RENEWABLE ELECTRICITY IN DFW: ACCESS, DISTRIBUTION, AND CONSUMER AWARENESS

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Texas is the leading producer of renewable energy in the U.S, and Dallas-Fort Worth (DFW) is the largest metropolitan area in the state. Texas has a deregulated energy market, with three types of providers: privatized, public-owned, and co-operatives. Privatized providers compete in the deregulated market, and consumers choose between hundreds of electricity retailers. Public-owned providers are owned by the municipality, and electricity consumers that live within the city limits must use the municipal provider. Electric co-operatives operate similarly where customers within the region must use the co-operative, but instead of being owned by the city, co-ops are owned by the members (customers). To date, the availability, cost, accessibility, and outreach of renewable energy among these provider types remains unclear. For this reason, my research examines the renewable energy market in DFW by asking: (1) Who has access to renewable energy and how do they understand it? (2) How do electricity retailers distribute and make renewable energy available? and (3) If consumers can choose their provider, why do they select certain electricity plans over others? My findings suggest that while many consumers want or are open to using renewable energy, uncertainties surrounding how to find or choose a provider, price, and lack of information about renewables are obstacles for consumers to access renewable energy. Additionally, while renewable energy is widely distributed in the region, there are disparities in renewable energy options.
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CHAPTER 1
INTRODUCTION

There is global urgency to reduce the use of fossil fuels, to transition to renewable energy, and to achieve net-zero emissions by 2050, as evidenced by the Paris Climate Agreement signed by 197 countries in 2015 (U.N., 2015). The transition away from fossil fuels to renewable energy sources, therefore, must occur rapidly and at multiple scales. For this reason, access to renewable electricity should be considered a fundamental right for today’s global citizen (Clay, 2002; Tully, 2006). In the United States, Texas is the leading consumer of electricity; it also is the U.S.’s leading producer and consumer of renewable energy (EIA, 2021), with 22.8% of electricity sourced from wind and 3.9% from solar (ERCOT, 2021). Texas’ use of electricity is expected to increase due to urban expansion, industrialization, and an estimated 16% population growth rate in the next decade (Fremuth & Marcus, 2016; Ura et al., 2021). Concurrently, there have been large investments in renewable energy development, including the addition of 10 GW (gigawatts) of solar energy to the state’s grid (EIA, 2020).

Nearly all of the electricity produced in Texas is consumed in Texas. This is because the state’s privatized grid is independent of the other two large grids that extend over the lower 48 states. In Texas, there are three different electricity provider types (municipal, co-operatives, privatized) and hundreds of companies participate in the generation, transmission, and delivery of electricity to customers who often must choose among multiple retail providers (Cameron et al., 2021). In theory, Texas’ deregulated grid should provide electricity consumers easy access to the state’s large renewable resources. Yet, the availability, cost, accessibility, and outreach of renewable electricity among consumers remains unclear. For this reason, my research examines three questions: (1) Who has access to renewable energy and how do they understand it? (2)
How do electricity retailers distribute and make renewable energy available? And (3) If consumers can choose their provider, why do they select certain electricity plans over others? My examination of the renewable energy market in Texas considers the different provider types, providers, and plans offered in DFW. Using a survey and interviews with electricity customers, as well as archival and on-line research, I examine accessibility and knowledge around renewable electricity in this region.

Dallas Fort-Worth (DFW) is the fourth largest metropolitan area in the U.S. (9.28 million people in 2020) and many cities in DFW rely on or are currently transitioning to renewable energy (Metzger, 2020). For example, Dallas was publicly named the city with the most renewable energy in 2015 (EPA), and in 2021, Denton became the second Texas city to achieve 100% renewable energy. My thesis research examines access and distribution of renewable energy in DFW to better understand renewable energy equity in this large and expanding region. Three literatures inform my study: energy geography, energy transitions, and energy consumption.
CHAPTER 2
LITERATURE REVIEW

2.1 Energy Geography

Energy geography is the study of energy development, transportation, markets, or use patterns and their determinants from a spatial, regional, or resource management perspective (Calvert, 2016). In the United States, there are multiple electricity markets throughout the country. Twenty-four states have deregulated wholesale electricity markets, and thirteen states have deregulated retail electricity markets (Harrison, 2020). These differences make it imperative to understand energy processes better at local levels (Calvert, 2016). In current literature, there are debates about the most effective approach to increase renewable electricity. Some argue that a centralized and regulated government provider could be the only way to ensure clean, accessible, and affordable electricity for all (Baker, 2021; Luke & Huber, 2022; Li et al., 2022). Others argue that liberalized markets with investor-owned providers are best because privatized companies can invest in large renewable energy projects and a deregulated and competitive market will cause prices to remain low for customers (Harrison, 2020; Baker, 2021). Texas offers a unique place for electricity studies, as there are investor-owned, customer-owned, and government-owned electricity providers often competing in the same regions.

2.1.1 Energy Geography of Texas

Texas is the only state with an independent and privatized grid. Towards the end of WWII, Texas utilities formed the Texas Interconnected System (TIS), and in 1970, TIS formed the Energy Reliability Council of Texas (ERCOT) to comply with federal regulations (Hunter, 2012; Pressler, 2021). In the 1990s, the political drive for independence from the federal government and popular appeals for neoliberal free markets compelled Texas politicians to
explore free-market electricity models (Pressler, 2021). In 2002, Texas deregulated its electricity market (Hunter, 2012; Pressler, 2021). As a result, ERCOT was designated the state’s - and the country’s first - Independent System Operator (Aalen & Falcon, 2021). ERCOT oversees and manages the price of electricity, balances supply and demand, and is overseen by the Public Utility Commission of Texas (PUCT) (Hunter, 2012). While ERCOT manages the market, multiple generation, transmission, and retail companies produce and distribute electricity (Aalen & Falcon, 2021).

Not all electric providers in Texas decided to de-regulate in 2002. The deregulation law made it mandatory for investor-owned companies and optional for municipal providers and cooperatives (Pressler, 2022). The Texas Public Power Association (TPPA) represents municipal providers who chose not to de-regulate. TPPA currently has 72 member cities and ~5.1 million customers (Pressler, 2022). TPPA members include Austin, San Antonio, College Station, and Denton, which operate Denton Municipal Electric. However, Dallas and Fort Worth have deregulated energy markets, where commercial providers compete for customers (Pressler, 2022). Many rural areas in Texas and some areas within cities are served by energy cooperatives. Energy cooperatives operate like municipal providers, but with member-owners instead of customers (T.E.C., 2022). There are 76 energy cooperatives with over 3 million members across the state of Texas (T.E.C., 2022). Some DFW cities are ‘dually certified,’ meaning residents in the area can choose between using a cooperative or a commercial service provider (P.U.C., 2022). Other than that, if a customer lives in a cooperative territory, they must use the cooperative for their electric utilities. My study area in DFW includes cities with deregulated and regulated energy markets; and there are areas in DFW that utilize commercial, municipal, and cooperative providers.
2.1.2 Renewable Electricity in Texas

Texas produces 20% of the U.S.’s domestic energy (EIA, 2020). In addition, it is home to 40% of U.S. petroleum production and reserves, 25% of the nation’s natural gas reserves, 30% of its renewable energy production, and the state generates 4% of U.S. coal (EIA, 2020). Since the early 20th century, Texas has been well-known for its petroleum production and has remained one of the largest oil-producing regions in the world (Slijk & Phillips, 2021).

![Texas Electricity by Fuel Source over last ten years. Source: ERCOT](image1)

**Figure 1: Texas Electricity by Fuel Source over last ten years. Source: ERCOT**

![Texas Electricity by Fuel Source, 2021](image2)

**Figure 2: Texas Electricity by Fuel Source in 2021. Source: ERCOT**
However, in the last ten years, renewable energy has grown from 8% to 28% (ERCOT; Figure 1). In 2021, solar energy made up nearly 4% of electricity in Texas, and wind was around 25% (Figure 2). In 2011, Texas became the first state to reach 10,000 MW of wind energy capacity (EIA, 2020), and solar energy continues to expand. In 2023, Texas planned to add an additional 7.7 GW capacity of solar energy (EIA, 2023). In addition to renewable energy build-out, it is critical to understand the distribution and accessibility of solar and wind energy in the state.

Some suggest that Texas’ centralized grid management (ERCOT) and localized operations (with some cities deregulated and others not) will foster a quicker transition to renewables (e.g., Fremuth & Marcus, 2016; Cyrs, 2018; Gould, 2018). Likewise, pro-market commentators believe that Texas outproduces other states with greater wind energy capacity (per capita) because the privatized grid allows governance and resource allocation decisions to be made by fewer people with a strong centralized approach (Fremuth & Marcus, 2016; Cyrs, 2018). For this reason, it is pertinent to understand if Texans have equitable access to these resources. More specifically, determining how local variations affect renewable energy accessibility can help researchers and policymakers find ways to improve renewable implementation in the state’s large and growing metropolitan areas.

2.2 Energy Transitions

Over the last two hundred years, the types of energy consumed, the amount of energy consumed, and energy efficiency have increased. Energy transitions have been driven by both technological innovations and social values, patterns, and lifestyles (Bashmakov, 2007). Prior to the industrial revolution, biomass was the primary source of energy for humans (Smil, 2010). However, as energy consumption increased, biomass sources such as firewood and charcoal
became too expensive, pushing for the use of coal for energy and becoming the first historical energy transition (Smil, 2010). Following the widespread use of coal, new innovations such as oil lamps, internal combustion engine vehicles, and Bunsen burners opened new doors for oil and natural gas development (Smil, 2010). Currently, renewable energy sources, such as wind and solar, are driving the ongoing global energy transition as nations aim to reduce carbon emissions (Smil, 2010).

2.3 Renewable Energy Transition

Following the UN Paris Climate Agreement, signed by 197 countries in 2015, there has been a global push for increases in renewable energy. Global investments in renewable energy capacity reached $272.9 billion in 2018 (Baker, 2021). Globally, at least 100 cities are now 100% renewable (Wall et al., 2021). Currently, private investors have been a large contributor to increasing renewable energy development, with 90% of global renewable energy investment being provided by private sources (Baker, 2021). Since nations are at different levels and stages of development, and therefore energy use, there are multiple political-economic impacts on what renewable energy source is used, where renewable energy is developed and used, and how much renewable energy is used (Knuth et al., 2022). There are a few obstacles to the ongoing energy transition, and identifying solutions is critical (Bridge et al., 2013; Baker, 2021; Siciliano et al., 2021; Knuth et al., 2022). Physical obstacles include a need for enhanced storage and transmission infrastructure for a successful renewable energy transition (Knuth et al., 2022). Further, questions surrounding the extent and nature of extraction from renewable energy sources are raising concerns regarding the adoption of these technologies (Knuth et al., 2022). However, a just energy transition includes more than technological fixes and must also focus on socio-economic processes related to transitioning to renewable sources (Siciliano et al., 2021).
Currently, there is a large social disparity between local actors’ and institutional actors’ views of the renewable energy transition (Siciliano et al., 2021). Solving this disparity requires a holistic understanding of the interrelationships among society, the environment, and the economy (Siciliano et al., 2021).

