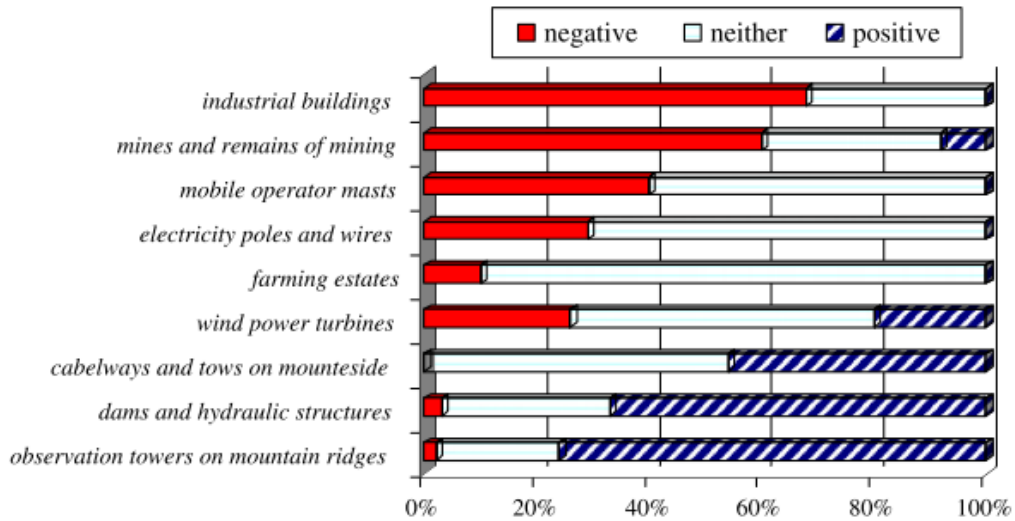

Figure 3.5
Local perception of anthropogenic objects in landscapes. Source: (Frantál & Kunc, 2011)

3.2.2.4 MARKETING STRATEGIES

The marketing behind wind energy dramatically impacts the perception of wind energy as a resource. Successful electric grid marketing is a simple way to ensure reliability across the grid. There are both positive and negative promotion styles. To negatively advertise wind energy, communities or governments may strictly focus on the negative aspects of wind energy, like harming nature or the visual impact (Hevia-Koch & Ladenburg, 2019). Positive promotion would look more like a community or government actively trying to engage the public with the wind energy, either by site location or from educational profits like tourism, associated with the wind power project sites. For instance, the Chinese government made a goal to develop wind farms in rural areas, in the hopes of growing sustainable rural development. The goal was to improve the residential livelihood, and to promote green energy consumption and eco-friendly tourism. The wind farm industry in China expanded the tourism and economic industry, and acted as a bridge connecting rural and urban planning (Liu et al., 2016). With rapidly developing economies, introducing a sustainable energy source is crucial for the continual support of the people and the country's expansion. To do so, there must be support behind the sustainable energy project. Positive eco-friendly promotion strategies can sustain public support and enhance growing economies (Liu et al., 2016).

3.2.2.5 U-SHAPED CURVE OF ACCEPTANCE

The acceptance of wind power follows a U-shaped or V-shaped curve (Figure 3.6) and is based on time (Wüstenhagen et al., 2007). The initial reaction to the wind energy project proposal is at first, positive (Ladenburg & Dahlgaard, 2012). However, these positive attitudes turn negative during the installation process due to the installation noise and construction (Aitken, 2010). After the installation phase, public opinion changes back to a high acceptance of wind energy (Wilson & Dyke, 2016). Most communities follow this acceptance curve. Only a small percentage of individuals continue to have negative perceptions of wind energy both before and after development (Firestone et al., 2015; Wilson & Dyke, 2016).

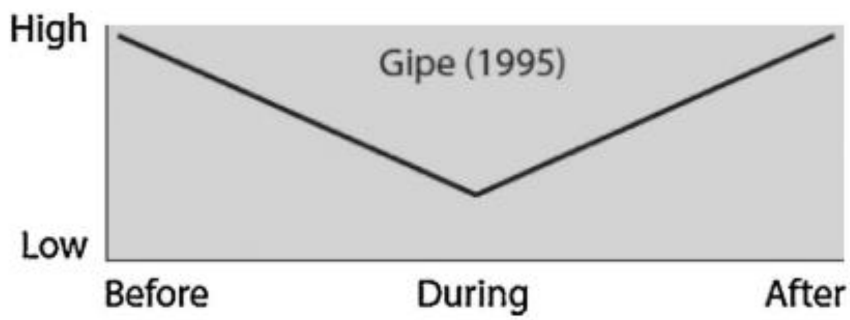

Figure 3.6
Acceptance curve during wind project installment. Source: (Wüstenhagen et al., 2007)

3.3 ECONOMIC IMPACT

Those who favor wind energy have a positive perspective that wind energy will boost economic sectors like tourism, agriculture, jobs and electricity rates (Boyle et al., 2019; Kipperberg et al., 2019). Countries with high economic growth can afford renewable energy and overcome the cost associated with implementing renewable energy facilities on a large scale. High income countries like China, Germany and the US are more capable financially of meeting the costs of new public policies that support renewable energy development and regulation (Biresselioglu et al., 2016). Economic growth is the most influential driver of a country's wind capacity development. Denmark and Spain are prime examples that illustrate how economies can rely on wind energy as a significant sustainable energy resource, as Denmark receives 21% of their electrical energy from wind and Spain receives 12% (Landry et al., 2012). Within the energy production sector, numerous barriers must be addressed. Local versus corporate needs have the potential to sharply divide and hinder the progress of renewable energy installment and expansion. There is also the issue of public trust among the residents, policy makers and stakeholders (Wüstenhagen et al., 2007). This issue of trust is defined by the extent of how much a local community can trust the information from outside investors, specifically the intentions of these investors.

3.3.1 ENERGY PRODUCTION

Wind energy is a clean fuel source. Wind turbines do not rely on the combustion of fossils, nor do such wind farm facilities produce air pollution that contribute to atmospheric emissions of greenhouse gases (Hoogwijk et al., 2007). Wind power is also one of the most cost effective and low-cost energy sources currently available. According to the U.S. Department of Energy (2011), wind energy costs between two to six cents per kilowatt-hour. Wind energy reduces the price uncertainty otherwise experienced by other forms of energy like coal-fueled power plants, as it is sold at fixed price rates over 20 years or more (Slattery et al., 2011, U.S. Department of Energy, 2011). In countries like the US, the wind sector has employed more than 114,000 workers in 2018, and wind turbine technician jobs have become the fastest growing job in the US of the decade, according to the American Wind Energy Association (AWEA, 2020).

In 2018, wind energy generated just 6.5% of the US electricity, enough to power 26 million households (AWEA, 2020). For 6 states, wind produced more than 20% of their electricity (Hoogwijk et al., 2007). In 2019, the US wind projects produced a total capacity of over 100 gigawatts (GW) and according to the German Wind Energy Association (BWE), Germany had a total of 55 GW of wind energy in 2017, generating 14.5% of the nation's electricity (BWE, Jung et al., 2018). Meanwhile, China leads the world with the highest number of wind power facilities (BWE). In 2018, China led the world by producing 187 GW of wind energy, and by the end of 2020, China strives to have 210 GW of grid connected wind energy (Yang et al., 2017). By 2050, China plans to reduce CO_2 emissions by 35.8 billion tons by expanding its renewable energy grid (Liang et al., 2019).

From a 2018 statistical report from Wind Europe, 41% of Denmark's electricity came from wind, 28% of wind energy was generated in Ireland, 24% for Portugal and 21% for Germany (Figure 3.7). In 2018, the EU installed more wind facilities than any other form of electricity generation, making 14% of the EU's electricity from wind (Colin

Walsh, 2018). The European wind industry invested a total of 27 billion euros in new wind farm installations in 2018, now making wind energy 60% of all power generation investments (Mbistrova, 2019). Over 260,000 jobs are supplied by the wind energy sector across Europe. By 2027, the International Energy Agency expects wind to become the number one power source in Europe, and by 2050, wind energy is predicted to meet more than half of Europe's power demands (Wind Europe).

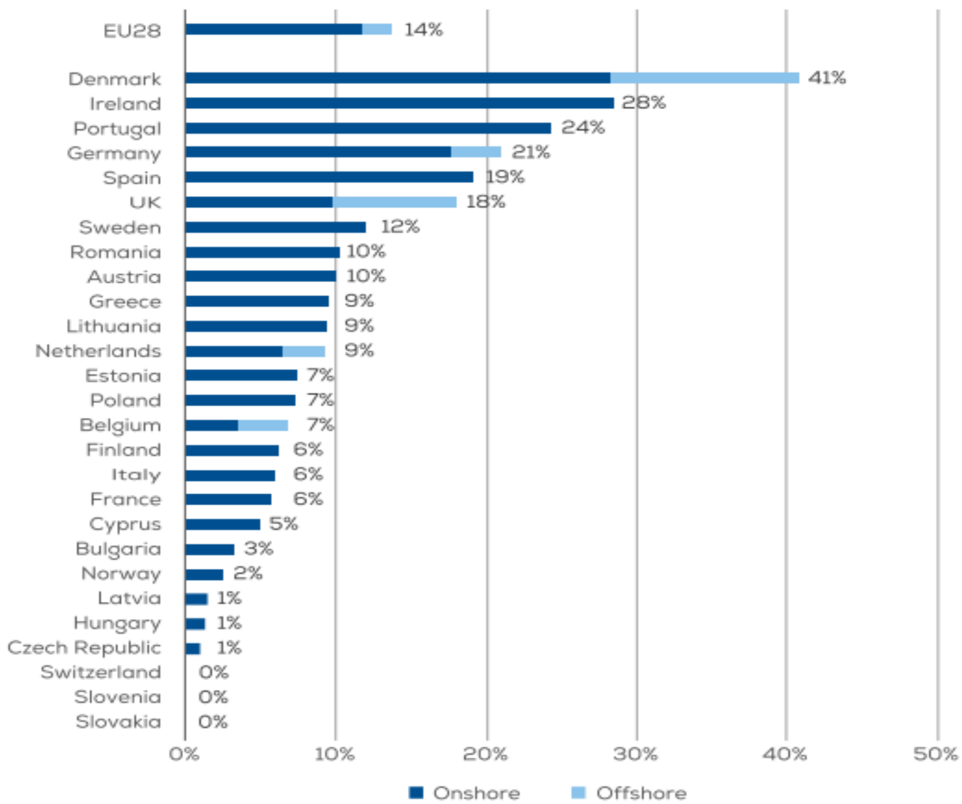

Figure 3.7
The annual average percentage of electricity demand covered by wind. Source: (Colin Walsh, 2018)

Wind projects enable economic growth. In 2019, the US wind energy contributed $20 billion to the US economy from wind energy investments (AWEA, 2020) and in 2016, Germany brought in 10 billion euros (BWE). In the US, wind projects pay over $1 billion to local and state governments and private landowners every year, to install and operate wind farms. This revenue expands local tax bases, which helps improve school facilities, fix roads and fund local law enforcement (AWEA, Slattery, Lantz, & Johnson, 2011). According to the United States Department of Energy (USDOE), wind projects pay for themselves in the long run due to increased economic benefits and reliability, resulting in significant savings to consumers. The Midcontinent Independent System Operator (MISO) is a grid operator in the US, covering 13 states throughout the

Midwest. MISO reported that with transmission upgrades to sustain renewable clean energy using wind, each consumer saves about $1000/year, which is 2.6 to 3.9 times greater than the grid upgrade costs. Over the next 20 to 40 years, there will be an estimated $13 billion to $50 billion in net benefits (Chang & Starcher, 2019, MISO).

Texas emits the most greenhouse gases in the US while also remaining the state with the highest number of operating wind turbines (more than 10,000) across all of the US and with the most wind facilities underway (Gabriel & Nathwani, 2018). The Competitive Renewable Energy Zones (CREZ) were built to relieve congestion on the Texas electric grid (USDOE). With great success, CREZ has more than doubled the amount of wind energy transmitted in Texas. With continuous wind energy expansion, nearly $10 billion is being invested in the state's economy. By 2030, wind power will supply electricity to over 15 million homes, meeting 37% of the state's electrical needs (AWEA, 2020) and as wind turbine technology improves, the developmental cost decreases (Gabriel & Nathwani, 2018). Texas contributes nearly one quarter of all electricity generated by wind power in the US, boosting the local and state economic growth, and promoting green energy consumption as a viable energy resource (Slattery et al., 2011). Overall, Texas continues to increase its use of renewable energy while lowering its consumption of natural gases (Figure 3.8).

