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Strategies Utility Managers Used to Implement Renewable Energy Technologies in the Caribbean

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Abstract

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Doctoral Study Submitted in Partial Fulfillment

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Abstract

Government officials in the Caribbean are encouraging the production of electricity from renewable energy sources to reduce the impact of high electricity rates to customers due to region's dependency on imported fossil fuel. The purpose of this single-case study was to explore the strategies electric utility managers in the Caribbean used to implement renewable energy technologies. The diffusion of innovation theory served as the conceptual framework for the study. Three managers of an electric utility in the Caribbean, who had created strategies to implement renewable energy technologies, participated in face-to-face semistructured interviews. These managers provided in-depth information on approaches used to implement these technologies. Three themes emerged from the thematic analysis of data that were collected from the semistructured interviews and document reviews: development and integration of renewable energy technologies into utility operations, avoidance of future investments in fossil fuels, and inclusion of key stakeholders in the transition to implementing renewable energy technologies. The implications for social change to the Caribbean region from a successful implementation of the technologies may include employment opportunities through the creation of new industries, eradication of energy poverty, and a healthier and cleaner environment. Also, government officials can save significant foreign exchange by not having to import fossil fuel for electricity generation and use these savings to invest in other sectors that can provide further economic and social growth for the people of the region.

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Section 1: Foundation of the Study

The Caribbean community (CARICOM) consists of 15 member states, which are islands in the Caribbean: Antigua and Barbuda, The Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, and Trinidad and Tobago (Caricom, 2013). Acting as the CARICOM Secretariat, the leaders of the member states crafted an energy policy in 2013 to ensure that all citizens of CARICOM have access to electricity and that electricity rates are stable and affordable; they also wanted to promote the use of cleaner technologies within the energy sector (Caricom, 2013). To begin the transition to cleaner technologies the Secretariat awarded a contract to Worldwatch Institutes, a research group, to develop strategies and targets for renewable energy for the region (Auth, Konold, Musolino, & Och, 2013). The recommended short-, medium-, and long-term targets for electricity generation from renewable energy sources are 20%, 28%, and 47% by 2017, 2022, and 2027, respectively (Auth et al., 2013). To reach these goals, significant investments in renewable energy technologies are required.

Background of the Problem

Several economic, social, and environmental challenges are associated with the use of fossil fuel for electricity generation; for these reasons, government officials increasingly support the use of renewable energy sources to generate electricity (Jenner, Chan, Frankenberger, & Gabel, 2012*).* Some CARICOM governments have created national policies to promote investments in renewable energy production (Auth et al., 2013). As Blechinger, Seguin, Cader, Bertheau, and Breyer (2014) noted, CARICOM

states have many renewable energy sources because of their geographic location. The popularity of these technologies is influencing change in the electricity sectors in the Caribbean.

The landscape of the electricity sector in the Caribbean region is changing as governments institute policies and targets for renewable energy production. The recommended short-, medium-, and long-term targets for electricity generation from renewable energy sources are 20%, 28%, and 47% by 2017, 2022, and 2027, respectively (Auth et al., 2013). The majority of electric utilities within the CARICOM are investor-owned and natural monopolies, which primarily generate electricity using fossil fuel (Caricom, 2013). With the introduction of policies and regulations for renewable energy, the uptake of investments in renewable energy production has resulted in demonopolization of some energy sectors in the Caribbean region (Caricom, 2013). Therefore, managers of some electric utilities are facing competition for electricity generation from other entities. The stakes are high. If managers of electric utility companies fail to generate electricity from renewable sources, they may be responsible for their companies losing up to 47% of their market share by 2027, based on the long-term renewable capacity targets set by Auth et al. (2013). In carrying out this study, I sought to identify effective strategies that managers of CARICOM electric utility companies might use in implementing renewable energy technologies.

Problem Statement

Electricity rates in the Caribbean are some of the highest in the world due to the region's dependence on imported fossil fuels for electricity generation (Shirley &

Kammen, 2013). Caribbean governments are introducing targets for electricity generation from renewable energy sources to reduce the region's dependency on fossil fuels, which account for 92% of all current electricity sources in the region (Caricom, 2013). The general business problem that motivated my research concerns the failure of some managers of CARICOM electric utility companies to implement renewable energy technologies, which is resulting in a loss of market share for electricity generation. In designing and carrying out this study, I addressed a specific business problem, which is that managers in some electric utility companies located in the Caribbean lack strategies to implement renewable energy technologies.

Purpose Statement

My purpose in conducting this exploratory case study was to explore the strategies that managers of an electric utility used to implement renewable energy technologies. Three managers, all of whom have experience with the implementation of renewable energy technologies and who all work in the same electric utility company located in one of the CARICOM member states, participated in semistructured interviews. My findings might contribute to social change in the region as a successful transition to renewable energy technologies may result in economic growth and development in the region, creation of employment opportunities, and cleaner and healthier environments.