2.4 Energy Consumption

To help foster the global push for renewable development, there is growing interest in energy consumption patterns and behaviors. Currently, the residential electricity sector accounts for ~32% of CO2 emissions in the U.S. (EIA, 2021). Reducing electricity consumption or transitioning to non-CO2 producing sources of electricity can help meet the UN’s 2050 emission goals (Guo et al., 2018). Changes in household behavior and technology could reduce energy consumption by 30% without people making an economic sacrifice or losing a sense of well-being (Gardener & Stern, 2008). Household characteristics greatly influence consumption patterns. Some of those household characteristics include the number of people living in the house, housing type, age of residents, presence of children, level of education, income, and socioeconomic status (Guo et al., 2018). Electricity consumer behavior is based on household characteristics, socioeconomic factors, social psychological factors, and environmental behavior theory (Guo et al., 2018). Recently, consumers have become increasingly aware of their consumption habits and the impacts of their habits (Wall et al., 2021), and attitudes toward renewable energy have changed because of increased climate change concerns (Paladino and Pandit, 2019). Factors that are believed to impact renewable energy access and consumption include perceived behavioral control, environmental concerns, subjective norms, price perceptions, and environmental involvement (Paladino & Pandit, 2019). Literature suggests various interventions that can help decrease energy consumption overall and increase renewable
energy consumption (Dietz et al., 2009; Attari et al., 2010; Momsen and Stoerk, 2014; Steg et al., 2015; Guo et al., 2018).

2.4.1 Energy Attitudes and Behavior

To encourage more sustainable habits, it’s crucial to understand how people consume energy and to identify factors influencing their behaviors. Attitudes are the foundation of resulting behavior, and parameters that underscore public behavior are (1) information possessed by the public (2) the public’s perceptions and positions, and (3) fear (Stigka et al., 2014). Behavior wedges can potentially be a viable target for reducing household electricity emissions. Several factors influence energy consumption behaviors including people’s failure to understand the relationship between energy consumption and efficiency (e.g., curtailment vs. efficiency) (Gardener & Stern, 2008; Attari et al., 2010; Steg et al., 2015), misunderstandings about the relationship between climate change and energy (Bord et al., 2000; Devine-Write, 2003; Sunblad et al., 2009; Whitmarsh et al., 2011; Tobler et al., 2012; Guy et al., 2014), misunderstandings about which behaviors are more sustainable (Gardener & Stern, 2008; Attari et al., 2010), and moral and conscientious consumer practices (Allcott & Mullainathan, 2010; Bolderdijk et al., 2013; Steg et al., 2015).

One of the largest limitations to practicing more efficient energy consumption behaviors is a lack of knowledge (Dietz et al., 2009; Attari et al., 2010; Steg et al., 2015). Intention to use renewable energy is influenced by consumer awareness, and awareness includes knowledge about renewable electricity, prices, and concerns (Wall et al., 2021). Steg et al. (2015) note that most people seem to understand that energy contributes to CO2 emissions but little more. For example, there are many misconceptions about climate change processes and how it occurs (anthropogenic vs. natural), how different behaviors impact emissions (few people understand
how cooling and heating homes contribute to emissions) (Bord et al., 2000), and how individual
decisions can affect global warming (many people believe global warming issues are caused by
distant entities such as industry, governments, etc.) (Whitmash et al., 2011). Devine-Write
(2003) found that people also misunderstood what renewable energy sources are, and 55% of
Devine-Write’s survey respondents stated that natural gas was renewable. People who are more
knowledgeable about environmental issues tend to care about the issues. For example, people
who understand climate change and its causes are generally more concerned about climate
change issues (Sunblad et al., 2009; Tobler et al., 2012; Guy et al., 2014). There is a need for
increasing public awareness regarding the benefits associated with renewable energy, including
air quality and the negative consequences of non-renewable energy energies, etc., to cultivate
positive attitudes toward renewable energy (Wall et al., 2021). Improving knowledge about these
subjects and their interconnections with lifestyle choices can enhance energy consumption
behaviors (Dietz et al., 2009; Attari et al., 2010; Steg et al., 2015). To fully understand
accessibility to renewable energy in DFW, it is important to know if customers are choosing
greener options when they are offered, and why or why not.

2.4.2 Energy Motivations

In addition to knowledge, motivations for sustainable behavior have a large impact on
individuals' energy consumption behaviors (Steg et al., 2015). Motivations for energy
consumption behaviors can be broadly categorized into moral considerations, economic
considerations, and personal values (Allcott & Mullainathan, 2010; Dietz et al., 2009; Attari et
al., 2010; Steg et al., 2015). Economic considerations are often the primary motivation (Dietz et
al., 2009; Steg et al., 2015), therefore, incentives and subsidies are effective ways to improve
energy consumption behaviors (e.g., choosing the fuel source type used for household electricity,
Unwillingness to pay has been attributed to low income, low priority of environmental issues, and distance from renewable energy source projects (Stigka et al., 2014). In traditional theories of self, people are more likely to engage in behaviors that make them feel ‘moral’ and morally just (Bem, 1972). This is true for energy behaviors and decisions as well, and personal values influence motivation as some people find that government-funded renewable energy may be wasteful, or that short-term approaches are not worth participating in, while others are motivated to engage in sustainable behaviors because they value the environment and identify as pro-environment (Bolderdijk et al., 2013; Steg et al., 2015).

However, pro-environment attitudes do not always mean better behaviors (Allcott & Mullainathan, 2010; Attari et al., 2010). While people who identified as caring about environmental issues have greater knowledge about energy-saving behaviors, on average, the behaviors that participants report practicing are similar to people who do not identify as pro-environment (Attari et al., 2010). This shows a gap between people caring for the environment and people practicing different energy habits or behaviors. My research aims to better understand this gap, and to better understand consumer awareness of renewable options and why consumers choose certain electricity plans.

2.4.3 Intention-Action Gap

The literature suggests there is a gap between willingness and behavior (intention-action gap), with willingness meaning oral support for renewable energy and behavior as the actual consumption of renewable energy (Fang et al., 2021). A few socio-economic factors consistently, positively correlate between intention and action, including income, education, age, gender, and profession (Fang et al., 2021). Increased information and knowledge can decrease the gap
between intention and action in renewable energy use (Momsen & Stoerk, 2014).

Several researchers identify successful interventions that can result in positive, more sustainable energy consumption behaviors (Dietz et al., 2009; Attari et al., 2010; Momsen and Stoerk, 2014; Steg et al., 2015; Guo et al., 2018). Dietz et al. (2009) found that the most successful interventions include: combining policy tools and approaches addressing barriers to behavior change, strong social marketing at multiple levels (from social media, participatory and community-level approaches, etc.), and targeting multiple audiences (individuals, businesses, etc.). In 2015, Steg et al. defined similar findings in more-broad terms and suggested that successful interventions required both structural and psychological strategies. Structural strategies include economic incentives, policies, subsidies, etc., while psychological strategies focus on strengthening individuals’ intrinsic motivations to participate in sustainable energy behaviors (Steg et al., 2015; Guo et al., 2018). This is relevant to consider when beginning to ask why people have certain energy consumption behaviors. This is because the literature outlines how energy decisions and behaviors are not simply economic, social, or moral decisions but are instead a complex mix. Although this may be true for many environmental behaviors and decisions, it is imperative to ask about energy consumption as renewable energy becomes more accessible, affordable, and attainable. It is also significant because the population will continue to increase and climate change is an ever-looming reality, so focusing on efficient energy consumption behaviors and on people willing to consume renewable electricity is crucial to a sustainable future.

2.4.4 Intervention Strategies

Intervention strategies that have been studied to reduce overall energy consumption include commitment (Katvez & Johnson, 1983), goal setting (Beker, 1978; Abrahamse et al.,
2007; Harding & Hsiaw, 2014), providing information (Hutton & Mcneill, 1981; Komatsu & Nishio, 2015), feedback (Karjalainen, 2011; Hargreaves et al., 2013; Burchell et al., 2016), and rewards (Bertoldi et al., 2013; Handgraaf et al., 2013). All of these intervention strategies have proven to be successful in other studies. However, a mix of multiple strategies can offer the most effective impact on electricity reduction behavior (Guo et al., 2018).

Commitment strategies include oral contracts or written contracts in which households agree to change their behavior and decrease energy use (Guo et al., 2018). Katvez & Johnson (2013) found that households who signed a contract to reduce energy consumption by 10% saved more energy and changed behaviors at higher rates than households that did not sign the contract. Goal setting is another common strategy to reduce energy consumption, where the goal is either set by the household or researchers (Guo et al., 2018). However, goals that are too large or too small often are ineffective (Beker, 1978; Abrahamse et al., 2007; Harding & Hsiaw, 2014). Providing energy-saving information to households does help them reach their goals than for households who do not receive information (Beker, 1978; Abrahamse et al., 2007; Harding & Hsiaw, 2014).

Providing information is an effective intervention strategy to reduce energy consumption (Guo et al., 2018). Information about environmental pollution, the significance of saving electricity, and electricity-saving tips have been found to be effective (Hutton & Mcneill, 1981; Komatsu & Nishio, 2015). Research by Hutton and Mcneill (1981) found that equipping homeowners with information manuals resulted in more changed behaviors and decreased energy consumption than not receiving a manual. Feedback is another common intervention strategy that has been found to reduce energy consumption by up to 2.9% (Carroll et al., 2014). Feedback strategies include providing feedback about energy use, savings, etc. either daily,
weekly, monthly, or annually to consumers, and feedback can be given to customers through various approaches whether it be text messages, emails, on their electricity bill, etc. (Guo et al., 2018). Karjalainen (2011) found that consumers case most about feedback on electricity expenses, proportion of appliance use, and other people’s consumption information.

Lastly, rewards have been identified as a successful strategy for reducing energy consumption. Rewards are incentives that are either financial or social (Guo et al., 2018). Bertoldi et al. (2013) found that economic incentives were helpful for adopting new technology but did not cause a behavior change. However, social incentives (both public and private) were found to be more effective at influencing behavior than economic incentives, and public social recognition was more effective than private social recognition (Handgraaf et al., 2013). Guo et al (2018) suggested that creating personalized consumer profiles using some of these strategies would be the most effective approach to reducing overall consumption.