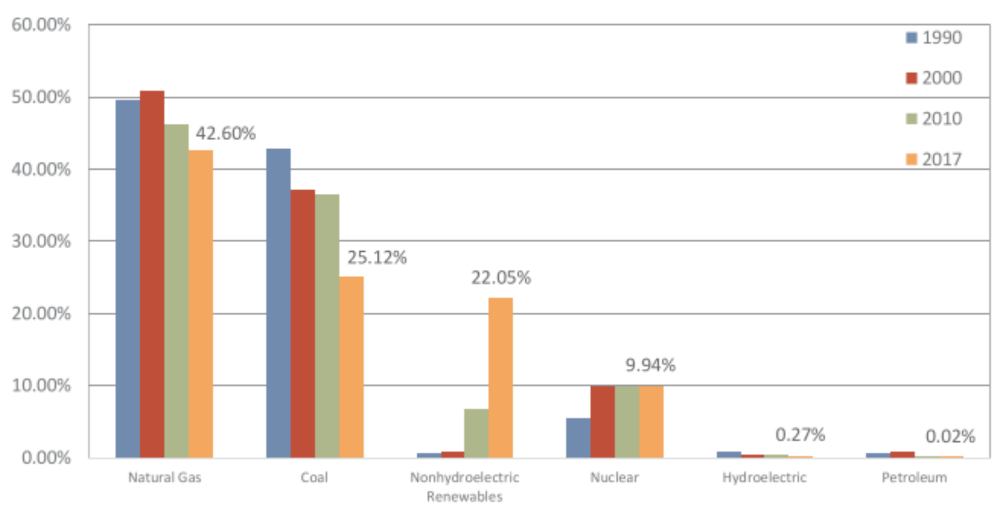

Figure 3.8
Energy consumption in the state of Texas (USA) over three decades. Source: (Gabriel & Nathwani, 2018)

3.3.1.1 GOVERNMENT VERSUS LOCAL

As countries continue with their efforts to reduce greenhouse gas emissions, some policy makers may implement a carbon emission tax on individual households. This could give future incentive to switch from a fossil fuel generated electric grid to green energy, or it may result in local community complaints and protests (Ghaith & Epplin, 2017). Community acceptance or resistance is a key component in the progress of wind power development and illustrates the gap between national and local demands. Local stakeholders and local authorities introducing a small-scale wind project may have more significant support among residents because local ownership and needs can be addressed and met faster. However, if a large-scale wind farm project is introduced into the area and is owned by a large corporation, local support will be low, as locals will have less of a chance to participate in the policy making decisions as the power generated is supplied to a larger population (Ólafsdóttir & Sæþórsdóttir, 2019). The issue of distributional justice and community trust also arises, as locals want to know the costs and benefits of the proposed wind projects, and who is benefiting. They also begin to question the intention of the outside investors of the projects (Wüstenhagen et al., 2007). NIMBY debates often occur, where residents may support the use of renewable energy if it is not in their backyard. The divide between national and local goals must be met with national industrial policies transformed into locally accepted policies. This relates to the topic of community trust and how much communities can trust outside investors meeting local demands while fulfilling large-scale corporate goals (Wüstenhagen et al., 2007).

3.3.2 SUSTAINABLE ENERGY

Wind energy is sustainable, but the extent to which wind energy is sustainable is questionable. Wind is caused by atmospheric heating of the sun and earth's rotation and surface topography. The harnessing of wind power has grown significantly over the past decade, and with technological advances, wind turbines are now built with higher efficiency with greater power capacity (Ólafsdóttir & Sæþórsdóttir, 2019). As more countries sign the Paris Climate Agreement, more action is being done to reduce greenhouse gas emissions. However, wind infrastructure may be vulnerable in tropical storms with high wind speeds. As climate change may intensify weather events, it is crucial to assess the extent of wind turbine operational capabilities (D. Zhang et al., 2019). Intense lightning storms can strike wind turbines as they are making them taller with higher angled blades, and sea ice can also cause damage to wind turbine operations (D. Zhang et al., 2019). Although wind energy is a promising alternative and significantly reduces GHG emissions, with weather conditions intensifying, the design of harnessing wind power may need to be altered in order to continue being an efficient renewable energy source while overcoming the new challenges of climate change.

Wind farms generate additional revenue not just from local taxes, but also from sustainable tourism. Some studies have been conducted to assess the impacts wind turbines have on tourism, and from one study conducted in the US, there were no negative effects on tourism caused by offshore wind farms (Carr-Harris & Lang, 2019). In Iceland, the construction of wind turbines and hydroelectric plants have expanded the tourism industry to the country's highlands, becoming a popular tourist destination for travelers (Ólafsdóttir & Sæþórsdóttir, 2019). These boosts in tourism can also be seen in countries like China, the US and Korea. However, further research is needed to assess the full extent of wind turbine impacts on areas of high recreational use.

3.4 ENVIRONMENTAL IMPACTS

Energy generated from wind has some of the lowest environmental impacts. Wind power reduces water consumption and carbon emissions, cutting air pollution by reducing the amount of Sulfur Oxides (SOx) and Nitrogen Oxides (NOx) released into the atmosphere, that leads to conditions like smog and acid rain. Since wind energy does not contribute to air pollution, it also does not contribute to the human health issues impacted by air pollution exposure (Hoogwijk et al., 2007). Wind energy has zero carbon emission. Wind turbines in the US generated enough electricity to avoid 200 million tons of carbon pollution, equivalent to 43 million cars worth of Carbon Dioxide (CO_2) emission (AWEA, 2020). Wind turbines do not require water to produce electricity or to cool down mechanical equipment. The more wind turbines installed and used, the more water is conserved (Denholm et al., 2009). Wind as a sustainable source of energy is expanding globally, but there are environmental concerns relating to animals and human activity.

3.4.1 TERRAIN DISRUPTION

The disruption of land is a critical issue that must be addressed when there is a wind project proposed for a specific region. Wind energy development or an expansion could disrupt animal migration paths, create new unwanted road paths, possibly fragmented land, interrupt the visual landscape, or result in cultural or financial land loss (van der Horst, 2007). Land values on an individual scale are created through years of memories and experiences with the land; sensory interactions (Kim & Chung, 2019). Wind turbine construction gives the impression of ecological disruption impacting animal migration. It brings the concept of urban, artificial, and mechanical operations which opposes the natural feeling of land and landscapes (Kim & Chung, 2019). At first impression, wind turbines are seen to lower the natural quality of the environmental landscape. However, terrain and landscape disruption are arguably significantly higher from hydroelectric or coal power plants. For economical and sustainability reasons, the public opinion of wind energy production is highly susceptible to change (Sæþórsdóttir & Ólafsdóttir, 2020).

3.4.1.1 LAND AND CULTURAL VALUES

Windmills have been a common feature in rural lands, for milling grains. Now, farmers are allowing their rural lands to be homes to new modern wind turbines that generate electricity. Landowners lease their land to wind companies, earning a stable source of income. This income helps if there are poor crop yields due to floods, fires, droughts, or other factors related to climate change, as well as protecting farmers from commodity price fluctuations. Cultural ties to the land are often seen as non-suitable project sites, or are met with heavy protests from locals (Pedersen et al., 2010). Depending on the country's cultural background, wind development can either enrich or damper the landscape values, and areas most vulnerable to landscape loss are areas of greatest cultural importance (Kazak et al., 2017). The erection of wind turbines in the Czech Republic has brought up political debates between landscape planners, land use policy makers, regional developers and locals/land owners (Frantál & Kunc, 2011). Land values may also be interpreted from an economic standpoint. Some lands are cheaper than others. For instance, the wind farms in Texas are in regions where the land is at a lower value (Chang & Starcher, 2019). Land prices may also differ if there is competition for the land. This competition can be for agricultural purposes, infrastructural battles, or the preservation of the land. Land value also comes in the form of existing and proposed value, influencing political decisions and contracts (van der Horst, 2007).

3.4.1.2 ANIMAL DISRUPTION

With the global expansion of wind energy, there is a growing concern over the wildlife impacts wind turbines possess, particularly on birds and bats. Wind turbines are believed to cause psychological stress for local wildlife. One case study measured corticosterone levels collected from animal feces, and the results demonstrated that ground dwelling animals like rodents, living near the wind turbine had higher corticosterone concentrations than rodents living in undisturbed areas (Łopucki et al., 2018). These increased stress hormones can be attributed to noise frequency waves exerted by wind turbine rotating blades, underground vibrations at the base of the wind turbine, and construction associated with turbine installment. Animals have broad audible frequency ranges, so their ears can pick up on certain frequencies human ears cannot. These frequency waves are hypothesized to lead to a reduced number of larger wildlife animals in areas, such as foxes or other predatory animals (Łopucki et al., 2018).

Bat mortality from turbine collision is caused by blunt force trauma. Even with a bat's sensitive echolocation, the rotating turbine blade speed is too fast for bats to detect. Bat mortality is also dependent on the size of the wind farm (Parisé & Walker, 2017). Smaller farms have lower mortality rates than large wind projects. A Canadian case study done by monitoring birds and bats before, during, and after wind turbine installment, reports a bat mortality rate of 45 bats per turbine, and annually across North America, there are nearly half a million bats killed by wind turbines (Parisé & Walker, 2017). This makes turbines more dangerous to bat populations than to bird populations, resulting in bat mortality as one of the most significant environmental concerns with wind energy development. From this study, guidelines for regional monitoring of birds and bat populations should be implemented.

Wind turbines have both a direct and indirect impact on birds. Bird populations suffer a direct impact from collision with wind turbines. A study conducted over 36 states at 86 bird observation routes in the US, reported a bird mortality rate of 151,630 for the year. This study also concluded that the increase in blade length leads to higher collision rates, and the height of the turbine has a negative correlation to bird mortality (Miao et al., 2019). The indirect impact turbines have on birds is through bird avoidance or loss of habitat due to wind farm installment and operation (Miao et al., 2019). Miao suggests a tradeoff between the energy generated and the bird impacts, proposing future wind energy policies should encourage taller wind turbines, but not larger (blade length). The proposal of shutting down wind farms during bird migration season has also been discussed to reduce collision risks. One study used radar data to track the collision between wind turbines and nocturnal birds during the migration season in the mountainous region of Switzerland. Turbines in these locations had a height of 108 m, a rotor diameter of 80 m, and a total height of nearly 150 m. An estimated 1.65 million birds were crossing this region, and 390,500 birds flew within the height interval of the turbines. Of these 390,500 birds, they estimated only 0.25% of birds were at collision risk (976 birds) and the majority of birds at risk avoided collision (Aschwanden et al., 2018).

Even with bird collisions being a great concern, bird mortality is significantly higher from other causes such as collision with buildings and windows, or domestic and feral cats. A research study published in 2015 reported the annual bird mortality in the US with the associated causes (Figure 3.9). The report included high mortality values from building and window collision, feral cats, collision from transmission lines, pesticides, cars and trucks, and other concerns for bird population.

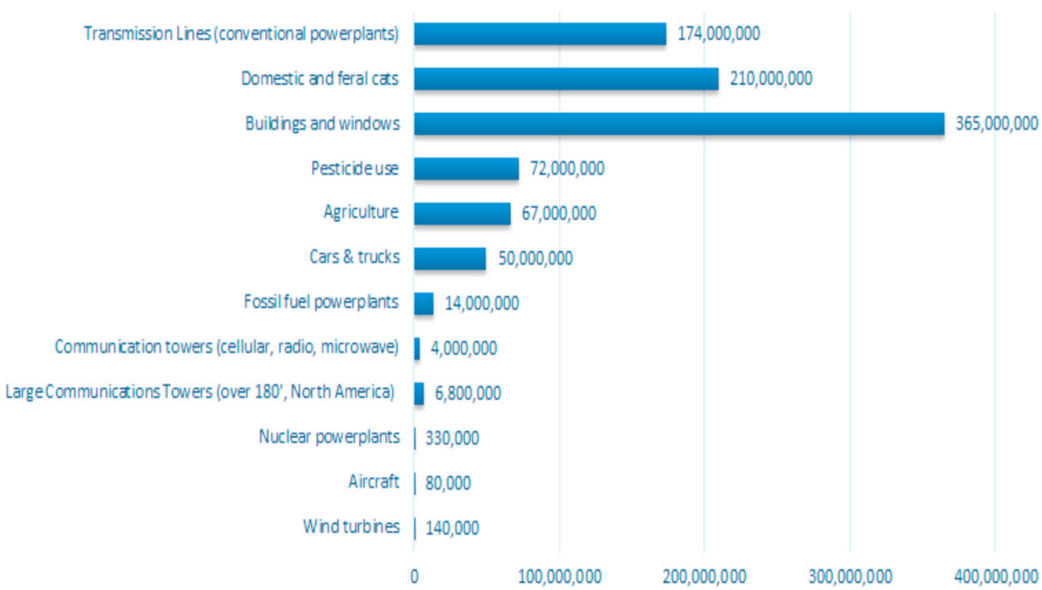

Figure 3.9
Annual mortality of avians in the US. Shows the lowest values of given estimated range. Source: (Wang, Wang, & Smith, 2015)

3.4.2 OFFSHORE INSTALLATION

Moving wind energy offshore eliminates some of the critical issues wind energy developments face inland. Offshore wind energy production does not interfere with daily human activity as much, nor does it bother people from the noise or shadow flicker (Landry et al., 2012). The transportation of the mechanical parts is easier for offshore installment, as ships are used rather than roads. However, ships use more fuel than cars and there are still environmental, visual, and aesthetic disturbances that the turbines have on coastal environments and marine life. A proposal for an offshore wind farm off the coast of France was met with local resistance, as locals argued that offshore wind farms would disrupt the unique seascape (Westerberg et al., 2015). Offshore wind energy also faces unpredictable winds, harsh seas and weather conditions such as strong storms (Akbari et al., 2019). However, these concerns have not slowed the expansion of offshore wind energy installment. North American, European and Asian countries have already implemented large-scale offshore wind projects. Offshore wind energy seems more favorable than onshore wind energy because it contributes to higher economic gain from higher production of clean energy, due to the high wind speeds and larger turbines installed (Akbari et al., 2019).