Nature of the Study

Qualitative, quantitative, and mixed methods are three methods that researchers use to conduct research. A qualitative method allows the researcher to perform an in-

depth exploration of a phenomenon by actively engaging with participants who have experience with the phenomenon (Bansal & Corley, 2011). Using quantitative methods, the researcher examines relationships by testing theories and hypotheses using statistical methods (Marais, 2012). In a mixed method study, the researcher uses both the qualitative and quantitative method. I used a qualitative method because I wanted to provide an in-depth exploration of the strategies that electric utility managers use to implement renewable energy technologies.

Phenomenology, narrative, ethnography, and case study are some popular design strategies of inquiry in qualitative research. I deemed a phenomenological design as inappropriate because my study focus was not on the lived experience of individuals (Bold, 2012). I deemed a narrative design as inappropriate because my study focus was not on the experiences of individuals in the form of stories (Sebastian, Stewart, & Bruce, 2011). I deemed an ethnographic design as inappropriate because my study focus was not on examining the cultural interactions within an organization (Van Maanen, 2011).

I chose to use an exploratory, single-case study design for this research study. Few researchers have examined issues related to renewables and electric utilities (Richter, 2012a). For this reason, I carried out exploratory research, which, according to Yin (2014), is appropriate when there is limited information on a phenomenon. By using a case study design (with a single or multiple cases) a researcher is able to provide a rich and thick description of a phenomenon and the context in which it occurs by using multiple data collection and analysis techniques (Yin, 2014). I wanted to gain insight into the strategies managers of an electric utility use to implement renewable energy

technologies. Therefore, I deemed an exploratory, single-case study design as appropriate for this research study.

Research Question

The research question guiding this research study was the following: What strategies do electric utility managers use to implement renewable energy technologies? The participants for this research study were three managers of a CARICOM electric utility who have experience in implementing renewable energy technologies. I posed several open-ended questions to participants when I interviewed them.

Interview Questions

The interview questions were as follows:

1. As a member of the management team, why do you think this electric utility needs to implement renewable energy technologies in this utility?
2. What are some of the strategies your team is using to implement renewables energy technologies at this utility?
3. What you found to be some of the possible opportunities associated with implementing these technologies?
4. What have you found to be some of the significant challenges or barriers to implementing these technologies?
5. What strategies are you using to address these challenges or barriers?
6. How have you found the considerations for investing in renewable energy technologies to differ from those for investing in fossil fuels?
7. How have you used any lessons or observations from other implementation of

renewable energy technologies in creating strategies for implementing these technologies at this utility?

8. Based on your experience thus far, what recommendations would you give to other managers in electric utilities to assist them with creating strategies to implement renewable energy technologies?
9. What additional information would you like to share on the strategies being used to implement renewable energy technologies in this utility?

Conceptual Framework

I drew on Rogers's diffusion of innovation theory for my conceptual framework in carrying out this research study. In 1966, Rogers (2005) created the diffusion of innovation theory to explain how an innovation diffuses through a social system over time using certain communication channels. According to Rogers, several factors account for the length of time it takes for members of a social system to adopt an innovation. Rogers suggested that the characteristics of the innovation are used in diffusion research to study adoption rates by members of a social system. These characteristics include the perceived relative advantage, compatibility, complexity, trialability, and the observability of the innovation to the adopting unit. Examining these factors allows researchers and practitioners to identify the advantages and disadvantages of adopting an innovation.

Managers of CARICOM electric utilities have created strategies to implement renewable energy technologies. Their use of renewable energy technologies to generate electricity constitutes an innovation for the electricity industry and electric utilities

(Kind, 2013). I used Rogers's (2005) diffusion of innovation theory and key constructs to explore advantages and disadvantages, as well as barriers and opportunities, associated with managers' implementation of renewable energy technologies.

Operational Definitions

Feed-in tariffs: Monetary compensation for feeding electricity from renewable sources into public grids (Schaffer & Bernauer, 2014).

Fossil fuels: Fuel sources such as coal, natural gas, and oil that emit greenhouse gases during combustion. Greenhouse gases are sources of air pollution (United States Environmental Protection Agency, 2015).

Grid parity: A situation that occurs when the energy coming from the grid is more expensive than self-generated energy (Mir-Artigues, 2013).

Independent power producers: Privately owned companies whose main line of business is electricity production (Bergek, Mignon, & Sundberg, 2013).

Photovoltaic (PV): Cells made of semiconductors that directly transform sunlight into electric power (Schleicher-Tappeser, 2012).

Renewable energy: Electricity produced using renewable energy sources (United States Environmental Protection Agency, 2015).

Renewable energy sources: Resources such as wind, sun, moving water, organic plant waste, and heat that restore themselves over a short period and do not diminish (United States Environmental Protection Agency, 2015).

Renewable energy technologies: Technologies such as wind and solar power, geothermal, hydropower, and various forms of biomass that use one or more renewable

energy sources to produce electricity (United States Environmental Protection Agency, 2015).

Assumptions, Limitations, and Delimitations

Assumptions

Assumptions are things a researcher assumes to be true (Mushtaq, 2012). One assumption that I made in this study was that qualitative methodologies are appropriate for exploring the strategies that managers of an electric utility use in implementing renewable energy technologies. I further assumed that participants answered the interview questions honestly. Another assumption that I made was that participants had the relevant knowledge to answer the interview questions. In purposefully sampling managers who are experienced in the area that I studied, I am confident that I met this assumption.