While in theory, the energy consumption reduction interventions could be used to encourage the use of renewable electricity, the strategies that aim to increase the use of renewable energy in households are broadly categorized into structural and psychological approaches (Dietz et al., 2009; Attari et al., 2010; Steg et al., 2015). Structural interventions include electricity governance, economic incentives, policy, etc., which have been discussed and theorized in depth (Dietz et al., 2009). Price negatively impacts people’s acceptance and use of renewable electricity (Park & Kim, 2018; Paladino & Pandit, 2019; Wall et al., 2021), so a large and general goal is to make renewable energy affordable and available.

A large discussion in the transition to renewable electricity is how renewable energy should be governed to make renewables more affordable and available by structural interventions. Long debates in research on electricity governance suggest that electricity
governance should either be a state-controlled monopoly with central planning, or a liberalized market with an independent regulator (Baker, 2021). Luke & Huber (2022) argue that the privatization of power dispossessed citizens of the state-owned infrastructures that could provide affordable and accessible electricity and that we need more electricity democracy, which would include publicly owned utilities to create carbon-free and universal electricity.

The neoliberal approach to the electricity market, with some public control and some private control over electricity, has implications that are unevenly spread because public resources are directed to companies focused on accumulation and not providing a service (Luke & Huber, 2022). On the other hand, scholars have argued that a liberalized approach is more beneficial since there will be more investment in renewables by commercial actors, which would ultimately make renewable energy more affordable and available (Baker, 2021). This seems to be the current trend since private sources provide 90% of the global renewable energy investment (Baker, 2021). While it is difficult to say which electricity governing approach, if any, is suitable for the transition to renewable energy, it is imperative to discuss and look at both approaches in comparison, which is done in this study.

Another suggested structural approach is incentives and policy (Lund, 2009; Li et al., 2022). Incentives such as green certificates, tariffs, renewable energy development quotas, etc., can help induce demand in the market (Lund, 2009). Economic incentives such as tax credits for providers and developers who invest in and develop renewables have also been successful in decreasing the price of renewable electricity. This makes renewable energy more widely accepted and used. Energy policies primarily address factors related to energy commodities, including the security of supply and environmental impacts and costs (Lund, 2009). Energy policies can significantly contribute to the expansion of industrial activities in sustainable energy
It is argued that tougher government regulations are better than market-based approaches (Li et al., 2022). A combination of multiple structural interventions, paired with technological improvements, will make renewable sources more affordable and available to consumers, thereby increasing the use of renewable energy and decreasing carbon emissions from the residential sector.

Behavioral approaches are also a common strategy to promoting renewable energy use (Stegg et al., 2015). Many of the suggestions are similar to proposals that aim to reduce overall energy consumption (Guo et al., 2018). There needs to be more transparency with consumers regarding renewable energy, its benefits, how to use renewable energy (such as whether it's changing plans or providers), etc. Governments should continue to increase investment in education, and renewable energy development policies and energy-related knowledge should be clear (Fang et al., 2021). We need a combination of structural and behavioral approaches to make renewable electricity more affordable and widely available, as well as ensure that consumers are aware of and choose to use renewable energy options.
CHAPTER 3
METHODS AND STUDY AREA

The study area selected for this research is Dallas, Denton, Collin, and Tarrant Counties located in the DFW metroplex. This area was selected for this research because these four counties are the most populated of the DFW (~6.7 million residents), and because all three provider types operate in the region: privatized, public, and co-operative. The privatized providers operate in most of the region but not in municipal and co-operative territories and offer a variety of different electric plans, including wide varieties in price and in renewable energy options. Denton Municipal Electric (DME) is the only municipal provider within Denton city limits, and only offers one electric plan, which is 100% renewable, and all residents within Denton city limits must use DME. Two large electricity cooperatives have territory in the study region. CoServ Electric Co-operative operates in parts of all four counties and Tri-County Electric Co-Operative operates in parts of Denton and Tarrant Counties.

This research examines three questions: (1) Who has access to renewable energy and how do they understand it? (2) How do electricity retailers distribute and make renewable energy available? And (3) if consumers can choose their electric provider, why do they select certain electricity plans over others? This study used mixed methodologies to develop a broad understanding of the distribution and accessibility of green electricity in DFW and to gain a baseline understanding of consumer decision-making when it comes to alternative energy options. First, a Qualtrics survey was distributed using a snowball sampling method. This was done by distributing it to friends and family in the DFW region and asking them to send it to friends and family, and so forth. The survey information was also posted in online Facebook
groups based in the region. Survey respondents who chose to do so also participated in the follow-up semi-structured interviews.

3.1 Qualtrics Survey

To establish information about consumer preferences, behaviors, options, providers, knowledge, etc. I created a Qualtrics survey and distributed it on a rolling basis starting with friends and family in the region. The survey was distributed between June 2021 and September 2021. The goal of the survey was to see if there were any initial patterns and to collect more quantitative data surrounding the participants in the four counties. The survey asked participants questions to establish zip codes, demographics, identify providers, and to assess their perceptions, behaviors, and access to renewable electricity (Appendix A). The survey questions were organized in an efficient and intuitive order. They were followed by questions about knowledge, questions about providers and provider choices, and lastly, questions to understand motivations and behaviors influencing energy decisions among respondents.

The demographic portion of the survey was established based on demographic questions posed in the 2020 U.S. Census (U.S. Census Bureau, 2020). For the survey to be more efficient, respondents were required to identify their county and zip code. This helped them determine which survey path they would be presented with based on where they lived in the region. If respondents were within Denton where there is a municipal provider, DME, they were not given questions about providers or provider choices. This is because they do not get to choose their provider and must use DME. With the zip code information provided by respondents, a map was created using Esri’s ArcGIS Pro and public county data to display where the survey respondents reside (Figure 3). The questions about knowledge were created based on past studies surrounding renewable energy consumer knowledge, with additional questions about fuel sources of
electricity, identifying renewable energy sources, and connections to climate change (Devine-Wright, 2003; Dietz et al, 2009; Attari et al, 2010). I structured my questions about peoples’ willingness to participate in more energy-efficient behaviors by drawing on other research into energy behaviors and decisions (e.g., Dietz et al, 2009; Attari et al., 2010; Steg et al., 2015). As well, I asked respondents about using new technology (NT) or about using more traditional energy reduction behaviors (ER). The respondents were prompted to rate how likely they were to do the following behaviors: install solar panels (NT), drive an electric vehicle (NT), use more energy-efficient appliances (ER), or reduce overall energy consumption (ER). The survey also asks respondents to identify the importance of certain motivations when it comes to energy decisions, including environmental, convenience, and economic motivations (Dietz et al., 2009; Attari et al., 2010; Steg et al., 2015). Respondents rank climate change, more energy options, accessibility to renewable energy, and price in their energy decision-making. Lastly, the survey offered the option for a follow-up interview. I contacted these individuals for semi-structured interviews.

3.2 Semi-Structured Interviews

Following the Qualtrics survey, I conducted semi-structured interviews with amenable survey participants. With the semi-structured interviews, I gained a deeper understanding of people’s perceptions of renewable energy options and people’s energy behaviors and knowledge (Table 1). The semi-structured interview questions explored similar themes to the Qualtrics survey: energy consumption habits, provider choice, perceptions, and knowledge of renewable energy, energy behaviors, and motivations behind energy decisions. However, the semi-structured interviews asked about specific provider choice (if any), electric plan choice (if any), feelings and perceptions about renewable energy and renewable energy accessibility and
affordability, energy consumption, role in energy decisions at home, and energy behaviors at home. I conducted the semi-structured interviews between June-September 2021, after receiving IRB approval to do so (Appendix C). The semi-structured interviews either took place face-to-face in local coffee shops, via phone calls, or via Zoom. The semi-structured interviews were recorded and transcribed, and Excel was used to organize the interview data and transcriptions. The results of the semi-structured interviews are displayed in Section 6 of this paper following the Qualtrics survey results.

3.3 Provider Data

To gather data on electricity providers, after identifying survey respondents’ providers, I accessed each provider’s website to determine the price and the amount of renewable energy used in their various plans. All provider websites were accessed on September 20\textsuperscript{th}, 2022, and the website for TriCounty Electric Co-Operative was revisited on January 15\textsuperscript{th}, 2023. For the privatized providers, the websites were all similar in structure. Table 1 shows the provider’s name, type, and website link.

<table>
<thead>
<tr>
<th>Provider</th>
<th>Provider Type</th>
<th>Website Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>TXU</td>
<td>Private</td>
<td><a href="https://shop.txu.com/">https://shop.txu.com/</a></td>
</tr>
<tr>
<td>Gexa Energy</td>
<td>Private</td>
<td><a href="https://www.gexaenergy.com/for-home">https://www.gexaenergy.com/for-home</a></td>
</tr>
<tr>
<td>Green Mountain Energy</td>
<td>Private</td>
<td><a href="https://www.greenmountainenergy.com/">https://www.greenmountainenergy.com/</a></td>
</tr>
<tr>
<td>TriEagle</td>
<td>Private</td>
<td><a href="https://www.trieagleenergy.com/tx/residential/default">https://www.trieagleenergy.com/tx/residential/default</a></td>
</tr>
<tr>
<td>Direct Energy</td>
<td>Private</td>
<td><a href="https://www.directenergy.com/">https://www.directenergy.com/</a></td>
</tr>
<tr>
<td>Constellation Energy</td>
<td>Private</td>
<td><a href="https://www.constellation.com/#">https://www.constellation.com/#</a></td>
</tr>
<tr>
<td>Veteran Energy</td>
<td>Private</td>
<td><a href="https://www.veteranenergyusa.com/">https://www.veteranenergyusa.com/</a></td>
</tr>
<tr>
<td>Spark Energy</td>
<td>Private</td>
<td><a href="https://www.sparkenergy.com/">https://www.sparkenergy.com/</a></td>
</tr>
</tbody>
</table>

(Table continues)
<table>
<thead>
<tr>
<th>Provider</th>
<th>Provider Type</th>
<th>Website Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>TriCounty Electric</td>
<td>Electric Cooperative</td>
<td><a href="https://www.tcectexas.com/my-bill">https://www.tcectexas.com/my-bill</a></td>
</tr>
</tbody>
</table>

On each privatized provider’s website, I located the residential electricity plans, which is either the default page or a tab at the top of the webpage. After accessing the residential plans webpage, I was prompted to use a zip code and to select an estimated use of either 1000 or 2000 kWh per month. For each website, I entered the zip code ‘76205’ (Denton) because it is the zip code I reside in and pulls the closest service rate (since Denton is not serviced by privatized providers). For the estimated use, I selected 2000 kWh on each website. I recorded the number of 100% renewable plans on each website (Table 8). While some plans were mixed and offered a percentage of renewable sourced electricity, I only counted plans that were 100% renewable. I also recorded the price per kWh of the cheapest and most expensive plans offered (Table 9).