Offshore wind farm development faces fewer space restrictions compared to on-land farms (Weiss et al., 2018). However, the construction of offshore wind farms can disrupt marine life and activity. The larger the construction area, the larger the marine footprint. Large offshore wind farms can disrupt the transportation of bulk shipment vessels, fisheries and ferry lines (Akbari et al., 2019). The Taiwan offshore wind farm development deals with the overlapping issue of marine renewable energy with traditional fishing grounds (Y. Zhang et al., 2017). The Taiwan offshore wind farm developers believe traditional fishing grounds should be avoided if possible. However, if another service with greater national interest wants to utilize the coastal area, fisheries must make a sacrifice with government compensation for its losses (Y. Zhang et al., 2017). Marine spatial plans are carried out in order to designate specific zones for the use of wind energy (Schütz et al., 2019).

Countries like Norway and Scotland have implemented large-scale strategic marine planning ecosystems aimed at fulfilling international obligations such as reduction in GHGs while adhering to the values of ecosystems. These plans allow countries like Norway and Scotland to record and monitor the state of the ecosystem, habitat structures, pollution or impacts on human activity. Sizeable marine ecosystem planning promotes environmental accountability, as marine management will be based on up to date knowledge of the marine ecosystem impacts (Schütz et al., 2019). Spain has also implemented a marine spatial planning directive, aimed at establishing a balance between marine environment protection and sustainable energy development. Based on the strategic environmental assessment of the Spanish coast, they have established exclusive zones where offshore wind turbines are allowed and prohibited (Salvador et al., 2018).

Corrosion of offshore infrastructure from the seawater is another issue that must be addressed, as the release of metals into the ocean from galvanic anodes can impact marine species (Kirchgeorg et al., 2018). The current solution to this problem is to use organic coatings for the infrastructure. The organic coating overtime releases organic substances into the water from weathering or leaching, currently assumed to have low environmental impact. However, the organic substances released are not heavily monitored, so there is no sufficient data to give an in-depth assessment of the environmental impact (Kirchgeorg et al., 2018).

3.4.3 CARBON EMISSIONS

Greenhouse gas emissions remain one of the biggest global concerns. Increases in atmospheric carbon influences several environmental factors, including ocean salinity and marine life, sea level, precipitation patterns, storm intensity, plant productivity and atmospheric temperature (Ghaith & Epplin, 2017). A statistical report was released from the International Energy Agency in 2017 reporting that global carbon emissions from fossil fuel combustion had reached 32.29 billion tons, of which 13.54 billion tons were directly attributed to heat production and electricity (Xu et al., 2018). China's carbon emissions from electricity and heat production, accounted for 32.64% of the global total, followed by the US and then India. As China remains one of the highest contributors to greenhouse gas emissions, they also remain the country with the highest demand for green energy (Xu et al., 2018).

Wind power remains the quickest and cheapest form of electricity to reduce carbon pollution. In 2018, the US wind sector cut nearly 43 million cars' worth of CO_2 emissions (AWEA, 2020). The typical amount of carbon emission associated with the mechanical production of wind turbines is repaid within six months of operation or less, further generating carbon-free electricity for the remaining 20 to 30 year lifespan (AWEA, Ji & Chen, 2016). Global action continues to address the concern of greenhouse gas emissions and regions of the world, like the EU, making commitments to reducing CO_2 emissions. A study done in Ireland found that there would be a 14.6% increase in carbon emissions, if the country had an absence of wind power (Forbes & Zampelli, 2019). In Germany, they avoided emitting 158.8 million tons of CO_2 in 2016 by using renewable energy resources, 40% of this was achieved by wind power (Eichhorn et al., 2019). From various case studies and reports, it can be concluded that wind energy is efficient at reducing emission of greenhouse gases as well as remaining a non-contributor to air pollution.

4. METHODOLOGY

This section includes a basic overview of our methodological framework. The goal of our study is to further decipher the visual preference of wind turbines in various recreational and scenic landscapes, particularly in areas of high tourism. Our survey consists of multiple questions, scenarios and images participants rank based on a -5 to +5 scale of negative to positive visual impact. Survey participants also can provide a written explanation to their answers. Adobe Photoshop 2020 was used to digitally manipulate photos, Google Forms served as the online survey platform, and Excel 2016 was used to provide diagrams for our data representation.

4.1 PREVIOUS METHODOLOGIES

Assessing the public opinion and acceptance of wind turbines has been evaluated through numerous methodological approaches, although none so heavily on the visual impact or preference of wind turbines in areas of high recreational use or scenic value. One study based in central Europe used Adobe Photoshop to visually manipulate images of landscapes, digitally adding wind turbines into various photographs. From these images, they created a survey asking respondents to rank the landscapes from -10 (dislike very much) to +10 (like very much) indicating their preferred landscapes based on perceived visual attractiveness (Sklenicka & Zouhar, 2018). In a separate case study, the computer program Autodesk 3ds Max along with Adobe Photoshop were used to create the wind turbine model simulation and to digitally incorporate them into the landscape photographs. These images were used in a survey to quantify the perceived scenic beauty in Dutch landscapes. The survey consisted of several sets of images (each set with the same image) and within each set, the distance between the observer and the wind turbines changed as well as the height of the turbine (de Vries et al., 2012).

Geographic Information System (GIS) and Digital Elevation Model (DEM) have been widely used in visual impact assessments when evaluating the visibility and visual disturbance of wind turbines. Maslov et al. (2016) used GIS and quantifiable parameters, including horizon occupation, distinguishable wind turbines, aesthetic indicators and wind turbine alignment, in order to estimate the visual impact of an offshore wind farm in North West France (Maslov et al., 2017). Another case study by Wróżyński et al. (2016) used a combination of GIS tools, Digital Surface Models (DSM) DEM, and 3D software to create 3D models and computer animations, to further assess the visual impact of wind turbines from various spatial extents and visibility range schemes. The simulations reflect the wind turbine visibility, accounting for distance and any visual obstacle between the observer and the wind turbine (Wróżyński et al., 2016).

A study conducted in Denmark collected data from an online panel of respondents. This survey was designed to determine if there is a correlation between observer attitudes towards wind turbines based on the number of daily encounters with wind turbines and their proximity to the wind turbines. The questionnaire included basic demographic questions like age, annual income, education as well as asking respondents how many wind turbines they encounter on a daily basis, with ranges varying from 0-5 and >20 (Ladenburg & Dahlgaard, 2012). One online public opinion survey was released to China's general public, collecting data from a wide range of respondents while recording respondent age, gender, education, marital status and income. The main purpose of the survey was to aquire data on public opinion on wind turbines, focusing on the NIMBY concept. Questions included how much respondents would be in favor towards wind turbines, based on the distance from the wind turbine to their home. Questions also focused on how respondents attitudes changed based on an increase of their electricity bill as well as asking questions to guage public opinion on the governments actions to combat climate change and the public's trust in their government's actions (Shen et al., 2019).

A mix of followup interviews and surveys were used in one study by Firestone et al. (2015). There were three groups of respondents, each group of different proximity to the Lewes Wind turbine and Delware's Atlantic seaboard. Participants were collected from Survey Sampling International (SSI) and included respondents both of full-time and part-time working residents, homeowners and renters. Survey questions addressed resident opinions and attitudes on community scale wind projects, including their perception of wind turbines having negative or positive impacts on the environment and community income/benefit, and how these attitudes change based on whether or not the wind turbines are exclusively privately owned. Followup interviews were conducted to gain further reasoning behind respondent's answers (Firestone et al., 2015).

4.2 LANDSCAPE PHOTOGRAPHY AND VISUALIZATION

The survey assessment consists of 16 photographs of various recreational landscapes and scenic views. Photographs were taken in Guam during the end of August 2019, a popular tourist destination off the coast of Southeast Asia. Images were captured using a Nikon D800 digital camera with image quality set for fine/high resolution. File size of each image was approximately 25 MB in size. Photos were digitally manipulated using Adobe Photoshop 2020 to incorporate the visualization of wind turbines. The turbines used for the photo visualization were photographed in Northwestern Czech Republic and were scaled down to represent a turbine height of 105 m and a rotary blade diameter of 90 m (size of a typical wind turbine in the EU).

Photos were taken from a viewer perspective, and the positioning of the wind turbine blades differ from one another, to give a more realistic perception. Images used are comprised of coastal, mountainous, recreational, and scenic views, including landscapes with buildings, golf courses and scenic viewpoints. Photos consist of six to seven wind turbines, each scaled appropriately to correspond to distance. Each image underwent light manipulation, to create the visual appearance of a sunny day for the viewer, allowing a clear visual of the wind turbines in the photo. Some photos were used more than once in the survey, with a different layout and positioning of turbines. However, these images were not shown directly after one another, to limit respondents comparing the same image to one another.


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Images 1-16 are photos used for the online survey. Each photo represents a different recreational or scenic setting. Image 1, 4 and 16 are the same scenic viewpoint, but with different positioning of wind turbines as well as turbine count. Original Photo: Peter Kumble (2019).

4.3 SURVEY AND PARTICIPANTS

The survey questionnaire includes basic demographic questions such as age, gender, education level, place of residence, as well as descriptive scenarios (see Appendix A). For each scenario, participants were asked to rate on a scale of -5 to +5 how much impact wind turbines would have on their decision to visit a location, depending on whether the wind turbines are visible, or were located nearby but not visible. Ranking of -5 represents negative impact, zero represents neutral and +5 represents positive impact. Questions also included whether the participants have been to areas with wind turbines, and if these areas were recreational or scenic areas. Other questions queried if participants think wind turbines should be located in areas including agricultural crop production, places of historic or cultural features, offshore in coastal areas, and within or adjacent to scenic and coastal landscapes as well as national parks. Participants also had the opportunity to write an explanation to their response. For each of the 16 photos used for the photo simulation, participants were asked to rank the image based on their perceived positive, negative or neutral attitude of the landscape using the -5 to +5 scale. No statistical analysis will be used for data interpretation.

Participation was conducted through an online survey using Google Forms, sent to schools in both the EU and US. Participants include students and former students with an educational background in environmental sciences and or with a design background, from Czech University of Life Sciences, University of Koblenz and Landau, University of Oregon, University of Guam, Utah State University, Technical University in Berlin, University of Lisbon, Technical University in Dresden, University of Maryland, University of Arizona, BOKU in Vienna, Arizona State University, Warsaw University of Life Sciences, University of Massachusetts, American University Beirut, CVUT, University of Arkansas, Wageningen University of Research, Netherlands, Portland State University, University of Denver, University of Laval, Canada, Monash University Australia, Hochschule Osnabruck University, Germany, University of Illinois Urbana, Lincoln University, New Zealand, Curtin University Australia, North Carolina State University, MIT University, India, West Virginia University, University of Hohenheim, Germany, University of Alberta, Canada, Hafen City University, Germany, University of Maine, Cranfield University, UK, Manchester Metropolitan University, UK, ENSAT Toulouse, France and University in Avignon, France. Students were used as a survey base due to their accessibility, availability and rapid responses.

5. RESULTS

5.1 DEMOGRAPHICS

The results from the online survey were collected during a four-week period from February 18 to March 16 (2020), obtaining 116 responses. All questions were answered; none were left blank. Participant ages range from 16-19 years to 60-69 years, with a large majority falling in the 20-29 age range. More than half the participants' identity as female and a vast majority have or are currently obtaining a master's degree or PhD. (Table 5.1.1). The survey asked participants to include their permanent place of residence and if they are originally from a country other than their permanent place of residence, to list that country (see Appendix A). Seen in Figure 5.1.2, survey responses were collected over a wide range of participant background, with most respondents from the US (48 respondents excluding the Island of Guam). Of all the respondents from the US, a large majority are from the West Coast region and Utah. Czech Republic had the next highest respondent count (8), followed by France (6) then Germany (6). All other respondents are from various countries throughout Europe, the Middle east, three from Africa and two from Canada. Figure 5.1.3 illustrates the vast difference between those who reside in Czech Republic (30) versus those who are originally from Czech Republic (8).