Limitations

Limitations are those conditions that are beyond the control of the researcher (Mushtaq, 2012). A limitation of this study was that my findings were gained through semistructured interviews. A further limitation was that I choose to use a single-case study design. I interviewed managers who worked at one utility (in one member state). CARICOM has approximately 14 other utilities in its 14 other member states (Caricom, 2013). Had I interviewed managers working at other utilities and in other countries, I might have generated different research findings.

Delimitations

Delimitations highlight the boundaries of the study (Mushtaq, 2012). I interviewed a small sample of electric utility managers who have created strategies to implement renewable energy technologies. I also drew my sample from a single electric utility from one of the 15 CARICOM member states. The boundaries of this study were therefore limited to a small sample of utility managers and the limited geographical location of a single member state.

Significance of the Study

Contribution to Business Practice

The findings from this research study may be of value to managers of electric utility companies who have not yet created strategies for implementing renewable energy technologies. Failing to implement strategies for renewable energy production has resulted in reductions in market share and performance of electric utilities across the globe (Bergek et al., 2013; Kind, 2013; Richter, 2013a). Therefore, the results from this research study might assist managers of electric utility companies across the globe in creating strategies for renewables. If utility managers are able to create proactive and effective strategies for implementing renewable energy technologies, these electric utilities may be better able to remain and or become profitable as electricity markets become increasingly competitive.

Implications for Social Change

The successful deployment of renewable energy technologies may produce several positive implications for society. Rogers (2005) stated that successful diffusion of

an innovation usually results in social change. In the Caribbean, using renewable energy technologies in electricity production might have a positive impact on the economies of the region's countries. Electricity rates may become more stable and affordable with decreased dependence on the volatilely priced and imported fossil fuels (Shirley & Kammen, 2013). A reduction in fossil fuel imports will result in a reduction in the quantities of foreign reserves required to purchase these fuel sources (Caricom, 2013). Therefore, successful deployment of renewable energy technologies may lead to economic growth and development in countries.

Additionally, the implementation of renewable energy technologies by electric utility managers may provide Caribbean government officials with a means of eradicating energy poverty by making electricity accessible to underserved communities (Caricom, 2013). It is costly to the electric utility to install infrastructure to provide electricity to some locations within islands in the Caribbean (Caricom, 2013). A renewable energy technology such as roof top photovoltaic systems (PV) provides a means of supplying individual customers with electricity. These technologies require less capital in comparison to the assets required to generate, transmit, and distribute electricity to the customer. In addition, an unsuccessful implementation of renewable energy technologies can also create energy poverty if electric utilities are unable to stabilize electricity rates.

Electric utility managers may be able to effect social change if they are able to use strategies and successfully implement renewable energy technologies. However, the capital costs of large-scale renewable energy technologies are significantly higher than those of similarly scaled fossil fuel technologies (Vithayasricheon, Riesz, & MacGill

(2014). According to Vithayasricheon, Riesz, and MacGill (2014), due to the cost of these technologies, customers would have to pay high electricity rates if utilities radically shift to implementing renewable energy technologies. At the same time, ratepayers would continue to be susceptible to high future fossil fuel costs if managers of utilities fail to implement these technologies (Vithayasricheon, Riesz, & MacGill, 2014). Vithayasricheon et al. suggested that electric utility managers should gradually implement renewable energy technologies.

A successful transition to these technologies will also result in environmental benefits. Renewable energy technologies are environmentally friendly as these technologies use cleaner sources of energy for electricity generation than fossil fuel technologies (Smith, Kern, Raven, & Verhees, 2014). In addition, Kelly et al. (2014) noted renewable energy is associated with improved water quality. Kelly et al. noted that fossil generators require significant water for cooling and that the water used is re-circulated and can potentially have a negative impact on ground water quality. Kelly et al. stated that this could adversely affect plant and aquatic life. Therefore, if managers of Caribbean electric utility companies are able to successfully devise strategies for implementing renewable energy technologies and begin the transition to increasing use of these technologies for electricity generation, this could have a positive social impact, environmentally and economically, on all members of society.

A Review of the Professional and Academic Literature

My purpose in carrying out this exploratory single-case study was to explore the strategies that managers of an electric utility company used to implement renewable

energy technologies. My research question was the following: What strategies do electric utility managers use in implementing renewable energy technologies? CARICOM electricity markets are becoming competitive due to the introduction of policies and legislation by government officials to encourage investments in renewable energy production.

I explored the literature from the perspective of the factors influencing the rate of adoption of renewable energy technologies and highlighted some advantages and disadvantages of implementing these technologies by managers of electric utilities. I used these advantages and disadvantages to understand some of the strategies electric utility managers can use to implement these technologies. The presentation of the literature review includes a discussion on the research strategy, an argument on the unsustainability of electricity generation from fossil fuel, a discussion on the diffusion of innovation theory using research studies, an exploration of the rate of adoption of renewable energy technologies using research studies, and a summary of some possible strategies for implementing renewable energy technologies.