The websites for Denton Municipal Electric (DME) and TriCounty Electric Co-operative are structured a little differently. For DME, I accessed the website using the link provided in Table 1. On the lefthand side of the webpage, I selected ‘Residential Electric Services.’ At the top of the ‘Residential Electric Services’ page, there is a tab titled ‘Current Residential Rates’ which I selected to find the rates provided in Table 11. To find information about DME’s use of 100% renewable, I clicked on the tab on the lefthand side titled ‘Power Supply,’ which takes users to a webpage with many tabs about the power supply used in Denton. For TriCounty Electric, finding the price and use of renewable energy is difficult. To find the electric rate, I clicked the tab titled ‘My Cooperative’ and then the dropdown option titled ‘How to Read My Bill.’ On the ‘How to Read my Bill’ page, there is a table called ‘Bill FAQs,’ and one of the
questions is: ‘What is the Energy Charge?’ which I clicked to find the electric rate per kWh (Table 12).
CHAPTER 4

RESULTS

4.1 Qualtrics Survey Results

4.1.1 Demographic Data

There was a total of sixty-eight respondents to the Qualtrics survey. Having the survey distributed on a rolling basis may have affected the low number of respondents, thereby affecting the demographics of the survey. I address this and other limitations of my study in the Conclusion section below. The low number of respondents becomes obvious in the demographic data from the survey displayed in Table 2. Of the sixty-eight respondents, 62.3% were female, 72.1% identified as white/non-Hispanic or Latino, 34.9% of respondents were between the ages of 18 and 29, 54.1% of respondents estimated their annual house income to be above $65,000, 95.2% of respondents had a computer in their homes, 98.4% of respondents had wireless internet in their home, while 54.1% of respondents were homeowners while 45.9% were renters. Of the 45.9% of renters, 67.9% were renting apartments. Since 45.9% of the respondents were renters, this may impact their ability to decide if their provider or not.

Table 2: Demographics of survey respondents.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>29.5</td>
</tr>
<tr>
<td>Female</td>
<td>62.3</td>
</tr>
<tr>
<td>Other/non-binary</td>
<td>8.1</td>
</tr>
<tr>
<td>Race</td>
<td></td>
</tr>
<tr>
<td>White, non-Hispanic/Latino</td>
<td>72.1</td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>9.8</td>
</tr>
<tr>
<td>Asian</td>
<td>6.6</td>
</tr>
<tr>
<td>Black/African American</td>
<td>3.3</td>
</tr>
<tr>
<td>Native American/Alaskan Native</td>
<td>1.6</td>
</tr>
<tr>
<td>Two or more races</td>
<td>6.6</td>
</tr>
<tr>
<td>Hawaiian Islander/Pacific Islander</td>
<td>0</td>
</tr>
</tbody>
</table>

*(table continues)*
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
</tr>
<tr>
<td>18-29 years old</td>
<td>34.9</td>
</tr>
<tr>
<td>30-41 years old</td>
<td>23.3</td>
</tr>
<tr>
<td>42-53 years old</td>
<td>18.6</td>
</tr>
<tr>
<td>54-65 years old</td>
<td>18.6</td>
</tr>
<tr>
<td>65+ years old</td>
<td>4.7</td>
</tr>
<tr>
<td><strong>Annual Household Income</strong></td>
<td></td>
</tr>
<tr>
<td>Less than $18,000</td>
<td>8.2</td>
</tr>
<tr>
<td>$18,000 - $25,000</td>
<td>9.8</td>
</tr>
<tr>
<td>$26,000 - $35,000</td>
<td>4.9</td>
</tr>
<tr>
<td>$36,000 - $45,000</td>
<td>4.9</td>
</tr>
<tr>
<td>$46,000 - $55,000</td>
<td>9.8</td>
</tr>
<tr>
<td>$56,000 - $65,000</td>
<td>8.2</td>
</tr>
<tr>
<td>More than $65,000</td>
<td>54.1</td>
</tr>
<tr>
<td><strong>Computer in House</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>95.2</td>
</tr>
<tr>
<td>No</td>
<td>4.8</td>
</tr>
<tr>
<td><strong>Wireless Internet in House</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>98.4</td>
</tr>
<tr>
<td>No</td>
<td>1.6</td>
</tr>
<tr>
<td><strong>Homeownership</strong></td>
<td></td>
</tr>
<tr>
<td>Homeowner</td>
<td>54.1</td>
</tr>
<tr>
<td>Renter</td>
<td>45.9</td>
</tr>
<tr>
<td><strong>Renter Residence Type</strong></td>
<td></td>
</tr>
<tr>
<td>Renter- Apartment</td>
<td>67.9</td>
</tr>
<tr>
<td>Renter- Townhouse</td>
<td>10.7</td>
</tr>
<tr>
<td>Renter- House</td>
<td>21.4</td>
</tr>
</tbody>
</table>

4.1.2 Location Data

The survey was distributed across Dallas, Denton, Collin, and Tarrant Counties. The survey asked respondents to identify both the county and zip code they reside in. Using the zip code information provided in the survey, a map (Figure 3) was created to display the location and spread of respondents. Most of the respondents resided in Denton County (49.2%) mostly around the zip codes of the cities of Denton, Flower Mound, and Lewisville. In the other three counties, there was less concentration around specific zip codes. 27.9% of respondents were in Dallas County, 19.7% were located in Tarrant County, and only 3.3% of respondents were in Collin County. In the city limits of Denton, located in Denton County, all of the residents must
use the municipal provider, Denton Municipal Electric. In the survey, the respondents using TriCounty Electric Cooperative were located in the zip code of 76244 which is the city of Fort Worth located in Tarrant County. For the rest of the zip codes highlighted in this map, the residents are using privatized providers.

![Figure 3: Map of survey respondents zip codes.](image)

4.1.3 Renewable Energy Knowledge

To assess knowledge about renewable energy and energy consumption in general, survey respondents were asked to: identify the primary fuel source for their electricity, select renewable energy sources, and share if they think electricity contributes to climate change (Appendix A). Table 3 shows the responses of survey respondents to each question in percentages. More than half of respondents were unsure of the primary fuel source of their electricity (58.3%). When
asked to identify renewable electricity sources, the renewable sources included in the question, solar, wind, and biomass were identified at the highest percentages of 34.6%, 32.7%, and 17.6% respectively. However, for the two non-renewable sources included in the question, natural gas, and coal, 11.1% of respondents identified natural gas as a renewable source and 3.9% of respondents identified coal as a renewable source. Lastly, when asked about the contribution of electricity to climate change, 57.4% of respondents stated that electricity was a contributor to climate change. However, 37.7% of respondents seemed less sure and selected ‘maybe’, and 4.9% of respondents selected ‘no’.

Table 3: Survey responses to questions about knowledge.

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify primary fuel source used for your electricity</td>
<td>Natural Gas</td>
<td>26.7</td>
</tr>
<tr>
<td></td>
<td>Coal</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>Solar</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>Wind</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Not sure</td>
<td>58.3</td>
</tr>
<tr>
<td>Please select ALL the renewable sources provided below</td>
<td>Natural gas</td>
<td>11.1</td>
</tr>
<tr>
<td></td>
<td>Solar</td>
<td>34.6</td>
</tr>
<tr>
<td></td>
<td>Wind</td>
<td>32.7</td>
</tr>
<tr>
<td></td>
<td>Coal</td>
<td>3.9</td>
</tr>
<tr>
<td></td>
<td>Biomass</td>
<td>17.6</td>
</tr>
<tr>
<td>Does electricity contribute to climate change?</td>
<td>Yes</td>
<td>57.4</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>4.9</td>
</tr>
<tr>
<td></td>
<td>Maybe</td>
<td>37.7</td>
</tr>
</tbody>
</table>

4.1.4 Energy Motivations and Behaviors

The survey asked respondents to rate how significant certain motivations were when it came to making energy decisions. The motivations provided were based on previous literature that suggested environmental motivations (ENV), convenience (CON), and economic motivations (ECON) affect energy decisions (Dietz et al., 2009; Attari et al., 2010; Steg et al.,
The motivations displayed in the survey included: climate change (ENV), more energy efficient options (CON), access to renewable energy (CON), and cheaper electricity options (ECON). The survey respondents were asked to rate the importance of these motivators from 1-5, with a rating of ‘1’ representing ‘not important’ and ‘5’ representing ‘very important’ (Appendix A). However, after collecting data for the survey, there was a minimal variance between ratings ‘2’ and ‘3’ and ratings ‘4’ and ‘5’. To display the data in a more meaningful way, the categorization of responses was adjusted, where ratings ‘1’ remained in the category of ‘not important’, ratings of ‘2’ and ‘3’ were grouped into the ‘moderately important’ category, and ratings ‘4’ and ‘5’ were grouped into the ‘very important’ category. The results are displayed in Table 4.

<table>
<thead>
<tr>
<th>Motivation</th>
<th>Not Important</th>
<th>Neutral</th>
<th>Very Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate Change</td>
<td>9.9</td>
<td>27.9</td>
<td>62.3</td>
</tr>
<tr>
<td>More energy efficient options</td>
<td>14.6</td>
<td>18.0</td>
<td>67.2</td>
</tr>
<tr>
<td>Access to renewable energy</td>
<td>11.5</td>
<td>18.0</td>
<td>70.5</td>
</tr>
<tr>
<td>Cheaper energy options</td>
<td>14.8</td>
<td>4.9</td>
<td>80.3</td>
</tr>
</tbody>
</table>

To gain insight into energy behaviors, or willingness to adopt certain energy behaviors, respondents were asked to rate the likelihood of utilizing new technologies to decrease energy consumption (NT) and engaging in more traditional behaviors to reduce energy consumption (ER). Participants were given the option to choose from various behaviors including using solar panels on their houses (NT), driving electric cars (NT), using more energy-efficient appliances (ER), or using less energy overall (ER). They were asked to rate their willingness to adopt these behaviors between 1-5, with a rating of ‘1’ representing ‘extremely unlikely’ and a rating of ‘5’ representing ‘extremely likely’. Again, there were minimal differences between some of the ratings, so the categories were adjusted after data collection. Ratings ‘1’ and ‘2’ were grouped
into the category of ‘unlikely’, rating ‘3’ was categorized as ‘don’t care’, and ratings ‘4’ and ‘5’ were grouped into the category of ‘likely’. The results are displayed in Table 5.