Basic Demographics	**Respondents**	**%**
Highest Level of Education		
Undergraduate (Associates or Bachelors)	44	38 (%)
Master's Degree	61	53 (%)
PhD, MD or equivalent	10	9 (%)
Gender		
Male	45	39 (%)
Female	69	60 (%)
Other	1	0.8 (%)
Age		
16-19	3	2.6 (%)
20-29	91	79.1 (%)
30-39	12	10.4 (%)
40-49	4	3.5 (%)
50-59	2	1.7 (%)
60-69	3	2.6 (%)
70-79	0	

Table 5.1.1 Demographic information including level of education, age, and gender.

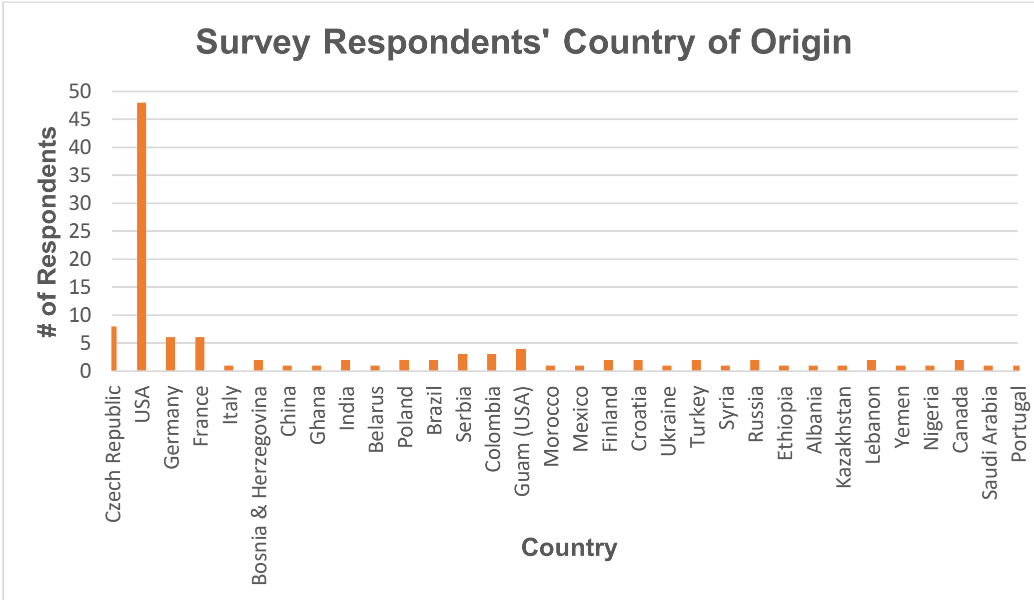

Figure 5.1.2. Demographic information on survey respondents' country of origin. Notice the large number of respondents from US.

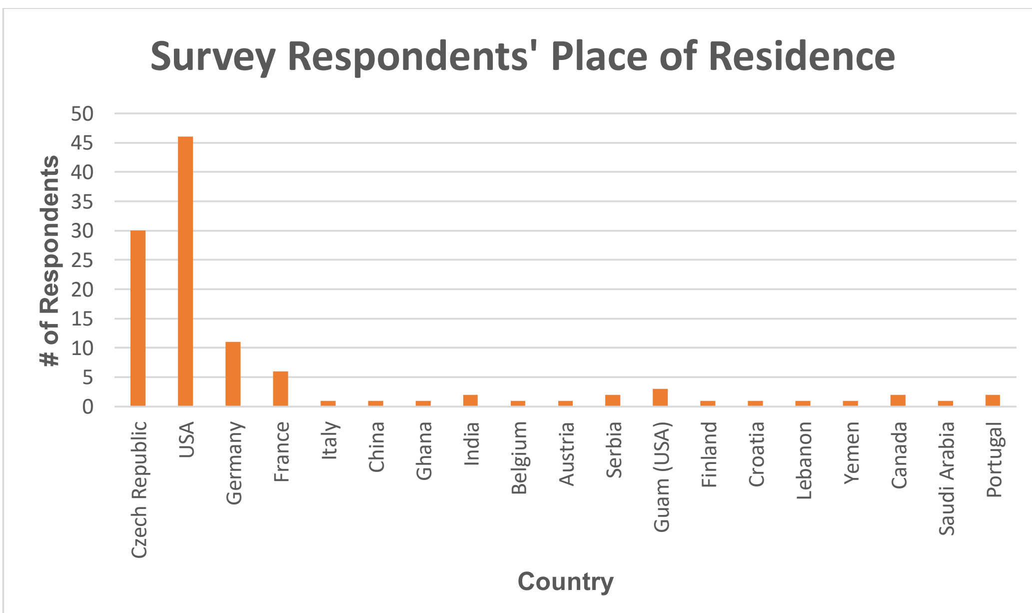

Figure 5.1.3. Demographic information on survey respondents' current place of residence. Notice the difference of respondents from Czech Republic in both figures 5.1.1 and 5.1.2.

5.2 PREFERED RECREATIONAL AND TOURIST ACTIVITIES

Survey participants were asked to select which activities they prefer to do, from a list of recreational and tourist activities. Each participant had the option to select multiple activities. Nearly all participants (80%) enjoy visiting historic/cultural landscapes, and the next most popular activity is hiking or running in mountainous areas (75%). Roughly 65% of all respondents selected the activities including hiking or running in coastal or mixed landscapes and beach/swimming coastal areas. Activities such as biking and swimming in lakes or rivers is popular among 45% of respondents, while skiing activities in mountainous areas as well as snorkeling or scuba diving are preferred activities for approximately two thirds of respondents. The activities with the lowest preference include horseback riding, with 20 respondents marking this as one of their preferred recreational or tourist activities, bird watching with 19 respondents, sail boating with 15 respondents and playing golf, received the lowest preference with 7 respondents marking this as a preferred activity (Figure 5.2).

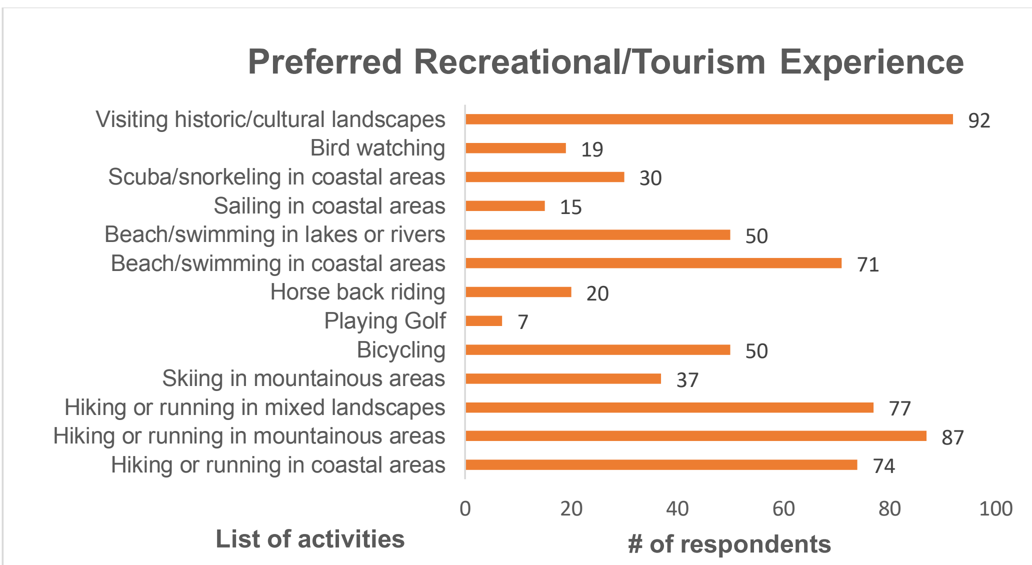

Table 5.2 List of activities respondents could select from, indicating their preferred recreational or tourist activities. Respondents could select multiple options.

5.3 WIND TURBINE LOCATION AND ATTITUDES

A section of the survey asked participants basic yes or no questions, followed by the option of a response section. When asking respondents if they had ever visited a place where wind turbines are present, 78% responded positively and answered yes. In the response section, respondents wrote where they had seen wind turbines. Answers included participants from the US, as well as from various countries such as Austria, Germany, Czech Republic, the Netherlands, and France (Figure 5.3.1). Roughly 40% of respondents reported seeing wind turbines in the US, including states like California, Oregon, and Utah (Figure 5.3.2). However, when asked if respondents had ever visited a touristic or recreational area with wind turbines visible or in close proximity only 35% responded positively while the remaining percentage of respondents responded negatively and answered no. These tourist or recreational areas included various coastal regions like cliffs overlooking the coast or coastlines, near rivers, renewable energy centers, and various mountain regions. Other responses listed various countries or cities high in tourism (see Appendix B).

Participants were asked whether or not wind turbines should be places within or adjacent to national parks, and 23% of respondents said yes, while the rest had a split response of 36% saying no and 41% of respondents marking the “not sure” option (Table 5.3.3). When asking participants if they think wind turbines should be located within or adjacent to scenic landscapes, 43% said yes, 37% said not sure and 21% said no. Placing wind turbines within or adjacent to coastal areas or landscapes, 55% of respondents agreed with this location, while 34% were not sure. More than half the respondents (52%) agree that wind turbines should be situated offshore in coastal regions, while 34% were not sure. When it comes to placing turbines within or near historic or cultural landscapes, 49% said no, while 31% said not sure and 20% said yes. When asked if wind turbines should be placed in agricultural crop production areas, a clear majority said yes (80%) while 18% said not sure and only 2% said no (Table 5.3.3). Most of respondents believe placing wind turbines in agricultural lands will lower the annoyance impact on nearby people and that the land would serve as multi-purpose, as long as the owner of the land agrees, perhaps even benefits from the wind turbines directly. A common opinion is if the land is already being used for industrial purposes, there is no harm placing wind turbines there.

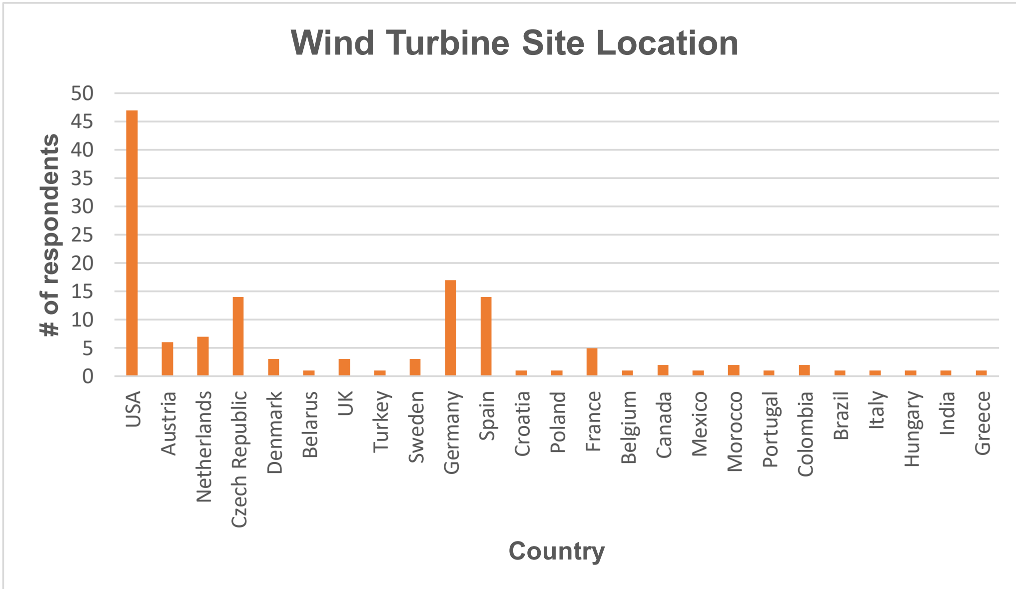

Figure 5.3.1. Illustration of all the countries respondents have seen wind turbines.