Research Strategy

I used Google Scholar and Business Source Premier, Science Direct, and other databases as part of my literature review search. In using these tools, I used keywords and phrases such as *electric utilities and renewable energy, diffusion of renewables, barriers to renewable energy technologies, diffusion innovation theory,* and *strategies for implementing renewable energy*. I also searched for literature on organizational and company websites.

Based on my literature review, I believe that I have an in-depth understanding of the research topic. I found few studies or literature relating to renewable energy technologies and electric utilities in the Caribbean. I do not believe that the lack of research indicates that these topics are unimportant as renewable energy is a global concern, and electric utilities around the world must replace fossil fuel technologies with cleaner technologies for electricity generation (Fernandez, Ortiz, & Bernat, 2013; Jenner, et al., 2012; Matthews, 2013). There is a plethora of literature and studies conducted across the globe on the subject of renewable energy technologies. Therefore, Table 1 summarizes the type of and the age of sources used in my literature review. Most of the sources used in this literature review are peer-reviewed and were published within the past 5 years.

Table 1

Summary of Literature Review Sources

Literature	*Total*	*%*
Peer reviewed sources	63	90
Non peer reviewed sources	7	10
Sources published within 5 years of study	67	96
Sources published more than 5 years ago	3	4

Unsustainability of Electricity Generation from Fossil Fuels

The reliance of electric utility managers on fossil fuel for electricity generation is becoming unsustainable because of the impact of fossil fuel prices on electricity rates and

negative impact fossil fuel generation has on the environment. Eight-three percent of electricity generated globally is from fossil fuels (Richter, 2012). Likewise, electric utilities in the CARICOM generate 90% of electricity from fossil fuels (Caricom, 2013). Because of their countries' dependence on fossil fuels, CARICOM residents face several environmental, economic, and social challenges.

Environmental challenges. Fossil fuels like coal, gas, oil, and nuclear energy produce greenhouse gas emissions such as carbon-dioxide which are hazardous to the environment, contribute to global warming, and also discourage sustainable growth (Bazilian et al., 2013). Although developing countries such as those found in the Caribbean do not contribute significantly to carbon dioxide emissions like large developing countries do (Masslyuk & Dharmaratna, 2013); some scientists claim that greenhouse gases affect climate change and that global weather events are more severe as changes in climate become more extreme (Weinhofer & Busch, 2012). Because the Caribbean is a low-lying coastal region, extreme weather conditions such as rising sea levels and hurricanes can result in flooding and therefore considerations for the impact of carbon-dioxide is relevant to the region (Caricom, 2013) . In addition, researchers have found evidence of other environmental impacts of fossil fuel. For example, Kelly et al. (2014) noted that fossil fuel generation requires significant quantities of water for cooling. According to Kelly et al., this water recirculates into water streams and can possibly result in air and water pollution. Therefore, the environmental impact of fossil fuel use is important to the CARICOM.

Economic challenges. The cost to purchase fossil fuel is a drain on CARICOM economies. The Caribbean community consumes more fossil fuel than it produces (Caricom, 2013). As a result, the governments of the CARICOM member states spend significant foreign reserve importing fossil fuel (Caricom, 2013). Caribbean governments recover the costs from purchasing fossil fuel on the world market through a customer fuel surcharge, which results in the region having some of the highest electricity rates in the world (Shirley & Kammen, 2013). Thus, the economic challenges associated with fossil fuels have a significant impact to the Caribbean region.

Social challenges. A social challenge facing the region is energy poverty. Even though most of the individual CARICOM member states have over 90% access to electricity, because of Haiti, 50% of the population in the Caribbean does not have access to electricity (Caricom, 2013). Haiti, which is one of the poorest countries within the Caribbean, contributes to high levels of energy poverty in the region because electricity is inaccessible to 1.7 billion persons (Caricom, 2013). Furthermore, the escalating costs of fossil fuel may contribute to even higher levels of energy poverty throughout the Caribbean region.

These economic, social, and environmental challenges associated with fossil fuel generation are growing concerns for the governments of CARICOM. To address these concerns, the CARICOM Secretariat pledged to ensure that each citizen will have access to stable and affordable electricity produced using renewable energy sources (Caricom, 2013). An increase in renewable energy production will reduce the significant drain on foreign reserves from governments' purchase of imported fossil fuels (Caricom, 2013).

However, as of 2013, only 9% of the electricity produced in the CARICOM region was from renewable energy sources (Caricom, 2013). Even though the high cost of fossil fuel continued to be a challenge to electricity consumers, electricity utility managers were not required to shift towards producing renewable energy.