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Unlikely</th>
<th>Neutral</th>
<th>Likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use solar panels on house</td>
<td>31.1</td>
<td>18.0</td>
<td>50.8</td>
</tr>
<tr>
<td>Drive an electric vehicle</td>
<td>27.9</td>
<td>27.9</td>
<td>44.2</td>
</tr>
<tr>
<td>Use more energy efficient options</td>
<td>6.6</td>
<td>16.4</td>
<td>77.1</td>
</tr>
<tr>
<td>Reduce overall energy use</td>
<td>11.5</td>
<td>9.8</td>
<td>78.7</td>
</tr>
</tbody>
</table>

4.1.5 Electric Providers

The agency of choice for electric providers varies greatly depending on the geographical location of respondents and on ownership. For respondents in Denton City, they do not have a choice of provider type since they use the municipal provider, DME. Respondents living in electric cooperative territories also have limited choices and can only use the cooperative. Respondents outside co-operative or municipal provider territories are able to select from over 50+ private providers in the region. There is one exception to this in a privatized market where respondents rent homes, apartments, or townhomes that require a tenant to select a specific provider. For the efficiency of the survey, respondents that identified living in Denton city limits were not asked if they had decided on their provider. This is because we know they do not. Since 29.5% of respondents reside in Denton and are using DME, only 70.5% of respondents were asked if they chose their electric provider. The results are displayed in Table 6.

<table>
<thead>
<tr>
<th>Choice in Electric Provider</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>77.3</td>
</tr>
<tr>
<td>No</td>
<td>22.7</td>
</tr>
</tbody>
</table>

Slightly more than twenty percent of respondents indicated they do not choose their electric
provider, meaning they either live in electric co-operative territories or they are renters who use the provider requested or suggested by tenants/complexes.

Respondents outside of Denton were asked to identify their electric provider. The providers are organized into either privatized providers or electric co-operatives. Table 7 displays the data for each provider type. Respondents identified ten different providers and 61.4% of respondents used privatized providers. For the electric cooperatives, only one cooperative was identified by respondents, TriCounty Co-Operative, and 9.1% of respondents were using this cooperative.

Table 7: Number of providers in each provider type and respondents using each type.

<table>
<thead>
<tr>
<th>Provider Type</th>
<th>No. of Providers of This Type Identified in Survey</th>
<th>Respondents Using Provider Type (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Privatized</td>
<td>10</td>
<td>61.4</td>
</tr>
<tr>
<td>Municipal</td>
<td>1</td>
<td>29.5</td>
</tr>
<tr>
<td>Electric Co-Operative</td>
<td>1</td>
<td>9.1</td>
</tr>
</tbody>
</table>

4.1.5.1 Privatized Providers

Of the 61.4% of respondents who used a private provider, ten different providers were identified. Table 8 displays the ten different providers, the percentage of respondents that use the provider, and the number of renewable energy plans each of the providers offer.

Table 8: List of privatized providers with respondents using each provider and number of RE plans each provider offers

<table>
<thead>
<tr>
<th>Provider</th>
<th>Respondents Using Provider (%)</th>
<th>No. of Renewable Energy Plans</th>
</tr>
</thead>
<tbody>
<tr>
<td>TXU</td>
<td>20.5</td>
<td>2</td>
</tr>
<tr>
<td>Gexa Energy*</td>
<td>9.1</td>
<td>10</td>
</tr>
<tr>
<td>Reliant Energy</td>
<td>9.1</td>
<td>3</td>
</tr>
<tr>
<td>Green Mountain Energy*</td>
<td>6.8</td>
<td>5</td>
</tr>
<tr>
<td>TriEagle</td>
<td>6.8</td>
<td>3</td>
</tr>
<tr>
<td>Just Energy</td>
<td>4.5</td>
<td>3</td>
</tr>
</tbody>
</table>

(table continues)
<table>
<thead>
<tr>
<th>Provider</th>
<th>Respondents Using Provider (%)</th>
<th>No. of Renewable Energy Plans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Energy</td>
<td>4.5</td>
<td>4</td>
</tr>
<tr>
<td>Constellation Energy</td>
<td>4.5</td>
<td>0</td>
</tr>
<tr>
<td>Veteran Energy</td>
<td>2.3</td>
<td>1</td>
</tr>
<tr>
<td>Spark Energy</td>
<td>2.3</td>
<td>0</td>
</tr>
</tbody>
</table>

*Providers are 100% renewable energy; they only offer renewable energy plans.

Gexa Energy and Green Mountain Energy are both 100% renewable providers, meaning all their electricity plans are renewable. Neither Constellation Energy nor Spark Energy offer any renewable energy plans.

Since 80.3% of respondents identified cheaper electricity options as a motivator in energy decisions (Table 4), Table 9 shows the cheapest and most expensive plan provided by each of the ten providers in ¢/kWh per 2000 kWh. Gexa Energy has the most affordable plan of all ten providers (11.9¢/kWh) and the plan is 100% renewable (as are all of Gexa Energy’s plans). The most expensive plan offered by all ten providers is supplied by Spark Energy (25.0¢/kWh) and is not a renewable plan. In most cases, renewable energy plans were neither the cheapest nor the most expensive option among the providers. The exceptions to this are the two providers who only sell renewable energy plans (Gexa Energy and Green Mountain Energy), and TriEagle Energy, whose most expensive plan offered was one of their three renewable energy plans. This means for all of the other providers their renewable energy plans are priced somewhere between the plans listed in the table (with the exception of Constellation Energy and Spark Energy which do not have any renewable plans). Gexa Energy also offers a renewable energy plan whose price is highly competitive compared to other plans at 11.9¢/kWh. This suggests that cheap renewable energy options exist, however only 9.1% of respondents were using the provider with the cheapest renewable energy option (Gexa Energy). The average Texas household uses approximately 1,094 kwh of electricity per month (EIA, 2021).
Table 9: Privatized providers and the cheapest and most expensive plan they offer

<table>
<thead>
<tr>
<th>Provider</th>
<th>Cheapest Plan Offered (¢/kWh)</th>
<th>Most Expensive Plan Offered (¢/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TXU</td>
<td>18.9</td>
<td>24.2</td>
</tr>
<tr>
<td>Gexa Energy</td>
<td>11.9*</td>
<td>23.0*</td>
</tr>
<tr>
<td>Reliant Energy</td>
<td>22.9</td>
<td>24.5</td>
</tr>
<tr>
<td>Green Mountain Energy</td>
<td>22.9*</td>
<td>22.9*</td>
</tr>
<tr>
<td>TriEagle</td>
<td>17.9</td>
<td>22.0*</td>
</tr>
<tr>
<td>Just Energy</td>
<td>16.3</td>
<td>21.6</td>
</tr>
<tr>
<td>Direct Energy</td>
<td>22.4</td>
<td>23.5</td>
</tr>
<tr>
<td>Constellation Energy</td>
<td>16.7</td>
<td>20.7</td>
</tr>
<tr>
<td>Veteran Energy</td>
<td>17.8</td>
<td>20.7</td>
</tr>
<tr>
<td>Spark Energy</td>
<td>17.5</td>
<td>25.0</td>
</tr>
</tbody>
</table>

*100% renewable energy plan

To give a better understanding of the range of prices available from private providers, I applied the price per kwh to the usage of 1000 kwh, 1,094 kwh, and 2000 kwh (Table 10) to give an example of what monthly electricity bills at these prices would look like. The figures in the table were rounded to the nearest dollar amount. In addition to paying the cost of electricity, customers must pay an electricity transmission fee. Transmission companies are paid by the electric providers, but the providers charge a transmission fee to the customers. In the DFW region, Oncor is a dominant transmission company. To gain a general idea of how much transmission fees may be in the area, I looked at Oncor’s rate on their website. Oncor’s website indicates that the transmission fees include a fixed monthly charge of $3.42 and then a charge of 4¢ per kwh used (Oncor, 2022).
## Table 10: Estimated monthly bill per kwh used, by privatized provider plan type

<table>
<thead>
<tr>
<th>Provider</th>
<th>1000 kwh, per Plan Type</th>
<th>1094 kwh, per Plan Type</th>
<th>2000 kwh, per Plan Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cheapest</td>
<td>Most Expensive</td>
<td>Cheapest</td>
</tr>
<tr>
<td>TXU</td>
<td>$189</td>
<td>$242</td>
<td>$207</td>
</tr>
<tr>
<td>Gexa Energy</td>
<td>$119*</td>
<td>$230*</td>
<td>$130*</td>
</tr>
<tr>
<td>Reliant Energy</td>
<td>$229</td>
<td>$245</td>
<td>$251</td>
</tr>
<tr>
<td>Green Mountain Energy</td>
<td>$229*</td>
<td>$229*</td>
<td>$251*</td>
</tr>
<tr>
<td>TriEagle</td>
<td>$179</td>
<td>$220*</td>
<td>$196</td>
</tr>
<tr>
<td>Just Energy</td>
<td>$163</td>
<td>$216</td>
<td>$178</td>
</tr>
<tr>
<td>Direct Energy</td>
<td>$224</td>
<td>$235</td>
<td>$245</td>
</tr>
<tr>
<td>Constellation Energy</td>
<td>$167</td>
<td>$207</td>
<td>$183</td>
</tr>
<tr>
<td>Veteran Energy</td>
<td>$178</td>
<td>$207</td>
<td>$195</td>
</tr>
<tr>
<td>Spark Energy</td>
<td>$175</td>
<td>$250</td>
<td>$192</td>
</tr>
</tbody>
</table>

*100% renewable energy plan
4.1.5.2 Municipal Provider

As mentioned previously, the sole municipal provider in the study area is Denton Municipal Electric (DME) in Denton city. 29.5% of respondents to the survey lived in Denton and used DME. Denton Municipal Electric offers one plan at one price, and their plan is 100% renewable as of 2020. The pricing of electricity in Denton is a bit different from other providers, with a base price of $8.67 for the first 600 kWh used. This is followed by 0.06 per additional kWh consumed. When applying the price to 2000 kWh of use to estimate a monthly bill to compare to other providers, DME costs approximately $92.67 per 2000 kWh (Table 11).