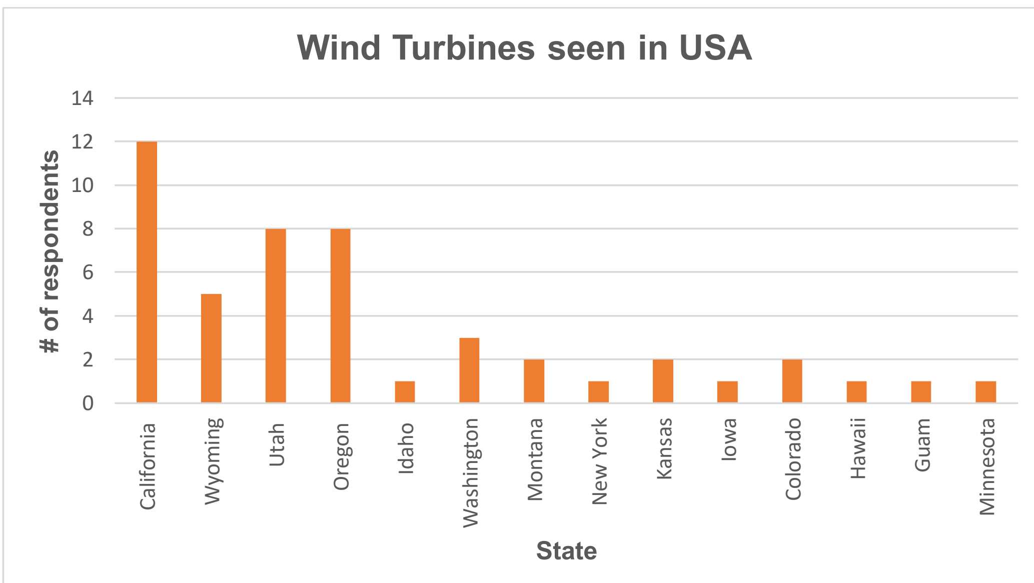

Figure 5.3.2. Illustration of all US states (including the territory of Guam) where respondents had seen wind turbines.

Survey Questions	Respondents	%
1) Have you ever visited a place where wind turbines are present?		
Yes	90	78 (%)
No	25	22 (%)
2) Have you ever visited a tourism or recreational area where wind turbines are visible or are in close proximity?		
Yes	43	37 (%)
No	72	63 (%)
3) Should wind turbines be located within or adjacent to a national park?		
Yes	26	23 (%)
No	42	36 (%)
Not Sure	47	41 (%)
4) Should wind turbines be located within or adjacent to a scenic landscape?		
Yes	49	43 (%)
No	24	21 (%)
Not Sure	42	37 (%)
5) Should wind turbines be located within or adjacent to a coastal area landscape?		
Yes	63	55 (%)
No	13	11 (%)
Not Sure	39	34 (%)
6) Should wind turbines be situated offshore in a coastal region?		
Yes	60	52 (%)
No	16	14 (%)
Not Sure	39	34 (%)
7) Should wind turbines be situated within or near places with historic or cultural features in the landscape?		
Yes	23	20 (%)
No	56	49 (%)
Not Sure	36	31 (%)
8) Should wind turbines be situated within agricultural crop production areas?		
Yes	92	80 (%)
No	2	2 (%)
Not Sure	21	18 (%)

Table 5.3.3. Questions from the survey that required a simple yes, no or not sure answer. Respondents also had the option to explain their answers.

5.4 WIND TURBINE VISUAL IMPACT

Respondents were asked to rank each scenario on a scale of -5 to +5, on how wind turbines would impact their decision to visit this location. A score of -5 represents the most negative impact on the respondents' decision, +5 being the most positive impact on the respondents' decision, and a ranking of zero represents the presence of wind turbines having no impact on their decision for each scenario. For the first scenario, respondents were asked to rank how positive or negative wind turbines would be if they were nearby but not visible, to a recreational area. Approximately 45% of respondents felt there would be no positive or negative impact on their decision to visit a recreational area with wind turbines nearby but not visible. These respondents ranked this scenario with a zero. However, most of the remaining respondents marked this scenario with positive scores, with 13 respondents ranking a +2 and 16 giving a score of +5, and 9% of respondents ranked this scenario with negative scores, suggesting wind turbines would negatively impact their decision to visit this recreational area (Table 5.4).

For the next scenario, respondents were asked to rank on the same scale, how positive or negative the visibility of wind turbines in tourist or recreational landscapes would have on their decision to visit such areas. While 41 respondents (37%) indicated visible wind turbines would have no impact on their decision to visit, 4 respondents (3.6%) ranked this scenario with a -5, with a total of 33 respondents (29%) marking various scores of negative impacts. This suggests wind turbines would negatively impact their decision to visit this area. On the contrary, 41 respondents (36%) marked various positive scores, suggesting wind turbines would have a positive impact on their decision to visit these areas (Table 5.4).

If asked whether or not wind turbines have a positive or negative impact on the respondents' decision to live in a specific location, 8 respondents (7%) marked this scenario with a score of -5 and 9 respondents (8%) marked a score of -1. In total, 27 respondents (23%) indicated wind turbines would negatively impact their decision to live in a specific area. There are 41 respondents (35%) who marked neutral, meaning wind turbines would have no impact on their decision to live somewhere, and 47 respondents (41%) ranked this scenario with positive scores. There are 11 respondents (10%) with rankings of +5, 10 respondents (9%) with rankings of +4, and 14 respondents (12%) with rankings of +2.

For the last scenario, participants compared wind turbines and photovoltaic panels, to assess whether or not photovoltaic panels have a greater, equal or lesser impact upon the landscape in comparison with wind turbines (-5 being lesser impact, +5 being greater impact). From the 116 respondents, 34 (29%) marked negative values, implying they think photovoltaic panels have a lower impact on a landscape compared to wind turbines, 44 (38%) marked zero or neutral, suggesting the impact between the two forms of energy is equal, and 39 respondents (34%) think photovoltaic panels have a greater impact on the landscape than wind turbines (Table 5.4).

1) Would the presence of wind turbines nearby but not visible to a recreational area have any impact upon your decision to visit? Please answer based upon a scale of -5 to +5: -5 being most negative and +5 being the most positive.

-5	-4	-3	-2	-1	0	1	2	3	4	5
2	0	4	2	2	52	7	13	8	9	16

2) Would wind turbines visible to a tourism or recreation landscape have negative, neutral, or positive impact upon your decision to visit this place? Please answer based upon a scale of -5 to 5: -5 being most negative and +5 being the most positive.

-5	-4	-3	-2	-1	0	1	2	3	4	5
4	1	11	11	6	41	8	11	8	4	10

3) Would the presence of wind turbines have a negative or positive impact upon your decision to live in a specific location? Please answer based upon a scale of -5 to +5: -5 being most negative and +5 being the most positive.

-5	-4	-3	-2	-1	0	1	2	3	4	5
8	2	6	2	9	41	6	14	6	10	11

4) Do you feel that photovoltaic panels located on the ground have a lesser, equal, or greater impact upon the landscape to that of wind turbines? Please answer based upon a scale of -5 to +5: -5 being lesser and +5 being greater impact.

-5	-4	-3	-2	-1	0	1	2	3	4	5
4	7	6	9	6	44	3	14	9	7	6

Table 5.4. Survey ranking on each scenario of wind turbine impact and if this impact is positive or negative. Last scenario compares wind turbines to photovoltaic panels. Answers are based upon a scale of -5 to +5: -5 being lesser and +5 being greater impact.

5.5 PHOTO VISUALIZATION RESPONSE

Image 1										
-5	-4	-3	-2	-1	0	1	2	3	4	5
0	1	6	8	8	18	6	9	24	18	17

Table 5.5.1. Survey responses for image 1 with -5 representing strong negative attitude, +5 representing strong positive attitude, zero being neutral.

Participants were asked to rank each image during the photo visualization survey assessment (see Appendix C). Ranking took place using the same -5 to +5 scale. Image 1 shows wind turbines placed in a coastal area, with 4 onshore wind turbines. From all respondents, 20% (23 respondents) ranked this image with negative values. There are 8 respondents ranking image 1 with a score of -1 and 8 respondents ranking with a score of -2. There are 18 respondents (16% of all respondents) who felt neither a negative nor positive attitude towards image 1, ranking image 1 with a zero. Most of the respondents had a positive attitude towards image 1, with 74 respondents (64%) giving this image a positive score. The highest marks image 1 received is +3 from 24 respondents, +4 from 18 respondents and +5 from 17 respondents.

Image 2										
-5	-4	-3	-2	-1	0	1	2	3	4	5
0	1	2	4	9	16	7	11	21	19	25

Table 5.5.2. Survey responses for image 2 with -5 representing strong negative attitude, +5 representing strong positive attitude, zero being neutral.

Image 2 portrays a different coastal area with wind turbines set in the distance on higher elevated ground. Like image 1, image 2 received a small percentage of negative rankings (14%) with the most rankings of -1 from 9 respondents, contributing to a total of 16 respondents who perceived image 2 with negative attitudes. There are 16 respondents who ranked this image with a zero, having neither positive or negative attitudes towards image 2, and 83 respondents (72%) who ranked image 2 positively, with the highest score of a +5 ranked by 25 respondents, a score of +3 ranked by 21 respondents, and +4 ranked by 19 respondents.

Image 3										
-5	-4	-3	-2	-1	0	1	2	3	4	5
1	1	7	1	6	18	5	11	23	16	26

Table 5.5.3. Survey responses for image 3 with -5 representing strong negative attitude, +5 representing strong positive attitude, zero being neutral.

Image 3 depicts wind turbines placed in higher grounds in a landscape with nearby homes. There are 16 respondents (14%) ranking this image with negative values, with scores of -1 (6 respondents) and -3 (7 respondents) having the highest number of respondent markings. A neutral response was received by 18 respondents, marking this image with a score of 0, while 81 respondents (70%) ranked this image with positive scores, the highest score of +5 receiving 26 respondent rankings and +3 receiving 23 marks from respondents.

Image 4										
-5	-4	-3	-2	-1	0	1	2	3	4	5
4	5	9	6	7	18	5	15	13	17	16

Table 5.5.4. Survey responses for image 4 with -5 representing strong negative attitude, +5 representing strong positive attitude, zero being neutral.

Image 4 is the same photo used for image 1, however image 4 consists of both onshore and offshore wind turbines, with a total of 7 wind turbines. This image received a higher percentage of negative marks, with 7 respondents giving this image a score of -1, 6 respondents marking a score of -2 and 8 respondents marking this image with a score of -3. In total, 31 respondents (27%) had negative attitudes towards image 4. There are 18 respondents who found image 4 to have neither negative or positive impact on their perception, and 66 respondents (57%) found image 4 to positively impact their perception, with +2 (15 respondents) and +4 (17 respondents) being the most highly marked.

Image 5										
-5	-4	-3	-2	-1	0	1	2	3	4	5
3	0	1	5	9	18	7	10	21	15	26

Table 5.5.5. Survey responses for image 5 with -5 representing strong negative attitude, +5 representing strong positive attitude, zero being neutral.

Image 5 depicts a scenic view from a local cemetery with wind turbines in the distant hills. Overall, most respondents perceived this image with a positive attitude (69% of all respondents), with 21 respondents ranking this image with a +3 and 26 respondents with a +5. There are 18 respondents who ranked this image with a neutral value of 0, and 18 respondents (16%) who ranked this image with negative values, with -1 being the most commonly ranked by 9 respondents, and -2 being marked by 5 respondents.

Image 6										
-5	-4	-3	-2	-1	0	1	2	3	4	5
6	3	6	6	11	14	9	9	17	15	19

Table 5.5.6. Survey responses for image 6 with -5 representing strong negative attitude, +5 representing strong positive attitude, 0 being neutral.

Image 6 is a photo of a shoreline, with both offshore and onshore wind turbines. Roughly 28% of respondents (32 respondents) perceived image 6 with a negative attitude, with most rankings being -1 (11 respondents) and 6 respondents ranked image 6 with a -5. There are 14 respondents who gave image 6 a neutral ranking of zero and 69 respondents (60%) gave image 6 positive rankings, with most common scores being +3 from 17 respondents and +5 from 19 respondents.

Image 7										
-5	-4	-3	-2	-1	0	1	2	3	4	5
3	1	4	4	11	12	7	13	22	17	21

Table 5.5.7. Survey responses for image 7 with -5 representing strong negative attitude, +5 representing strong positive attitude, 0 being neutral.

Image 7 shows a golf course with wind turbines just beyond a tree ridgeline. There are 23 respondents who had negative attitudes when viewing image 7, 11 respondents marking image 7 with a score of -1 and 3 respondents marking image 7 with a score of -5. In total, 20% of respondents perceived this image with a negative attitude, 12 respondents ranked image 7 with a neutral score of 0, and 70% (80 respondents) viewed this image with a positive attitude, with +3 marked by 22 respondents and +5 marked by 21 respondents.

Image 8										
-5	-4	-3	-2	-1	0	1	2	3	4	5
5	2	6	4	5	18	5	8	18	19	25

Table 5.5.8. Survey responses for image 8 with -5 representing strong negative attitude, +5 representing strong positive attitude, 0 being neutral.

Image 8 is of a tourist destination, with a cement structure for locals and tourists to sit under, overlooking the coastline with offshore wind turbines. Most respondents viewed image 8 with positive attitudes, with 25 respondents ranking image 8 with a +5 and 19 respondents ranking +4. In total, there are 75 respondents (65%) viewing image 8 with a positive attitude. There are 18 respondents who have neutral attitudes towards the image 8 while 22 respondents (19%) ranked image 8 with negative values. The score of -5 was marked by 5 respondents and 6 respondents ranking image 8 with a score of -3.