Across the globe, governments are setting goals to promote investments in renewable energy within the power industry. The European Union (EU) is a leader in renewable energy investments; EU leaders are setting legally binding targets for renewable energy for each member country (Fernandez, Ortiz, & Bernat, 2013). Although the United States does not have legally binding targets for its states, governors of individual states such as California have instituted targets for renewable energy production (Electricity Currents, 2014). Similarly, lesser developed countries such as the Republic of Korea and South Africa governments have set targets for renewable energy production (Kim, Park, Kim, & Heo, 2013; Oliver, Volschenk, & Smit, 2011). Governments across the globe are setting targets to demonstrate their commitment in promoting renewable energy.

In 2012, the CARICOM Secretariat hired the Worldwatch Institute to develop strategies and targets to promote deployment of renewable energy in the region (Auth et al., 2013). Because the Caribbean region has access to so many renewable energy sources, Auth et al. recommended the following short-, medium-, and long-term goals for renewable power capacity: 20% by 2017, 28% by 2022, and 47% by 2027. To reach the region's renewable power capacity goals and to ease the burden of high electricity costs, the CARICOM Secretariat is encouraging leaders of member states to demonopolize the

energy sector and introduce mechanisms to encourage more investments in renewable energy (Caricom, 2013). In preparation, individual governments have highlighted renewable power capacity targets for their countries and are drafting legislation to encourage competition in the energy industry and allow customers to generate their own electricity (Auth et al., 2013). This activity indicates the extent of government officials' efforts to promote the production of renewable energy in the region's energy sector. Also, it demonstrates that Caribbean governments and regulators are not solely relying on electric utility companies to meet the region's renewable energy goals.

For utilities to remain competitive, managers of electric utility companies in the Caribbean need to transform their utility operations and incorporate increasing shares of renewable energy technologies into the generation mix. Most of the electric utilities in the Caribbean are monopolies (Auth et al., 2013). The successful introduction of independent power producers to electricity markets in the region may result in reduction of electricity generation and profits for these utilities. In the United States, the ability of customers to generate and sell their own electricity has resulted in financial losses for electric utilities (Duthu, Zimmerle, Bradley, & Callaham, 2014; Kind, 2013). It is likely that as Caribbean energy sectors transform to allow investments in electricity generation by other entities, managers of electric utility companies will need to find strategies to implement these technologies to remain profitable. In the next section, I discuss the theoretical framework that I used in considering this dilemma.

Diffusion of Innovation Theory

In 1966, Rogers (2005) devised the diffusion of innovation theory to describe the process how an innovation becomes communicated and accepted over time. Rogers defined an innovation as an event, process, technology, or object that is new to members of a social system. Rogers noted that there are some characteristics of an innovation that determine its rate of adoption. According to Rogers these are (a) relative advantage (i.e., the perceived degree to which the innovation is perceived to be more beneficial than the current practice), (b) complexity (i.e., the perceived ease of use and understanding of the innovation), (c) compatibility (i.e., the degree to which the innovation aligns with the existing cultural values and norms of those who adopt it), (d) trialability (i.e., the possibility of experimenting with the innovation by implementing for a limited time), and (e) observability (i.e., the degree to which the results of the innovation is visible by others).

Researchers who have studied the characteristics identified by Rogers (2005) have found that some characteristics are more widely examined by researchers. For example, Dingfelder and Mandell (2011) examined the characteristics of an innovation to understand health officials' lack of adoption of interventions for autism in public mental health and education systems. Dingfelder and Mandell focused on the relative advantage, compatibility, and complexity attributes. In another example, Yoon and George's (2013) studied organizations' slow adoption of virtual worlds. In this case, Yoon and George focused on the relative advantage and complexity characteristics as past research

conducted in the information technology field showed that these two characteristics were more significant in influencing adoption.

Also using Rogers's (2005) characteristics, Rambocas and Arjoon (2012) performed a quantitative study to examine the limited adoption of Internet banking in Trinidad. Rambocas and Arjoon excluded the observability characteristic. They stated that Internet banking is unobservable because customers perform this type of banking transaction in private. Their results indicate that relative advantage and compatibility influenced adoption; there was no evidence to suggest that complexity and trialability had any influence on adoption of Internet banking. The propensity to use the various characteristics seems to depend on the type of innovation and its context.

Kapoor, Dwivedi, and Williams (2014) performed a meta-analysis of research conducted using Rogers's (2005) diffusion of innovation theory between 1996 and mid-2011. The authors synthesized the findings of 226 studies using Rogers's five characteristics. They found that relative advantage, compatibility, and complexity influenced adoption; trialability and observability did not influence adoption. Kapoor et al. concluded that most researchers failed to use the five characteristics and focused exclusively on complexity, compatibility, and relative advantage.

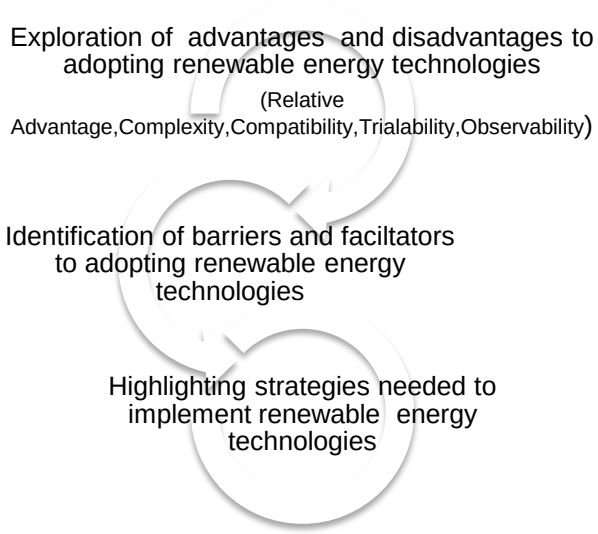

Figure 1: Use of diffusion of innovation theory to explore Strategies to implement renewable energy technologies.