<table>
<thead>
<tr>
<th>Provider</th>
<th>% of Respondents</th>
<th>Price</th>
<th>Monthly bill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denton Municipal Electric (DME)</td>
<td>29.5</td>
<td>$8.67 for first 600 kWh usage, 6¢ per additional kWh</td>
<td>$32.67, $38.31, $92.67</td>
</tr>
</tbody>
</table>

4.1.5.3 Electric Co-Operatives

Two large electric co-operatives operate in the study area, CoServ Electric Co-Operative, and TriCounty Electric Co-Operative (TCEC). However, only TriCounty Electric Co-Operative was identified as being used by survey respondents. TCEC services territories in both Denton and Tarrant Counties. Of the survey respondents, 9.1% were using TriCounty Electric Co-Operative. TriCounty Electric Co-Op only offers one plan to members, which is 0% renewable, and costs 14.4¢/kWh. When the price was applied to 2000 kWh to estimate a monthly bill to compare to other providers, the estimated monthly bill was approximately $288 (Table 12). In addition to the cost of electricity, members of TCEC pay a monthly customer fee of $18 for transmission and distribution costs of electricity (TriCounty Electric Cooperative, 2022).
Table 12: Electric Co-operative, price, and estimated bill with 1000, 1094, and 2000 kwh of usage

<table>
<thead>
<tr>
<th>Provider</th>
<th>% of Respondents</th>
<th>Price</th>
<th>Monthly bill</th>
</tr>
</thead>
<tbody>
<tr>
<td>TriCounty Electric Co-Operative</td>
<td>9.1</td>
<td>14.4¢ per kwh</td>
<td>$144 $158 $288</td>
</tr>
</tbody>
</table>

4.2 Semi-Structured Interview Results

A total of nine semi-structured interviews were conducted between July and September 2022. Of the 9 interviews, one interviewee was using an electric co-operative, four interviewees were using Denton Municipal Electric, and four interviewees were utilizing private providers. However, upon interviewing the respondent that was using an electric co-operative, they were an energy market expert and therefore an outlier when compared to other interviewees, so the results from their interview were removed from the study. Therefore, I am focusing on the eight respondents, including the four using DME, and the four using various privatized providers (Table 13). The privatized providers among interviewees included TXU, Just Energy, and Constellation. One interviewee was unsure of the provider they were utilizing since it was provided by their apartment complex. The results will be presented using pseudonyms and organized by which type of provider the interviewee used: DME or a private provider. Pseudonyms were used to protect the identity of participants.

Table 13: Provider and number of interviewees using each provider

<table>
<thead>
<tr>
<th>Provider Type</th>
<th>Provider</th>
<th>No. of Interviewees Using Provider</th>
</tr>
</thead>
<tbody>
<tr>
<td>Municipal</td>
<td>Denton Municipal Electric</td>
<td>4</td>
</tr>
<tr>
<td>Privatized</td>
<td>Just Energy</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Constellation</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>TXU</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Unsure</td>
<td>1</td>
</tr>
</tbody>
</table>
4.2.1 Denton Municipal Electric

There were four interviewees that were using DME (Mary, Amanda, Tony, and Julie). Some of the respondents to our interview who used Denton Municipal Electric were unaware of whether DME offered multiple plans or if it was 100% renewable. However, all four interviewees using DME seemed to be pleased with both the service and the price of their electricity. As stated by Mary, a DME customer:

I have a very affordable energy bill compared to the rest of my family, so yes. Something is working.

Mary was not alone in being happy with DME. Other participants cited having affordable bills during the Texas freeze and grid crash in 2021 that led many privatized providers to increase their prices. However, there were a few expressions of confusion from one participant. She was not aware that DME was 100% renewable prior to the interview. She seemed a tad frustrated that DME did not tell residents more about their electricity. When Amanda was asked about the options that she had within DME, she stated:

Again, I am not sure if I have any options when it comes to renewable energy plans because I just use Denton [Municipal Electric]. So, no, I don’t think so. I feel like Denton should tell us more about their energy.

Amanda was not the only participant who asked me questions throughout the interview process about more information about DME and what their options were. Although she was the only participant unaware that DME was 100% renewable, others were unsure about pricing (Tony and Julie). They were also unsure if there were multiple plans offered, and if they could use other providers (Julie and Mary).

4.2.2 Investor-Owned Providers

There were four interviewees that were utilizing private providers (Sara, Arya, Candice, and Jenny). None of the interviewees knew exactly which plan they were using with their
provider, and one was unaware of who their provider was (Candice). Candice was unaware of the provider she was using because she lives in an apartment complex that chooses for her. Among the interviewees using TXU, Constellation, and Just Energy, they chose the cheapest plan available, and only one had a plan with renewable energy. Both Arya and Jenny expressed concerns about fluctuating prices and made sure to choose the cheapest fixed rate. Jenny, who uses Constellation, stated:

Just the price and in terms of fluctuations just like in term of when things cost more, like inflation, when the price fluctuates because its summer and winter. If I could avoid natural gas at the same cheap price, I would go to the side of more renewables. If I could afford renewable energy, I would use it.

Arya, who was using Just Energy, expressed multiple times feeling frustrated with having so many options when it came to choosing an electricity plan and provider. She chose Just Energy because a salesman came by her door offering a cheaper plan than she was previously using, and she decided to switch over. When discussing what plan she selected when switching to Just Energy, Arya said:

I just signed up for the plan they were offering when they came by. I am not sure of the plan name. I should’ve thought more about it, but it was convenient.

As seen in the narrative of Jenny and Arya, price is a large concern amongst those in the deregulated market when it comes to choosing a provider and plan. While Jenny, Arya, and Candice seemed to be in favor of using renewable energy if it was affordable, Sara did not share the same sentiment. Sara, who uses TXU energy stated that when it came to looking for plans her concerns were:

Mainly price. We don’t really look at renewables. One thing is we don’t know much about [renewable energy], and the other thing is we can pay for renewable [energy] but is it actually renewable?
Of the eight semi-structured interviews, Sara was the only respondent who expressed concerns about the actual use of renewables. The others expressed positive sentiments with small concerns about price and implementation but never about the reliability of actually receiving renewable energy. Tony, a resident of Denton, and a customer of DME stated:

I think [renewables are] great. It would be great if everyone got their energy from renewables, that is the goal, I think. I think renewable in energy, in general, is going to take time [to be everywhere] but it’s totally worth it, I would like to see more of it.
CHAPTER 5
DISCUSSION

My results show disparities in consumers' access to renewable energy in the DFW region. The disparities mainly involve electricity provider types and their availability by location as well as differences in costs. In addition to differences in accessibility to renewable electricity, the results offer some insight into respondents’ motivations and willingness to change their energy consumption behavior. Because of this, I discuss some intervention strategies that might persuade DFW consumers to change their energy behaviors.

5.1 Comparison of Electricity Provider Types

The providers identified in this study offer a variety of different renewable options at different price points. The type of provider that consumers can choose also depends on where they live. Most respondents in this study (61.4%) use private electricity providers and, therefore, must choose which provider and plan to use and whether to use renewables at all. Private providers offer multiple renewable electricity options and a variety of different pricing options (see Table 9). Consumers who live in an electric cooperative territory or municipal utility territory may have very limited access to renewable electricity if their co-op or utility company does not offer renewable options. This is the case with TriCounty Electric Co-Operative. It does not offer a renewable electricity plan for consumers, who therefore cannot access renewables on the grid. The only renewable option for TriCounty Co-op members is to install solar panels, which is a major obstacle for renters, lower income households, and others (Phua, 2020).

However, this is not the case for residents of the City of Denton, because Denton Municipal Electric offers 100% renewable electricity. It was surprising to find that although TriCounty Electric was cheaper than some of the privatized options, it was more expensive than Denton
Municipal Electric’s 100% renewable electricity plan. However, all consumers living within Denton city limits must use renewables. Nevertheless, compared to all other providers identified in this study, Denton Municipal Electric offers the cheapest option for electricity and therefore offers customers the most affordable renewable electricity in the region (see Table 9).

This finding can inform long-running debates over how to make renewable electricity affordable and accessible, and whether privatized electricity is the best way to do this. Baker (2021) argues that when privatized companies invest in renewables, renewables become more available and, eventually, become cheaper for customers. Luke and Huber (2022) counter this by noting that for-profit electricity providers will never be able to offer the most affordable prices because of their profit motive, which limits access to renewables for people who rely on privatized providers. The situation in DFW, supports the later argument. It shows that Denton Municipal Electric provides customers with 100% renewable energy at a lower cost than other providers in the region. DME can do this because it is revenue-neutral, meaning it only charges customers for the cost of transfer and use, and does not seek profit (Denton Municipal Electric, 2023). As Luke and Huber (2022) note, since there is no push for profit, municipal-owned electric providers are less expensive than for profit electricity providers. Thus, the City of Denton can provide its residents with cheap renewable electricity via multiple PPAs with wind and solar farms around the state. It also uses its quick-start natural gas facility – or peaker plant – to match demand and keep prices from fluctuating too severely (Denton Municipal Electric, 2021). The DME model may be the best solution to providing affordable renewable electricity to the most people.

Currently, six of the twenty major cities in Texas use municipal owned providers, with San Antonio being the largest city using a public provider (Milton, 2020); however, only the
cities of Denton and Georgetown are 100% renewable (Reed, 2018). This means that in other municipal-owned territories, energy is affordable, but customers have no option to use renewables, which inhibits accessibility to renewables. Denton Municipal Electric offers the best-case scenario to customers (affordable, reliable, and renewable electricity) and can offer a model for other cities and public-utilities.

Despite Baker’s (2021) argument, for DFW residents who are dependent on the open, privatized electricity market, it is complicated to access renewables. While there were options for renewables in the free market and some private providers were affordable, none of the private options were as affordable as the 100% renewable price provided by the municipal-owned provider in this study (DME). Unfortunately, privatized providers are far more common and are widely used in Texas, with approximately 75% of households in Texas served by investor-owned electric providers (Milton, 2020).

5.2 Energy Motivations and the Intention/Action Gap

Due to the dominance of the privatized electricity market in DFW, consumer choice and motivation play important roles in peoples’ renewable electricity options. It is worth mentioning here that all consumers of privatized providers may not have a choice in their provider or electric if they are renters, but homeowners in the unregulated market do choose their provider and plan. Participants were asked what motivates them to make decisions about household electricity. The literature identifies four primary motivations for changing energy behavior: (1) concern about climate change; (2) access to cheaper energy options; (3) access to more energy efficient options; and (4) access to renewable options (Allcott & Mullainathan, 2010; Dietz et al., 2009; Attari et al., 2010; Steg et al., 2015). Table 4 shows participants responses to what motivates their electricity decisions. Most respondents selected ‘cheaper energy options’ as a very important
motivation when making electricity decisions (80.3%) and this ranked highest among all options. This is not surprising given that economic motivations are often the strongest motivation when making energy decisions (Dietz et al., 2009; Steg et al., 2015).