Image 9										
-5	-4	-3	-2	-1	0	1	2	3	4	5
3	2	3	5	9	16	6	12	20	14	25

Table 5.5.9. Survey responses for image 9 with -5 representing strong negative attitude, +5 representing strong positive attitude, 0 being neutral.

Image 9 depicts a viewpoint where a respondent is on a beach, viewing wind turbines off in the distance behind a high tree ridgeline. There are 9 respondents who gave image 9 a score of -1, with 22 respondents (19%) viewing this image with a negative attitude. A neutral response was received by 16 respondents and 77 respondents (67%) ranked image 9 with positive scores, majority with a score of +5 from 25 respondents and +3 from 20 respondents.

Image 10										
-5	-4	-3	-2	-1	0	1	2	3	4	5
2	2	4	6	8	18	10	10	17	20	18

Table 5.5.10. Survey responses for image 10 with -5 representing strong negative attitude, +5 representing strong positive attitude, 0 being neutral.

Image 10 was taken from a coastal area. The viewer would have their back to the ocean, looking onwards to see wind turbines off in the distance. Image 10 received a total of 22 respondents (19%) with negative responses, with a score of -2 from 6 respondents and -1 from 8 respondents receiving the most marks. There are 18 respondents who ranked this image with zero and 77 respondents (65%) ranking image 10 with positive values, +4 being the most common ranking from 20 respondents and 18 respondents ranked image 10 with a +5.

Image 11										
-5	-4	-3	-2	-1	0	1	2	3	4	5
0	2	4	4	7	17	11	11	17	20	22

Table 5.5.11. Survey responses for image 11 with -5 representing strong negative attitude, +5 representing strong positive attitude, 0 being neutral.

Image 11 was taken at a viewpoint overlooking a mountainous area, with wind turbines placed in the distance. Majority of respondents perceived this image with positive attitudes, with 81 respondents (70%) ranking image 11 with positive values, with +5 marked by 22 respondents and +4 marked by 20 respondents. There are 17 respondents who felt neutral towards image 11, and 17 respondents (15%) who perceived image 11 with negative attitudes, with scores of -1 from 7 respondents, -2 from 4 respondents and -3 from 4 respondents.

Image 12										
-5	-4	-3	-2	-1	0	1	2	3	4	5
0	1	2	3	11	19	8	13	20	13	25

Table 5.5.12. Survey responses for image 12 with -5 representing strong negative attitude, +5 representing strong positive attitude, 0 being neutral.

Image 12 is another photo taken from the same golf course, again with the wind turbines being overlooked in the distance. Overall, image 10 has few negative responses. There are 17 respondents (15 %) who marked negative values for image 12, with 11 respondents marking -1. There are 19 respondents who felt neutral towards image 12 and 79 respondents (69%) who had positive attitudes towards image 12, with +3 marked by 20 respondents and +5 marked by 25 respondents.

Image 13										
-5	-4	-3	-2	-1	0	1	2	3	4	5
3	3	6	6	8	16	4	6	26	16	21

Table 5.5.13. Survey responses for image 13 with -5 representing strong negative attitude, +5 representing strong positive attitude, 0 being neutral.

Image 13 was taken at a mountainous viewpoint with wind turbines placed at the top of the mountain ridges. Responses are similar to how respondents ranked the previous mountainous landscape from image 13. There are 26 respondents (23%) who marked image 13 with negative values, with 8 respondents marking -1 and 6 respondents marking both -2 and -3. There are 16 respondents who marked image 13 with a neutral score of zero and 73 respondents (63%) who ranked image 13 with positive scores, +3 marked by 26 respondents and +5 marked by 21 respondents.

Image 14										
-5	-4	-3	-2	-1	0	1	2	3	4	5
0	1	4	7	7	15	10	16	20	11	24

Table 5.5.14. Survey responses for image 14 with -5 representing strong negative attitude, +5 representing strong positive attitude, 0 being neutral.

Image 14 is similar to image 10, where the photo was taken from a coastal area. The viewer would have their back to the ocean, looking onwards to see wind turbines off in the distance. There are 19 respondents (17%) who ranked image 14 with negative values, 15 respondents who ranked image 14 with a neutral value of zero and 81 respondents (70%) who ranked image 14 with positive values. Majority of the negative marks consist -1 and -2, both marked by 7 respondents, while most of the positive marks consist of 20 respondents marking +3 and 24 respondents marking +5.

Image 15										
-5	-4	-3	-2	-1	0	1	2	3	4	5
5	3	4	6	10	14	9	12	23	11	18

Table 5.5.15. Survey responses for image 15. -5 representing strong negative attitude, +5 representing strong positive attitude, 0 being neutral.

Image 15 is the same photo used for image 11, however the wind turbines are perceived to be closer to the viewer at this viewpoint. Image 15 received some negative attitudes, with 6 respondents ranking image 15 with -2 and 10 respondents ranking this image with -1, contributing to a total of 28 negative responses (24%). There are 14 respondents who marked image 15 with a neutral score of 0, and 73 respondents (63%) who ranked image 15 with positive scores, with 23 respondents marking image 15 with a score of +3 and 18 respondents marking +5.

Image 16										
-5	-4	-3	-2	-1	0	1	2	3	4	5
3	3	10	4	8	23	6	6	24	14	14

Table 5.5.16. Survey responses for image 16 with -5 representing strong negative attitude, +5 representing strong positive attitude, 0 being neutral.

Image 16 is the same photo used for image 1 and 4, however image 16 only consists of 6 onshore wind turbines. Image 16 received the most neutral marks, with 23 respondents ranking image 16 with a zero. There are 28 respondents (24%) who viewed image 16 with negative attitudes, 10 of these respondents marking -3 and 8 respondents marking -1. In total, there are 64 respondents (56%) who perceived image 16 with positive attitudes, 24 respondents ranking image 16 with a +3 and 14 respondents marking both +4 and +5.

6. DISCUSSION

6.1 OVERVIEW OF DEMOGRAPHICS

From the online survey, multiple responses were collected and interpreted for the purpose of this research (see Appendix A), however no statistical analysis was used for data collection or interpretation. The survey was sent to multiple universities, resulting in most of the respondents currently obtaining or have obtained an undergraduate, master's or PhD degree, reflecting the large percentage of respondents falling within the 20-29 age group (Table 5.1.1). Comparing respondents' country of origin and place of residence (Figures 5.1.2 & 5.1.3), the number of those residing in countries such as Czech Republic, Germany and France differ from those who are originally from these countries, due to the fact that a large majority of the respondents are studying abroad and away from their country of origin, or have simply relocated due to work. Although there are only 8 respondents originally from Czech Republic (Figure 5.1.2), there are 30 survey respondents who are currently residing in Czech Republic. This is important to be aware of for interpreting results, because if respondents reside in a country with few wind turbines, this could influence the respondents' attitudes towards wind turbines, compared to respondents who are from or reside in countries with a large number of wind turbine daily encounters (Hevia-Koch & Ladenburg, 2019; Ladenburg & Dahlgaard, 2012).

Illustrated figures 5.1.2 and 5.1.3 also show a large group of respondents from and or currently residing in the US. The survey was sent to numerous schools within both the US and Europe, however more US residents responded to the survey compared to any other nation. Several universities that received the survey are not represented in the data, as there are no survey respondents from those university cities. Respondents from or residing in countries such as the US, Czech Republic, Germany or France will have a larger impact on survey responses, as opposed to respondents from other cultures or countries such as Finland, India, China or Ghana (Figure 5.1.2 & 5.1.3). With this data, the results may be skewed and may not fully portray the range of attitudes towards wind turbines in recreational or scenic landscapes.

6.2 PREFERRED WIND TURBINE PLACEMENT

Countries including Austria, the US, Germany, Netherlands, France and Spain are known for having a high density of wind turbines throughout various regions of their landscape, which is why these are the countries frequently listed among the 90 responses from respondents who have visited places with wind turbines (Figure 5.3.1). However, only one third of respondents have visited areas with wind turbines in tourist or recreational areas, with most of these locations residing in the countries previously listed, predominantly within the US (Figure 5.3.2).

6.2.1 NATIONAL PARKS

For the survey question asking respondents if wind turbines should be located within or adjacent to a national park (Table 5.3.3), responses vary significantly. Respondents heavily opposed to question 3 expressed the concern over wildlife protection, specifically with birds, and an overall environmental impact. These respondents believe wind turbines are not pretty and would change the park's appeal to the public, believing national parks should have few disruptions or interactions from humans or anthropogenic influences (de Vries et al., 2012). These respondents have a strong cultural tie to the national parks. The stronger the cultural ties are to the land, the heavier the protests will be against change (Pedersen et al., 2010). Some national parks are under federal protection and the wildlife may be more vulnerable in these areas, which further contributes to greater cultural importance (Kazak et al., 2017).

Respondents who marked the option "not sure" listed several factors to consider. This included looking at the purpose of the national park, whether the park is trying to preserve habitat life and restrict human access, or if the national park promotes recreational activities such as biking, hiking, horseback riding, while making profits from restaurants and campsites. Other responses express how wind turbines would be more appropriately placed adjacent to national parks, rather than within, from a visual perspective. These respondents discussed where within the park the turbines would be placed, what specific park, and how good the park management and maintenance would be. Other respondents wrote how they do not know enough about wind turbines and cannot make a consolidated decision. Respondents who mark "not sure" are crucial for these types of assessments, because they become the members in society that can push for or against wind turbine project proposals.

However, those in favor of placing wind turbines within or adjacent to national parks highlight how park facilities would benefit from the renewable energy. Respondents marking “yes” think wind turbines within or near national parks is a better alternative than other forms of energy, which release pollutants into the atmosphere, such as the burning of coal. This seems to be similar to previous research, where attitudes are in favor of wind turbines over coal or natural gas plants (Frantál & Kunc, 2011; Thomson & Kempton, 2018). These respondents are also in favor if the benefits from the wind turbines are greater than the environmental impacts. Other respondents simply stated they like wind turbines because they add beauty or make landscapes interesting. This is similar to previous research, demonstrating how some viewers perceive wind turbines as adding beauty and meaning to landscapes (Smith et al., 2018). These survey responses demonstrate the complexity of wind turbine project proposals, as well as illustrating what respondents’ values and experiences are, and highlighting how much each respondent knows about wind turbines.

6.2.2 SCENIC LANDSCAPES

Question 4 from table 5.3.3 asks respondents if wind turbines should be located within or adjacent to a scenic landscape. With 24 respondents marking option “no”, their explanation can be summarized mainly from the visual pollution factor. These respondents believe wind turbines in scenic landscapes will disrupt the beauty, stating how they would visit a scenic landscape to see the nature, not the wind turbines (de Vries et al., 2012). Animal disruption is another issue expressed, and respondents reported not wanting to see man-made things in nature, stating they would “draw attention away.” Some respondents stated they do not like wind turbines, thus seeing them in a scenic landscape would ruin the view for them. For the 42 respondents who marked “not sure”, the most common remark mentioned is that it depends on what type of landscape the turbines are in. Some view wind turbines onshore as an appropriate location but would not wish to see them offshore, possibly depicting a NIMBY attitude. Other respondents argued that scenic landscapes are too subjective, as one person could argue a landscape is scenic, while another could argue the opposite.

For the 49 respondents who are in favor of placing wind turbines in scenic landscapes, their responses reflect a similar finding from previous research. The more environmentally aware and committed someone is to making change, the more accepting they are to renewable energies (Hui et al., 2018; Liu et al., 2016). Those who are in favor wrote how they think wind turbines are a great form of sustainable energy as well as being a great opportunity for tourists to view. Some respondents even said they do not think wind turbines ruin the scene, but “enhance” it, explaining how they enjoy seeing a blend of technology and nature. Other respondents see renewable energy as progress towards “saving the planet,” and think saving the planet outweighs the visual impact experienced from wind turbines (Lang et al., 2014; Sardaro et al., 2019).

6.2.3 COASTAL LANDSCAPES AND REGIONS

Responses to questions 5 and 6 (Table 5.3.3) received similar attitudes. Both questions asked respondents if wind turbines should be in coastal areas, however question 5 asked about onshore wind turbines, while question 6 asked about offshore wind turbines. The common concern for both questions is associated with the visual pollution and unattractiveness associated with wind turbines, specifically noting how wind turbines would not look good in nature (de Vries et al., 2012). Those who marked “not sure” shared concerns about the specific location of the wind turbines, how popular the coastal area is, how far from the coast they would be (both on and offshore concern), and whether or not the coastal area is flat terrain or high cliffs (Kazak et al., 2017; Teisl et al., 2018). Specifically, for question 6, concerns over the ocean ecosystem and sea life were commonly discussed.