Figure 1 illustrates the application of Rogers's (2005) diffusion of innovation theory to assist with the exploration of the strategies managers of electric utilities use to implement renewable energy technologies. The use of renewable energy technologies by others to generate electricity is an innovation that can disrupt the electric utility if leaders of utilities fail to embrace these technologies (Kind, 2013). Rogers's (2005) characteristics of innovation adoption allow researchers to further explore some of the possible advantages and disadvantages of the adoption of renewable energy technologies by decision makers in electric utilities. Exploring the literature and identifying some possible advantages and disadvantages should reveal some of the possible barriers and facilitators to adopting these technologies and should highlight some of the strategies electric utility managers needed to implement these technologies.

Justification of theory selection. Mustaq (2012) noted although theories contain generalizations, researchers ground academic studies in a theoretical framework to build hypotheses or concepts to guide their interpretation of study results. Researchers have used various theories to explore renewable energy adoption within fossil fuel industries and more specifically the adoption of renewable energy by electric utilities. As it is possible for more than one theory to be applicable to a study, the researcher not only needs to focus on theory alignment but also needs to consider the theory that will provide most guidance in fulfilling the study's purpose and assist with answering the research question.

For studies on fossil fuel industries and the transition to renewable energy technologies, researchers used the business model concept and the theory of disruptive innovation. Miller (2013) performed a qualitative study to examine why two large oil companies were unsuccessful in adopting solar technology using Christensen's (2006) theory of disruptive innovation. Bohnsack, Pinske, and Kolk (2014) used the business model concept to analyze the adoption of renewable energy technologies in fossil fuel industries. Huijben and Verbong (2013) used the business model concept in their study to explore the growth in renewable energy markets in Netherlands. Similarly, Richter used the business model concept to explore barriers and opportunities to adopting photovoltaic systems by mangers of German electric utilities (Richter, 2013a, 2013b). According to Richter (2012) the business model concept and the innovation theory highlights the need for changing business models for renewable energy technologies but does not provide strategies for implementing these business models. Focusing on utility business models

will narrow the scope of this explorative case study, therefore, the innovation theories and the business model concept will not be suitable for this study.

Researchers have used the behavioral concepts and theories to explore the characteristics of decision makers to explain their resistance to investing in new technologies. Bergek, Berggren, Magnusson, and Hobday (2013) used the theory of competence destroying to perform a case study to explore the challenges decision makers in incumbent organizations face with developments in technologies that make their knowledge base and business models obsolete. Shah, Palacios, and Ruiz (2013) used the concept of strategic rigidity in performing a qualitative case study to explore why decision makers of an electric utility failed to adopt renewable energy technologies. In his study, Richter (2013a) used the theory of organizational ambidexterity to examine the decision making approach of German electric utility managers towards making investments in renewable energy. Even though the cognitive abilities of leaders and their attitudes towards renewables are pertinent, focusing on behavioral attributes as barriers or facilitators to implementing renewables will limit the explorative intent of this study and will not provide enough data to explore the strategies utility leaders need to implement these technologies.

Rogers's (2005) adoption of an innovation provides a comprehensive framework to assist with exploring the strategies utility managers use to implement renewable energy technologies. However, this framework does not lack criticism. A criticism of Rogers's (2005) theory is that it does not take into consideration the human involvement in the decision making process (Kuo, Wei, Hu, & Yang, 2013). The validity of this criticism is

debatable. The behavioral or cognitive abilities of leaders are inclusive within the diffusion innovation framework; Rogers's (2005) noted that the compatibility of an innovation is the perceived degree in which the innovation aligns with the experiences of the members of the adopting unit. Additionally, researchers have used Roger's diffusion of innovation theory across various disciplines to understand the adoption or rejection of innovations (Kapoor et al., 2014). With specificity to adoption studies on renewable energy technologies, Silk, Hurley, Pace, Maloney, and Lapinski (2014) used Rogers's five attributes of an innovation, in a qualitative study, to understand various stakeholder perspectives of renewable energy initiatives to predict their likelihood of adoption. However, researchers have used other studies to examine renewable energy adoption.

For example, Viardot (2013) performed a qualitative study to examine the barriers to renewable energy adoption and to examine how electricity cooperatives are addressing these barriers to make use of renewable energy technologies for electricity generation. The theory underpinning Viardot's study was the theory acceptance model (TAM). Although other theories and models such as TAM exist to explain the adoption of technologies, Kappor et al. (2014) found that Rogers's (2005) diffusion of innovation theory incorporates the proponents of these models along with additional characteristics. Therefore, upon examination of other suitable theories, the diffusion of innovation theory was found to be most suited to this study. Rogers's (2005) proposed factors influencing the rate of adoption of an innovation provide guidelines to assists in performing a comprehensive and in-depth inquiry into the exploration of the strategies managers of electric utility companies use to implement renewable energy technologies.