During semi-structured interviews, many respondents also noted that price was a main motivation for choosing an electricity provider and a plan. Most respondents (70.5%) also identified ‘access to renewable energy’ as an important motivation, which suggests that people might be willing to choose renewable energy options if they were also cheaper options. However, determining if renewable options are available may not be as easy as finding cheap options; as semi-structured interview respondents noted that they were unaware of renewable options (Sara and Candice) or did not know about potential lower price differences for renewables (Sara, Arya, and Jenny). This suggests that although private electricity providers may offer a variety of affordable renewable options, not all consumers are aware of these options. This could be related to inaccurate price perceptions (Paladino and Pandit, 2019; Fang et al., 2021), which is the perception that renewable electricity is expensive and discourages consumers from using it. However, the provider data shows that there are renewable options as affordable or more affordable than non-renewable options (Table 10).

Although it is not clear from this study whether the lack of awareness about renewable options is due to consumer inattention or to corporate intent, the lack of awareness likely contributes to the gap between intention and action (see e.g., Momsen & Stoerk, 2014; Stigka et al., 2014; Fang et al., 2021; Wall et al., 2021). One large factor driving the gap between intention and action is price perception (Paladino and Pandit, 2019) and, although not directly measured in this study, this seems to be a factor influencing the intention and action gap among the respondents. Although 80.3% of respondents stated that cheaper energy options were very
important to them and 68.3% of respondents stated price influenced their decisions about using renewable electricity, many of the respondents who chose their provider were not choosing the cheapest option on the market (Table 9 and 10).

Climate change was the lowest ranked motivation (62.3%) when compared to the others. A smaller portion of respondents identified that electricity production contributes to climate change (57.4%). Participants might not understand the link between electricity and climate change, which could contribute to why some respondents did not rank climate change as an important motivation. It also could be because people prioritized the other options over renewables. Price and access to renewable energy were the highest prioritized motivations identified by the respondents, so to increase the use of renewable energy, affordable renewable energy needs to be made more available to consumers, whether it be literal (more resources, cheaper prices, etc.) or by making these options more visible. Since there are affordable renewable options provided by some of the investor-owned providers and by the municipal-provider (DME) in this study, these options need to be made more visible and easier to access for consumers, whether it be through advertisement or other interventions, as discussed below.

Another factor identified as increasing the gap between intention and action when deciding on renewable electricity options is convenience (Momsen & Stoerk, 2014). Convenience in choosing renewable electricity options include marketing information on renewables, distrust in providers and price, hesitancy to switch providers (or “switch inertia”), and search costs involved with switching (Diaz-Rainey & Ashton, 2008; Stigka et al., 2014). All of these factors were present in the results of this study. The marketing information regarding renewable energy sources is sometimes unclear or nonexistent (Stigka et al., 2014). In this study, 50% of survey respondents stated that they were not sure if their provider offered renewable
options and only 29.5% of respondents stated that their provider promoted renewable options. This could mean that other providers poorly advertise or do not advertise renewable electricity, creating an obstacle for consumers to use renewable electricity sources (Momsen & Stoerk, 2014; Paladino & Pandit, 2019). Tellingly, in the semi-structured interviews, one DME customer, Amanda, was unaware that DME was 100% renewable, despite prominent ads, reports in local newspapers, and in monthly home flyers (see Figure 4).

Figure 4: Screenshot from DME's city page showing renewable electricity use and plan information. Retrieved from: https://www.cityofdenton.com/332/About-DME.

Distrust in providers and prices is an influential component of the intention and action gap (Paladino & Pandit, 2019). In this study, distrust in providers and prices was difficult to tease out in the survey but was apparent in the semi-structured interviews. Sara and Arya
expressed distrust that renewable sources provided by electric companies are actually renewable. Arya and Jenny mentioned distrust in price fluctuation when using renewable electricity. These misgivings might make consumers hesitant to use renewable sources over traditional sources and might hinder the transition to consumers adopting more renewables.

Hesitancy to switch to a new provider; costs associated with switching such as fees to break contracts, fees to start brand-new contracts; and time involved with finding and switching to a new provider create obstacles to choosing renewable energy (Stigka et al. 2014; Diaz-Rainey & Ashton, 2008). This became apparent in the semi-structured interviews when Arya, Sara, and Jenny who expressed feelings of anxiety when choosing their provider and plan. Sara and Jenny looked for the cheapest plan their providers offered but did little research into finding new providers with different prices and renewable electricity options. Arya chose the most convenient option when it came to a provider and expressed frustration with the process of ‘shopping’ for an electric provider. The costs and time involved in switching can cause hesitation, which leads to the intention-action gap (Diaz-Rainey & Ashton, 2008). This is because consumers are not able or willing to look for an affordable renewable plan. Other factors such as renting vs. owning, socioeconomic status, etc., play a role in consumers’ decisions (Stigka et al., 2014). However, in this study, price perception and convenience seemed to contribute more to the gap between intention and action.

To summarize, price perception, or the perception that renewable electricity is expensive and discourages consumers from using it (Paladino and Pandit, 2019), seems to be a factor influencing the intention and action gap among the respondents to this study. Although 80.3% of respondents stated that cheaper energy options were very important to them and 68.3% of respondents stated price influenced their decisions about using renewables, many of the
respondents who chose their provider were not choosing the cheapest option on the market (Table 10).

5.3 Behavior and Energy Efficiency

Energy efficiency was another important motivation for respondents (67.2%). This suggests that consumers want to reduce their household energy consumption (though it does not explain why they want to) and that they would choose to use more energy efficient appliances. The respondents were asked to rank their willingness to participate in different behaviors related to energy use (see Table 5). Participants were least willing to drive electric vehicles (44.2%), which could suggest some hesitancy to use new technologies such as EVs. However, since electric vehicles are generally expensive, and switching to an EV requires buying a new vehicle, having a charging port, etc., it may not be an option for all respondents. Approximately half of the participants were willing to use solar panels on their house (50.8%), which again reflects acceptance of using a newer technology. However, there may have been a low acceptance of solar panels in this study because 45.9% of the respondents were renters, and so installing solar panels may not be an option for respondents which impacts their willingness to consider it. A majority of the respondents (77.1%) selected that they were willing to use more energy efficient options (LED lightbulbs, smart thermostats, efficient appliances, etc.).

When discussing energy efficient options during the semi-structured interviews, most of the interviewees were already using some form of efficient energy options or appliances, and others were open to it but were renting so could not make decisions regarding which appliances to use in their homes. For the renters, many had taken other measures to try to reduce energy use, such as adding tint to windows (Arya), sealing windows and doors (Tony), or using light blocking curtains on sunny summer days (Jenny). However, most respondents were willing to
reduce overall energy consumption (78.7%). In the semi-structured interviews, all of the interviewees shared different techniques on how they reduce their energy consumption at home, including lowering thermostat settings, using lamps or windows instead of overhead lights, and using appliances such as dishwashers or washers/dryers sparsely. Participants’ willingness to reduce energy consumption is important because it offers a point of entry for different intervention approaches to affect energy consumption habits (see e.g., Beker, 1978; Katvez & Johnson, 1983; Abrahamse et al., 2007; Karjalainen, 2011; Hargreaves et al., 2013; Bertoldi et al., 2013; Handgraaf et al., 2013; Harding & Hsiaw, 2014; Burchell et al., 2016; Guo et al., 2018).

One intervention strategy is to provide information and feedback (Hutton & McNeill, 1981; Karjalainen, 2011; Carroll et al., 2014; Momsen & Stoerk, 2014; Komatsu & Nishio, 2015; Guo et al., 2018). For example, providing more information about the significance of saving energy, electricity saving tips, impacts of electricity on environmental pollution, etc. could help shorten the intention and action gap (Hutton & McNeill, 1981; Komatsu & Nishio, 2015). This requires that consumers have access to information that is impartial and gives them the proper tools to make better decisions. In DFW, where over half of the participants used private electric providers, the private actors have the responsibility to provide information, and should provide information that is personalized to each consumer and their needs. For example, this could involve creating consumer profiles and providing appropriate information to consumers based on their consumer profile (Guo et al., 2018). Information can be shared with consumers through information manuals that can be sent via mail or email, billboards, posters, commercials, etc. which can either be funded by the government (Fang et al., 2021) or providers (Momsen & Stoerk, 2014), or a combination of both.
A second intervention involves feedback that can help equip consumers with the proper knowledge and tools to reduce energy use and shorten the intention and action gap. Feedback interventions give customers personalized information about their energy consumption. Successful feedback interventions include more information on energy expenses, proportion of energy use by appliance, and consumption by neighbors (Karjalainen, 2011). Determining how often feedback is given to customers varies, but previous research shows that weekly or monthly feedback is more effective than daily or annual feedback (Carroll et al., 2014). Feedback can be provided in a variety of ways and consumers should be able to select a method that works best for them. Some channels used to provide feedback include text messages, emails, and including feedback on electricity bills (Guo et al., 2018).

Intervention strategies that target overall energy consumption should include a mix of approaches because different consumers respond differently to intervention strategies. Based on my results, interventions in DFW should focus on price, which was a consistent concern among respondents. Pricing mechanisms that make renewables more affordable is one way to address this concern (Fang et al., 2021). Another strategy to increase renewable electricity use is set the default plan to an affordable renewable plan. Momsen & Stoerk (2014) found that when renewable electricity plans were set as the default plan, 44.6% more people decided to continue to use the renewable option. Such a large increase suggests that private or public providers should consider the implementation of default renewable energy contracts as an alternative way to promote renewable energy use (Momsen & Stoerk, 2014).
CHAPTER 6

CONCLUSION

We are currently undergoing a global energy transition as more countries begin to adopt more renewable energy and reduce their emissions. The goals set by 196 nations in the Paris Agreement (2015) aim to reduce emissions by 45% by 2030 and to reach net-zero by 2050 (UNCCC, 2015). Reducing overall energy consumption and increasing the use of renewable electricity is crucial to reach these goals. Household energy consumption is responsible for ~32% of carbon emissions in the United States (EIA, 2020), so it is important that we begin to understand consumer attitudes towards and the use of renewables.

This study aimed to understand accessibility, affordability, and acceptance of renewables in DFW by asking: (1) Who access to renewable energy and how do they understand it? (2) How do electricity retailers distribute and make renewable energy available? and (3) If consumers can choose their provider, why do they select certain electricity plans over others? The results of this study revealed disparities amongst provider types, with noticeable differences between the investor-owned model and the municipal-owned model. The findings suggest that the municipal provider, Denton Municipal Electric (DME) offered the most affordable 100% renewable electricity plan. A few suggestions include more municipal-providers switching to renewable options at affordable rates, and that more cities adopt municipal-providers instead of the free market approach with hundreds of competing investor-owned providers. Further, governments should focus on making renewable energy more affordable through price policies and regulations to increase the accessibility and acceptance of renewable electricity.