The respondents who marked “yes” for both questions 5 and 6 had similar reasons. There are 63 respondents who said “yes” to question 5 and 60 respondents for question 6, mostly expressing how coastal areas are windy, making them great locations for wind turbines with lots of power potential. Others mentioned how wind turbines “add to the scene” and “look better near the coastal areas” (Smith et al., 2018). Another reason respondents had positive attitudes towards wind turbines in coastal areas is the reoccurring idea that wind turbines symbolize green energy, and therefore are better for the environment compared to other energy sources (Hui et al., 2018; Liu et al., 2016). The main difference between the responses from question 5 and 6 is some respondents prefer wind turbines offshore, while other respondents prefer them onshore.

6.2.4 HISTORIC OR CULTURAL LANDSCAPES

Question 7 asked respondents to mark whether they think wind turbines should be situated within or near places with historic or cultural features in a landscape. Most respondents felt wind turbines should not be placed within or near these landscapes, reflecting the 79% of respondents who prefer visiting historic or cultural landscapes as a form of recreation or tourism (Table 5.2). Respondents believe historic or cultural landscapes should be preserved and kept in its original state, noting that wind turbines represent a modern “new era” and how placing wind turbines in historic or cultural landscapes would not “mix” and disrupt the historic land, negatively impacting the landscape harmony (de Vries et al., 2012; van der Horst, 2007). Others believe wind turbines will negatively impact the view, and since wind turbines are not historic, they should not be in historic landscapes. Another important aspect to consider are the local or indigenous people in the area. One respondent pointed out how the wind turbines could emotionally disrupt the historic importance of the land (Kazak et al., 2017; Pedersen et al., 2010).

For neutral respondents, some believe wind turbines should only be allowed nearby, but not within these landscapes, while others argue if the cultural or historic areas already have man-made buildings, then adding wind turbines would not be any different. Some respondents said it highly depends on what features are in the historic or cultural landscape, and who would be benefitting from the wind energy. Those in favor of wind turbines mainly express their support only if the wind turbines do not interfere with the cultural or historic features and these features remain maintained. From a visual perspective, the respondents in favor see no issue, with one respondent stating how they have visited historic centers in Europe with nearby wind turbines and visually the wind turbines had no impact. Other respondents highlight the fact that if there is good wind, then wind turbines should be placed there to utilize the wind to produce green energy.

6.2.5 AGRICULTURAL AREAS

Most respondents seemed to share similar opinions towards the last question from table 5.3.3, which asks about wind turbines in agricultural production areas. Most think wind turbines should be situated in agricultural areas as the land is already being used for industrial purposes, making the land use multipurpose. Respondents think wind turbines would not distract from the landscape as they do not view agricultural landscapes as scenic. Others also mentioned how agricultural land is already man-made land, and they see no problem with wind turbines using the space to generate energy, if the wind turbines do not impact crop production. Positive responses were also attributed to the potential economic benefit for the farmers or nearby residents. The 2 respondents who marked “no” for question 8 dislike the idea of wind turbines in agricultural crop areas simply due to the visibility factor, stating how wind turbines negatively impact their view of agricultural crop production areas. Less than a quarter of respondents marked “not sure”, mainly due to the concern of wind turbines possibly interfering with the agricultural production process and affecting crops, while other respondents expressed concern over who would benefit more from the energy, the land owners or nearby towns. With potentially high economic benefits, the visual impairments from wind turbines become less impairing (Wolsink, 2010).

6.3 WIND TURBINE PRESENCE IMPACT

6.3.1 WIND TURBINE VISUAL IMPACT

We had respondents rank various scenarios (Table 5.4) to determine the impact wind turbines would have on their decision to visit recreational or tourist destinations. The first scenario asked respondents if the presence of wind turbines nearby but not visible to a recreational area would have any impact upon their decision to visit. Approximately 9% of all respondents marked scenario 1 with negative scores, indicating the presence of nearby wind turbines but not visible, would negatively impact their decision to visit a specific area. These respondents expressed concern over noise pollution from the wind turbines (Hübner et al., 2019), and how the presence of wind turbines would affect their overall experience and appreciation of the area, even if the wind turbines are not visible.

Respondents who marked scenario 1 with a neutral score of zero (45%), simply expressed how the presence of wind turbines would have no impact on their decision to visit a recreational area. More specifically, if they cannot see the wind turbines, then they do not think about them, “Out of sight out of mind.” This is a type of NIMBY attitude. Some respondents discussed the environmental impacts, specifically with bird and bat populations. However, a majority believe that if they cannot hear or see a wind turbine, then there would be no impact on their decision. For the remaining 41% of respondents who indicated the presence of wind turbines would positively impact their decision to visit a place, their responses share a common theme. These respondents think wind turbines are “cool” and “interesting,” expressing their support for wind turbines as they are a sustainable form of renewable energy. Some respondents even highlighted how wind turbines could become a tourist attraction (Smith et al., 2018).

Scenario 2 asks respondents how the presence of wind turbines would impact their decision to visit a tourist or recreational landscape if wind turbines were visible. The visibility of wind turbines has a negative impact for 29% of respondents, who marked negative values for scenario 2. Some respondents point out how their opinions would change based on the type of recreational landscape and activities available, while others claim their opinion would change based on the popularity of the recreational area. Other respondents discuss the road construction needed to install wind turbines, and how these roads would negatively impact the environment, similar to the terrain and community disruption discussed in the literature review (Kim & Chung, 2019; van der Horst, 2007). Visual disturbance is another key element, as some respondents do not want to see wind turbines while they are touring an area.

There are 41 respondents who felt indifferent about scenario 2. Some respondents indicated it would depend on what specific recreational area, however most respondents marking neutral to scenario 2 stated how the presence of visible wind turbines would have no impact on their decision to visit an area. The remaining 41 respondents marked positive values for scenario 2, implying that the visible presence of wind turbines would positively impact their decision to visit an area. These respondents had similar reasons as mentioned for scenario 1, drawing attention to their support towards renewable energies being incorporated into societies, as long as wildlife is not being harmed.

For scenario 3, respondents specified to what degree the presence of wind turbines would have on their decision to live in a specific location. With 24% of respondents indicating the presence of wind turbines would negatively impact their decision to live in a specific location as noise and visual pollution are the major concerns depending on how far the wind turbines are located. However, respondents are more willing to live near wind turbines if they are directly benefitting from the renewable energy, an attitude discussed in the literature review (Wüstenhagen et al., 2007). From the 41 respondents who are neutral towards scenario 3, their responses were all similar, in the sense that they either "do not mind" living near wind turbines, or the presence of wind turbines would have minor impacts on their decisions, but overall would not be the deciding factor of their decision to live somewhere. Most respondents (41%) indicated that the presence of wind turbines would positively impact their decision to live in a specific location, most noting how they want to live in a community that supports renewable energy, and how the visual aspect could be quite pleasing to the eye.

6.3.2 WIND TURBINES VERSUS PHOTOVOLTAIC PANELS

The last scenario presented to respondents (Table 5.4) asked them to rank whether photovoltaic panels have a lesser, equal or greater impact on the landscape compared to wind turbines. There are 32 respondents who think photovoltaic panels have less impact on a landscape compared to wind turbines, since photovoltaic panels are less visible as they are low to the ground. These respondents also pointed out how photovoltaic panels can be put on the roof of houses, lowering the visual impact. For 38% of respondents, they believe wind turbines and photovoltaic panels have equal impact on a landscape, noting how both the panels and wind turbines have their advantages and disadvantages with size and space. However, some respondents who marked a neutral score of 0, said they did not have enough knowledge to determine which has a greater impact on a landscape. The remaining 39 respondents believe photovoltaic panels have a greater impact because they take up more land and are not as pleasing to look at, as the sun reflects off the panels, possible causing more visual disturbance that a wind turbine.

6.4 PHOTO VISUALIZATION

6.4.1 NEGATIVE ATTITUDES

The photo used for both image 1, 4 and 16 capture the same coastal landscape. Image 1 consists of 4 onshore wind turbines, image 4 contains 4 onshore wind turbines and 3 offshore wind turbines, and image 16 is comprised of 6 onshore wind turbines. Image 1 received the least number of negative rankings, perhaps because the viewer only sees 4 wind turbines, whereas image 4, received the most negative marks, which has the greatest number of wind turbines. Comparing image 4 and 16, image 4 consists of 3 offshore wind turbines, possibly negatively impacting respondents' attitudes, as they see two clusters of wind turbines (Hevia-Koch & Ladenburg, 2019), while image 1 and 16 both have one cluster of onshore wind turbines. Also mentioned in literature review, wind turbines have a higher approval rate when limited in number (Ladenburg et al., 2013; Molnarova et al., 2012). Some respondents had also mentioned they do not like seeing offshore wind turbines, another factor possibly attributing to the negative attitudes towards image 4.

Like to image 4, image 6 portrays 2 clusters of wind turbines, 7 offshore and 3 onshore in the distance. Image 4 and 6 received the same number of respondents who had negative attitudes towards the landscape. Both images show coastal landscapes, and negative attitudes may be attributed to the belief that wind turbines do not look pretty in nature (de Vries et al., 2012). Other attributing factors mentioned earlier, include the cluster count, the number of wind turbines illustrated, and respondents' overall disproval of wind turbines being offshore.

Images 8 and 9 both depict a beach shoreline. Image 8 contains 6 offshore wind turbines far into the horizon, and image 9 consists of 7 onshore wind turbines, visible beyond a cliff ridgeline. Opposed to the images previously mentioned, image 8 and 9 received fewer negative rankings in comparison. This may be attributed to the image focal point. Image 8 contains a large structure for tourists to sit under, taking the focal point away from the wind turbines. Wind turbines in image 9 are near the shoreline but placed onshore and would not be seen if a viewer were to look towards the horizon. Few respondents stated they dislike offshore wind turbines because they do not want to see wind turbines when looking to the horizon. However, the wind turbines in image 8 are not the main focal point, and the placement of the wind turbines in image 9 may attribute to the low number of negative attitudes towards wind turbines in these specific coastal areas.

Images 2, 3, 5, 11, 12, and 14 all received less than 20 negative responses out of the total 116 survey participants. Each photo consists of different landscapes, ranging from golf courses, mountainous regions, and scenic viewpoints. Nevertheless, the wind turbines portrayed in these images are all in one cluster, and they appear further away in distance from the viewer, and therefore appear smaller. In comparison, images 7, 10, 13 and 15 consist of wind turbines appearing to be closer and larger to the viewer, each receiving more than 20 negative responses. The photo used for image 11 and 15 are the same, however, the wind turbines depicted in image 15 are larger and closer to the viewer, possibly attributing to the higher number of negative responses towards image 15 compared to image 11. Image 15 received the highest number of negative responses for any image illustrating onshore wind turbines.

Images showing coastal landscapes resulted in a higher amount of negative responses, likely due to respondents who dislike seeing wind turbines offshore. For onshore wind turbines, the wind turbine size, distance to viewer, and number of wind turbines seem to be the most influential factors of how positive or negative respondents view each image.

6.4.2 POSITIVE ATTITUDES

All images used for the photo simulation section received more positive attitudes than neutral or negative attitudes. Most respondents are in favor of wind turbines, which may be attributed to a few factors. First, 78% of all respondents have previously visited a place with wind turbines, possibly attributing to a higher number of positive attitudes, as higher encounters of wind turbines may result in higher acceptance rates (Ladenburg & Dahlgaard, 2012). Looking at the demographics, a large percentage of our respondents are in the 20-29 age range and are currently obtaining or have obtained a masters' degree. This reflects on the notion that the overall awareness and approval of renewable energy is dependent on a respondent's educational background (Klick & Smith, 2010). Those with higher education tend to be more aware of climate change and committed to making change (Hui et al., 2018; Liu et al., 2016), which is reflected in the positive responses from respondents, noting how they want to support sustainable energy as a method of combating climate change.

Several respondents also compared wind energy to alternative forms of energy, discussing how they prefer wind turbines over the burning of fossil fuels. This opinion contributes to respondents' acceptance of seeing wind turbines in various landscapes. This is similar to case studies which demonstrated how residents are more neutral and or positive towards viewing renewable energy resources, compared to mines, coal or natural gas plants, industrial buildings and electric poles and wires (Frantál & Kunc, 2011; Thomson & Kempton, 2018). These factors may attribute to the reason why many respondents who enjoy hiking or running in mixed, coastal, or mountainous landscapes (Table 5.2) feel either neutral or positive attitudes towards wind turbines being placed in such areas. The most prominent attitude from respondents which may have attributed to their positive perception towards images 1-16, is the belief that wind energy symbolizes an effort to combat climate change and air pollution (Westerberg et al., 2015), and this effort outweighs the visual impact wind turbines may have on a landscape, as long as wildlife habitat is not greatly at risk.