Rate of Adoption of Renewable Energy Technologies

This section includes an exploration of the factors influencing the rate of adoption of renewable energy technologies. Rogers (2005) noted that the perceived attributes of the innovation determine the relative advantages and disadvantages of the innovation to the potential adopter. The process of examining the compatibility, relative advantage, complexity, trialability, and the observability of renewable energy technologies should highlight some barriers and opportunities to adopting these technologies. In creating strategies to implement these technologies, managers of electric utilities will need to find ways to reduce any barriers and operationalize on the advantages associated with these technologies. Some of the five innovation characteristics are more widely used, and few researchers have used all the characteristics to study adoption rates (Kapoor et al., 2014). Given the exploratory nature of this study, this literature presentation includes an examination of the five innovation characteristics to explore the strategies managers of electric utilities use to implement renewable energy technologies.

Relative advantage. Several factors can contribute to the relative advantage of an innovation as the potential adopter determines the degree to which they view the innovation as an improvement over current practice (Silk et al., 2014). Rogers (2005) noted that relative advantage is the most significant characteristic influencing adoption. The analysis and synthesis of research on Roger's diffusion characteristics conducted by Kappor et al. (2014) revealed a significantly positive relationship between relative advantage and adoption. Based on the literature, economic factors, market opportunities,

and business opportunities are some possible relative advantages to implementing renewable energy technologies by managers of electric utility companies.

Economic factors. There are varying debates on the economic benefits of investing in renewable energy technologies. The price of electricity is heavily dependent on the production cost of electricity for regulated electric utilities. Using renewable energy technologies to replace fossil fuel technologies in electricity production will require investments. Frankfurt School of Finance & Management (2015) reported that globally there was a 17% increase in renewable power in 2014 over 2013 figures. The renewable investment analysts also reported that the costs of renewable energy technologies are decreasing especially those of solar. The analysts also reported that the 50% decrease in fossil fuel prices between June 2014 and March 2015 is "likely to dampen investor confidence". However, the analyst indicated that as the cost of the renewable energy technologies continue to decline, solar and wind will become cost competitive with fossil fuel technologies.

There exist some agreements by academics on the future costs benefits of renewable energy technologies due to the declining costs of specific technologies such as photovoltaic systems. Reichestein and Yorston (2013) performed an assessment of the cost competitiveness of solar power for electricity generation. The results from the study indicated at the end of this decade utility-scale photovoltaic systems will be cost competitive with conventional fuel plant. Kalniņš (2011) and Matthews (2013) in their studies on renewable energy markets similarly predicted solar will be cost competitive with fossil fuels in the future.

Even though solar technologies continue to decline, some researchers have shown that investments in renewable energy technologies resulted in a negative economic impact in some countries. Marques and Fuinhas (2012) performed an empirical study on 24 European countries to examine the relationship between the use of oil, coal, natural gas, nuclear, and renewable energy sources in electricity production and economic growth. The results from the study indicated that electricity from renewable energy sources does not promote economic growth. Marques and Fuinhas noted that due to the high costs of renewable energy technologies, increasing use of these technologies generally resulted in increased electricity rates and a decline in economic activity. They further noted that increased electricity costs have an impact on the costs for producing goods or services.

In other countries, the use of renewable energy technologies for electricity generation has had proven benefits. Burgos-Payan, Roldan-Fernandez, Trigo-Garcia, Bermudez-Rios, and Riquelme- Santos (2013) performed empirical research to examine the benefits of electricity production using renewable energy technologies in Spain. The researchers found that renewable electricity production resulted in reduced market prices for electricity and increased savings from importing fossil fuel. However, Burgos-Payan et al. (2013) and Marques and Fuinhas (2013) failed to include the impact of carbon-dioxide emissions in examining the economic benefits of renewable energy production.

In some countries, there are penalties for carbon-dioxide emissions. Kalniņš (2011) performed a comparative analysis in Lativa of the electricity cost per kilowatt-hour associated with electricity production using renewable energy sources to that of

conventional fossil fuel sources. The results indicated that even with the cost of carbon dioxide emissions taken into consideration, conventional sources of energy for electricity generation are cheaper than that from renewable energy sources. As there continues to be debate about the differences in investment costs between renewable energy and fossil fuel technologies, there will continue to be investor uncertainties about the benefits of investing in renewable energy technologies.