The results of this study also revealed that the largest motivations among participants when making energy-decisions include price and access to renewable energy, and that consumers
are willing to reduce energy consumption and use energy-efficient options. However, the study unveiled a gap between intention and action when it comes to energy decisions that is consistent with the literature. The participants expressed wanting to use renewable energy, however only 52.9% of participants chose renewables. The survey and semi-structured interviews helped identify that misinformation or lack of information seemed to be the largest contributing factor to the intention-action gap. Providing consumers more information and/or personalized feedback are a few intervention strategies that can help target the gap between intention and action.

There were a few limitations to this study. One of the largest limitations was the low participation rate of only sixty-eight participants in the survey and nine in the semi-structured interviews. Due to the low participation in general, the demographics of the participants is not necessarily reflective of the DFW region. If the study were to be conducted again, there would be different methods that are more efficient for spreading the survey around the region and data would need to be collected over a longer period of time. One way to increase participation, is to rely less on the snowball sampling method, and more on sharing the survey and research information in public spaces such as libraries, malls, coffee shops, etc. Another way to help recruit a larger and more diverse group of participants, a small financial incentive would help increase responses (Boes et al., 2020). Another limitation to this study is the limited number of participants who belong to electric cooperatives. A repeat study would need to involve more participants from each provider type. This study could be repeated in other regions of Texas, or possibly be a state-wide study. This study could also be repeated in other states that have private and public electricity providers.

Despite these limitations, this study is the first of its kind to compare the availability, affordability, and accessibility to renewable electricity by observing different electric provider
types in Texas. The research helps inform long-running debates in energy geography over the best methods for affordable and accessible renewable electricity. It also contributes to better understandings of consumer attitudes and behaviors towards household renewable electricity use, which is crucial for a successful global renewable energy transition. It is also important for electric providers to understand consumer attitudes and acceptance towards renewable electricity and some of the suggested interventions could be used by local governments and/or providers to increase renewable electricity use. In this study, the municipal provider (DME) provides affordable and 100% renewable electricity to customers and offers a model for other municipal providers and municipalities to consider. This study also uncovered that there are misunderstandings between consumers and providers about renewable options, prices, etc. which providers could use to create better advertisements and communication with consumers. Finally, this research serves as a baseline for other studies that aim to better understand the electricity market, renewable electricity, and consumer attitudes and behaviors.
APPENDIX A

QUALTRICS SURVEY QUESTIONS
<table>
<thead>
<tr>
<th></th>
<th>Question</th>
<th>Question Type</th>
<th>Answer Choices</th>
<th>Notes</th>
</tr>
</thead>
</table>
| Q1 | Please select your gender        | M/C; please select one | 1. Male  
2. Female  
3. Other |                                                                      |
| Q2 | Please select your race          | M/C; please select one | 1. White, non-Hispanic/Latino  
2. Hispanic or Latino  
3. Black/African American  
4. Asian  
5. Native American/Alaskan Native  
6. Hawaiian Native/Pacific Islander  
7. Two or more races |                                                                      |
| Q3 | Please select your age           | M/C; please select one | 1. 18-29 years old  
2. 30-41 years old  
3. 42-53 years old  
4. 54-65 years old  
5. 65+ years old |                                                                      |
| Q4 | Estimated annual household income| M/C; please select one | 1. Less than $18,000  
2. $18,000- $25,000  
3. $26,000- $35,000  
4. $36,000- $45,000  
5. $46,000 – $55,000  
6. $56,000- $65,000  
7. More than $65,000 |                                                                      |
| Q5 | Do you have a computer in your house? | M/C; please select one | 1. Yes  
2. No |                                                                      |
| Q6 | Do you have wireless internet in your house? | Multiple choice; select one | 1. Yes  
2. No |                                                                      |
| Q7 | Are you a homeowner or renter?   | Multiple choice; select one | 1. Homeowner  
2. Renter |                                                                      |
| Q8 | What type of housing are you renting? | Multiple choice; select one | a. Apartment  
b. House  
c. Townhouse  
d. Condo  
e. Other | If ‘other’ is selected, participants can type their response in a text box. |
<table>
<thead>
<tr>
<th>Question</th>
<th>Question Type</th>
<th>Answer Choices</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q9 Are you involved in decisions about energy in your residence?</td>
<td>Multiple choice; select one</td>
<td>a. Yes  b. No  c. Sometimes</td>
<td></td>
</tr>
<tr>
<td>Q10 What County do you live in?</td>
<td>Multiple choice; select one</td>
<td>a. Dallas County  b. Denton County  c. Collin County  d. Tarrant County  e. Other</td>
<td>If ‘other’ is selected, participants are brought to end of survey since this survey is only observing these four counties.</td>
</tr>
<tr>
<td>Q11 Please select your zip code:</td>
<td>Drop down selection</td>
<td>Each zip code in County is listed</td>
<td>The drop-down selection options that participants receive correspond to the County selected in Q4.</td>
</tr>
<tr>
<td>Q12 What is primary fuel source used for your electricity?</td>
<td>Multiple choice; select one</td>
<td>a. Natural Gas  b. Coal  c. Solar  d. Wind  e. Not sure</td>
<td></td>
</tr>
<tr>
<td>Q13 Would you use renewable energy if possible?</td>
<td>Multiple choice; select one</td>
<td>a. Yes  b. No  c. I do not have a preference  d. I already use renewable energy</td>
<td></td>
</tr>
<tr>
<td>Q14 Please select ALL the renewable sources provided below:</td>
<td>Multiple choice; select all that apply</td>
<td>a. Natural gas  b. Solar  c. Wind  d. Coal  e. Biomass</td>
<td>This question is designed to assess knowledge surrounding renewable energy sources.</td>
</tr>
<tr>
<td>Q15* Do you choose your energy provider?</td>
<td>Multiple choice; select one</td>
<td>a. Yes  b. No</td>
<td></td>
</tr>
<tr>
<td>Q16* Who is your electricity provider?</td>
<td>Text entry</td>
<td>Text entry</td>
<td></td>
</tr>
<tr>
<td>Q17* Does your provider offer any renewable energy options plans?</td>
<td>Multiple choice; select one</td>
<td>a. Yes  b. No  c. Not sure</td>
<td>Denton city participants do not get presented this question. If ‘yes’ is selected, Q18 is presented.</td>
</tr>
<tr>
<td>Q18* Did you choose to use any of the renewable energy options offered?</td>
<td>Multiple choice; select one</td>
<td>a. Yes  b. No</td>
<td>If ‘yes’ is selected, Q19 is presented  If ‘no’ is selected, Q20 is presented</td>
</tr>
<tr>
<td>Question</td>
<td>Question Type</td>
<td>Answer Choices</td>
<td>Notes</td>
</tr>
<tr>
<td>----------</td>
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</tr>
<tr>
<td>Q19*</td>
<td>Do you feel that by choosing renewable energy, you are helping the environment?</td>
<td>Multiple choice; select one</td>
<td></td>
</tr>
<tr>
<td>Q20*</td>
<td>Why not?</td>
<td>Text entry</td>
<td>Text entry</td>
</tr>
<tr>
<td>Q21</td>
<td>Does the price of renewable energy influence your decision on using renewable energy?</td>
<td>Multiple choice; select one</td>
<td></td>
</tr>
<tr>
<td>Q22</td>
<td>Does electricity production contribute to climate change? If you would like to, please explain your answer.</td>
<td>Multiple choice; select one choice with text entry</td>
<td>To assess knowledge on electricity and climate change connection</td>
</tr>
<tr>
<td>Q23</td>
<td>How important are the following issues to you? a. Climate Change b. Having more energy efficient options c. Access to renewable energy d. Cheaper electricity options</td>
<td>Slider scale: participants use slider to rank importance of each issue</td>
<td></td>
</tr>
<tr>
<td>Q24</td>
<td>How likely are you to do the following? a. Use solar panels b. Drive an electric vehicle c. Use energy efficient options d. Reduce energy use overall</td>
<td>Slider scale: participants use slider to rank importance of each issue</td>
<td></td>
</tr>
<tr>
<td>Q25</td>
<td>Would you be interested in a follow-up interview to provide more information?</td>
<td>Multiple choice; select one</td>
<td>If ‘yes’ or ‘maybe’ is selected, Q26 and Q27 are presented</td>
</tr>
<tr>
<td>Q26*</td>
<td>Please enter your first name</td>
<td>Text entry</td>
<td>Text entry</td>
</tr>
<tr>
<td>Q27*</td>
<td>Please enter a good email or phone number to contact you at</td>
<td>Text entry</td>
<td>Text entry</td>
</tr>
</tbody>
</table>
APPENDIX B

SEMI-STRUCTURED INTERVIEW QUESTIONS
**Electricity Provider Information**

1) Which provider do you use and why?
   a. If an electric co-operative, did you choose to use that co-operative?
   b. Are you happy with using a co-operative?
      i. Why or why not?

2) Which electricity plan do you use and why?

3) What is your primary concern when it comes to picking an electricity plan?

4) How often do you change electricity plans or providers?

**Renewable energy**

1) How do you generally feel about renewable energy?

2) Do you consider renewable energy to be an option that is available to you?

3) Do you feel like the renewable options that you have are affordable?

4) Do you have multiple options when it comes to renewable energy plans?

5) Is there a renewable energy source you prefer? Why?

6) Do you have any concerns about using renewable energy?

**Behavior/Values**

1) Describe the size and type of housing you live in?

2) How many people live in your residence?

3) Do you use any energy efficient alternatives around your house (energy efficient appliances, smart A/C systems, LED lightbulbs, etc.)?

4) Are there other ways you try to reduce energy consumption in your household?
   a. If participant is quiet... suggest ‘using fans more instead of A/C; sealing windows; etc.)
APPENDIX C

IRB APPROVAL
**Study Details**

**IRB-22-320**  Renewable Electricity in DFW: access, distribution, and equity

<table>
<thead>
<tr>
<th>Approval Date:</th>
<th>Expiration Date:</th>
<th>Organization:</th>
<th>Active Submissions:</th>
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<td>06-13-2022</td>
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<td>Geography</td>
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<td>Admin Check-In Date:</td>
<td>Closed Date:</td>
<td>Current Policy</td>
<td>Sponsors:</td>
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<td>N/A</td>
<td>N/A</td>
<td>Post-2018 Rule</td>
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</table>
REFERENCES

Aalen, F., & Falcon, R. (2021). The history of ERCOT: How Texas became the only state with its own power grid. KXAN Austin


Boas, T. C., Christenson, D. P., & Glick, D. M. (2020). Recruiting large online samples in the United States and India: Facebook, mechanical turk, and qualtrics. Political Science Research and Methods, 8(2), 232-250.