7. FUTURE WORK

Future research will take place on the island of Guam, a popular tourist destination off the coast of Southeast Asia. The survey will be conducted for at least one year, and will be administered to visiting tourists, as well as locals and business owners residing on the island. The aim of the research will be to determine what kind of impact (negative, positive, neutral) wind turbines would have on tourists and their experiences while visiting the island. Guam relies on tourism for much of their economy. However, photovoltaic panels and wind turbines have become a topic of conversation for the island as a form of sustainable energy, as the island has high sun and wind exposure all year round. The only concern would be strong winds during the typhoon season.

The survey will undergo some alteration to better fit our broader respondent base on the island. These changes will include possible language translations to Japanese, Korean and or Chinese, as most tourists are from these countries. The wording of some of the questions may also be changed, as the phrasing may have confused a few respondents. We may also try to include a response section after some of the images, to get a better idea of why tourists ranked each image the way they did. The demographic section will include more questions, such as how long the respondent plans on visiting the island and why they decided to visit Guam. We will also ask the respondent what activities they plan to do there, are they traveling with family or friends and how many, etc.

8. CONCLUSION

Climate change and air pollution are global concerns discussed among scientists and governments, with countries beginning to implement new regulations to reduce their combustion of fossil fuels and increase their use of clean renewable energy. Wind power has continued to be a controversial form of renewable energy, as it is known for efficiently producing green energy, while being visually impairing. This research offers further insight on how positively or negatively visitors perceive wind turbines in recreational or scenic areas. Most of our survey participants are young, highly educated, and enjoy being out in nature hiking or running. Most are in favor of wind turbines being placed in tourist, scenic or recreational landscapes, as they believe wind turbines symbolize an effort to combat climate change and reduce air pollution. Survey respondents opposed to wind turbines in such landscapes are concerned over wildlife habitat and preserving nature, as they believe nature should not include man-made objects.

All survey participants expressed concerns over environmental impacts associated with wind turbines, however the visual impact of wind turbines is commonly overlooked. Wind turbines are a form of sustainable green energy, viewed as a cleaner alternative, and used to reduce air pollution and actively tackle climate change. This representation of preferred green energy outweighs the visual impact that may be experienced by viewers. From a visual impact perspective, several respondents share positive attitudes towards both on and offshore wind turbines. Although, the visual impairment of wind turbines is just one factor of how viewers perceive wind turbines in a landscape. Other factors that must be taken into consideration is the size and precise location of the wind turbines, the number of wind turbines proposed for each project site and who will be benefitting from the wind energy. Through this research, visual impact from wind turbines in scenic or recreational landscapes appears to be of least concern compared to the possible environmental or social impacts imposed from wind turbines.

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10. APPENDIX

Appendix A: Survey questions and results administered through Google Forms

S u r v e y : Wind Turbines in Recreational and Scenic Landscapes

This research aims to explore the impacts that wind turbines may have upon the social, open space, and environmental features in areas that cater to recreation and tourism. We wish to explore if this impact has a negative, positive, or neutral consequence for visitor preferences at these locations.

A graduate student and professor at the Faculty of Environmental Sciences at Czech University of Life Sciences in Prague are conducting this research. The survey consists of both written questions and visual simulations which you will be asked to rate / evaluate.

If you agree to respond to the survey questions, you can be assured that the information you provide will be kept confidential and will only be used for research purposes.

Please complete the on-line survey; it will take approximately 10-15 minutes to answer all questions.

1. Where is your permanent place of residence?

If you are originally from a country other than the one you now live in, please indicate it here: ____

2. What is the highest level of education you have attained?

____ undergraduate degree (associate or bachelors)
____ graduate degree
____ PhD, M.D., J.D. or equivalent

3. Are you (*circle one*): *Male* *Female* *Transgender*

4. What is your age?

	____ 40 to 49 years
____16 to 19 years	____ 50 to 59 years
____ 20 to 29 years	____ 60 to 69 years
____ 30 to 39 years	____ 70 years or more

5. What are your preferred types of recreational and or tourism experiences? Please check all that apply.

Hiking or running in coastal areas
Hiking or running in mountainous areas
Hiking or running in mixed landscape areas
Skiing in mountainous areas
Bicycling
Playing golf
Horseback riding
Beach / swimming in coastal areas
Beach / swimming in lakes or rivers
Sail boating in coastal areas
Parasailing in coastal areas
Scuba or snorkeling in coastal areas
Bird watching
Visiting historic or cultural landscapes

6. Have you ever visited a place where wind turbines are present?

____ Yes
____ No
____ Not sure
If yes, please describe where: ______________________________

7. Have you ever visited a tourism or recreational area where wind turbines are visible or are in close proximity?

____ Yes
____ No
____ Not sure
If yes, please describe where: ______________________________

8. Would the presence of wind turbines <u>nearby but not visible</u> to a recreational area have any impact upon your decision to visit?
Please answer based upon a scale of -5 to +5: -5 = negative impact and +5 = positive impact

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

If negative impact, please describe why: ______________________________
If no impact, please describe why: ______________________________
If positive impact, please describe why: ______________________________

9. Would wind turbines <u>visible</u> to a tourism or recreation landscape have negative, neutral, or positive impact upon your decision to <u>visit this place</u>? Please answer based upon a scale of 1 to 5: -5 being most negative and +5 being the most positive.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

If negative impact, please describe why: ______________________________
If no impact, please describe why: ______________________________
If positive impact, please describe why: ______________________________

Rate the following images (1-16) based on your perceived positive, negative or neutral attitude of the landscape on a scale of -5 to +5. -5 = negative impact and +5 = positive impact.

Often wind turbines need to be located in areas where wind is most favorable for their optimal performance. Please answer the following questions based upon this reasoning.

10. Should wind turbines be located within or adjacent to a national park?
____ Yes
____ No
____ Not sure
If please describe why: ______________________________

11. Should wind turbines be located within or adjacent to a scenic landscape?
____ Yes
____ No
____ Not sure
If please describe why: ______________________________

12. Should wind turbines be located within or adjacent to a coastal area landscape?
____ Yes
____ No
____ Not sure
If please describe why: ______________________________

13. Should wind turbines be situated offshore in a coastal region?
____ Yes
____ No
____ Not sure
If please describe why: ____________________________

14. Should wind turbines be situated within agricultural crop production areas?
____ Yes
____ No
____ Not sure
If please describe why: ____________________________

15. Should wind turbines be situated within or nearby places with historic or cultural features in the landscape?
____ Yes
____ No
____ Not sure
If please describe why: ____________________________

16. Would the presence of wind turbines have a negative or positive impact upon your decision to live in a specific location?
Please answer based upon a scale of 1 to 5: -5 being most negative and +5 being the most positive.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

If negative impact, please describe why: ____________________________
If no impact, please describe why: ____________________________
If positive impact, please describe why: ____________________________

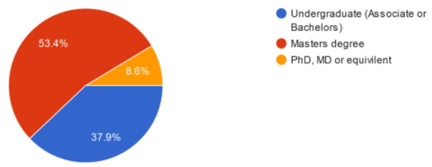
17. Do you feel that photovoltaic panels located on the ground have a lesser, equal, or greater impact upon the landscape to that of wind turbines? Please answer based upon a scale of 1 to 5: -5 being lesser and +5 being greater impact.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

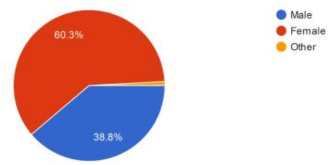
If lesser impact, please describe why: ____________________________
If no impact, please describe why: ____________________________
If greater impact, please describe why: ____________________________

Survey Demographics and Scenario Responses

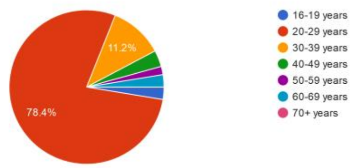
What is the highest level of education you have attained or are attaining?
116 responses



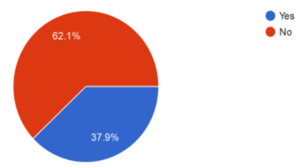
Do you identify as
116 responses



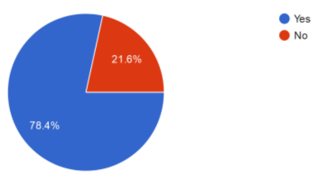
What is your age?
116 responses



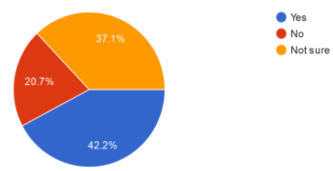
Have you ever visited a tourism or recreational area where wind turbines are visible or are in close proximity?
116 responses



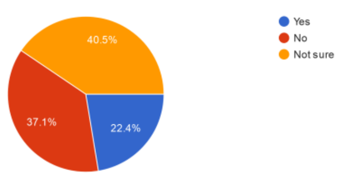
Have you ever visited a place where wind turbines are present?
116 responses



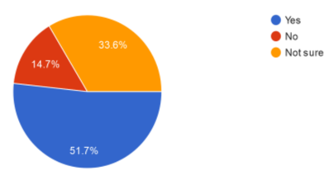
Should wind turbines be located within or adjacent to a scenic landscape?
116 responses



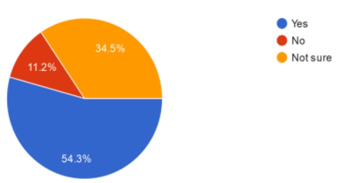
Should wind turbines be located within or adjacent to a national park?
116 responses



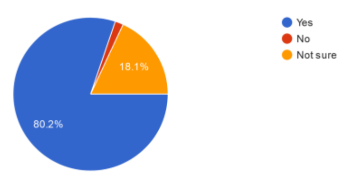
Should wind turbines be situated off-shore in a coastal region?
116 responses



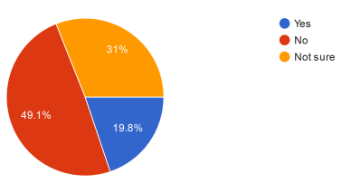
Should wind turbines be located within or adjacent to a coastal area landscape?
116 responses



Should wind turbines be situated within agricultural crop production areas?
116 responses



Should wind turbines be situated within or near places with historic or cultural features ir landscape?
116 responses



Tourist or recreational areas where respondents have seen wind turbines
Rügen island, Bornholm island, Copenhagen, seaside near Greifswald (DE)
Netherland
Dutch coast, Welsh mountains
Skåne, Sweden
north of the Czech Republic
Czech, Denmark, US
Sweden, ski areal
Netherlands
Spanish Fork Canyon
Ghent, Belgium
Lots of places in the UK
Japan
Spain, Netherlands
Zacatecas, México
Numerous beaches, or outdoor hiking trails
The Netherlands
The California Delta, close to Rio Vista.
Germany
Several hiking areas in Eastern Washington and Montana
Morocco over the coastal line, you can see on the cliffs turbines all over
Winden
Parks near Landau and from the mountains or castles in the Palatinate Forest
Wild Horse Renewable Energy Center
Germany
Palm Springs, California
Portugal, Central/southern California
Hood river (OR), the turbines were far in the distance but visible.
Columbia River Gorge (OR)
Near Joshua Tree / Ocotillo Wells in southeastern California
The Columbia River Gorge (OR)
Germany
On mountains
The gorge in Oregon
Tehachapi, California
Coastal areas
Springdale, AR
Latvia
Hsinchu Taiwan Coastline
France, Spain
India

Table 5.3.4. List of tourist or recreational areas respondents had visited and seen wind turbines.

Appendix C: Photo visualization results

Photo Visualization Rankings

Image	-5	-4	-3	-2	-1	0	1	2	3	4	5
Image 1	0	1	6	8	8	18	6	9	24	18	17
Image 2	0	1	2	4	9	16	7	11	21	19	25
Image 3	1	1	7	1	6	18	5	11	23	16	26
Image 4	4	5	9	6	7	18	5	15	13	17	16
Image 5	3	0	1	5	9	18	7	10	21	15	26
Image 6	6	3	6	6	11	14	9	9	17	15	19
Image 7	3	1	4	4	11	12	7	13	22	17	21
Image 8	5	2	6	4	5	18	5	8	18	19	25
Image 9	3	2	3	5	9	16	6	12	20	14	25
Image 10	2	2	4	6	8	18	10	10	17	20	18
Image 11	0	2	4	4	7	17	11	11	17	20	22
Image 12	0	1	2	3	11	19	8	13	20	13	25

Image 13										
-5	-4	-3	-2	-1	0	1	2	3	4	5
3	3	6	6	8	16	4	6	26	16	21
Image 14										
-5	-4	-3	-2	-1	0	1	2	3	4	5
0	1	4	7	7	15	10	16	20	11	24
Image 15										
-5	-4	-3	-2	-1	0	1	2	3	4	5
5	3	4	6	10	14	9	12	23	11	18
Image 16										
-5	-4	-3	-2	-1	0	1	2	3	4	5
3	3	10	4	8	23	6	6	24	14	14

Table 5.5.17. Survey ranking of each photograph used during the photo visualization section of the survey. Answers are based upon a scale of -5 to +5: -5 being lesser and +5 being greater impact.