Vithayasrichareon et al. (2014) stated that although renewable energy technologies are more expensive than fossil fuel technologies, there is a need to gradually transition to increasing use of these technologies. Vithayasrichareon et al. presented a paper to assess the value of investing in large-scale renewable generation to mitigate the impact of uncertain future fossil fuel prices, carbon prices, and electricity demand in Australia. Vithayasrichareon et al. found that if 75% of electricity generation were by renewable energy sources by 2030, there would not only be a decrease in electricity rates but also a decrease in the cost risks associated with fossil fuels and carbon emissions. However, the authors noted there is need for supportive policies to encourage investments in renewable energy, as renewable energy technologies are yet cost competitive with fossil fuel technologies. The authors noted that in the absence of these supportive policies, transitioning to increased renewable energy growth would result in high electricity rates for extended periods unless carbon emission penalties surpass the costs to invest in these technologies.

In the Caribbean, Shirley and Kammen (2013) suggested the region could derive economic benefits from investing in renewable energy technologies as the region has

some of the highest electricity rates in the world. Caribbean governments import significant quantities of expensive fossil fuels for electricity generation (Shirley & Kammen, 2013). Blechinger et al. (2014) performed an assessment of the global potential for renewable energy technologies systems for small islands inclusive of the Caribbean. Blechinger et al. (2014) found that these islands have a high presence of renewable energy sources and argued that the cost of electricity using renewable energy technologies will be less than that from fossil fuel generation. In addition, even though the region does not significantly influence carbon-dioxide emissions globally, the regional heads are also in the process of introducing emission targets (Caricom, 2013). The Caribbean regions can derive significant economic benefits by transitioning to renewable electricity generation. However, the low uptake of renewables in the region indicates that there are still some challenges and uncertainties with implementing renewable energy technologies.

Given the desired level of investment in renewable energy technologies required to begin the transition to cleaner electricity generation, globally policy makers and regulators are creating incentives to encourage investments in these technologies (Berg, 2013; Lehr, 2013; Nagar, 2011). Matthews (2013) noted that except in certain niche markets, regulatory support is still needed to encourage investments in solar. He stated that in Europe in 2011, solar photovoltaic (PV) systems received the most subsidiaries ($25 billion) in comparison to other renewable energy technologies. Rogers (2005) stated that incentives are sometimes useful to encourage adoption of an innovation.

In some countries, regulators have successfully introduced polices that have resulted in increasing investments in renewable energy production. For example, Sovacool (2013) reviewed the strategies used by Denmark in becoming 0% dependent on foreign sources of energy. Sovacool found that Denmark's regulators implementation of taxes on carbon-dioxide emissions, subsidiaries for renewable energy investments, feed-in-tariff mechanisms, and aggressive energy efficiency goals were responsible for its 0% dependence on fossil fuel. Likewise, in Germany and China, the introduction of effective policies resulted in favorable investments in renewable energy technologies in these regions (Haley & Schuler, 2011).

Researchers found that regulatory support influences investments in renewable energy technologies. Masini and Menichetti (2013) performed a mixed method study to examine how select factors influenced willingness to invest in renewable energy technologies. Masini and Menichetti's found that investors believe there is still need for effective policies to support investments in renewable energy technologies; these investments yield lower returns than investments in conventional energy systems. Also, Masini and Menichetti found investors have a strong preference for feed-in-tariffs. The results from some studies (e.g. Jacobs et al., 2013; Masini and Mencichetti, 2013) suggest that the implementation of different policies result in varying levels of renewable energy investments.

There exist research and shared experiences on the benefits of various types of policies on renewable energy investments. Garcia, Alzarate, and Barrera (2012) used economic models to analyze the effectiveness of using renewable portfolio standards

(RPS) and FITS to incentivize and encourage investments in renewable energy. The results from the study indicated that neither FITs nor RPS is capable of encouraging the desired investments in renewable energy technologies. Garcia et al. argued that implementation of RPS will result in underinvestment in conventional fuel and increased electricity prices as the investor seeks to recoup losses incurred from renewable energy investments.

Fagiani, Barquin, and Havkvoort (2013) also used economic models to determine the effectiveness of policy. In this study, Fagiani et al. (2013) examined how FITs and green energy policies encouraged investments in renewable energy technologies by risk adverse leaders of Spanish energy companies. With FITs, business owners received payments for a fixed amount of renewable electricity generated per kilo-watt-hour while with green certificates business owners received incentives for reaching desired renewable energy targets (Fagianni et al., 2013). The results from the study indicated the implementation of FITs resulted in more favorable investments and the achievement of renewable energy capacity targets compared to the results from the implementation of green certificates. The results also indicated that regulators could also use green certificates to reach desired goals for renewable energy capacity with moderately risk-averse investors.

Spanish energy companies are receiving benefits from FITS but in competitive electricity markets, utilities have to pay others for renewable generation. In Germany and New Zealand, FITs resulted in an increase in electricity rates for consumers (Morey & Kirsch, 2014; Sood, 2013). Morey and Kirsch (2014) and Sood (2013) explained that

nonrenewable customers paid higher electricity rates to allow utilities to recover costs from making FIT payments. Regulatory support is necessary to encourage investment in renewable energy technologies (Morey & Kirsch, 2014; Sood, 2013). Given the capital-intensive nature of renewable energy technologies, the effectiveness of the support is dependent on regulators implementing the correct type of policy, to minimize investor risks.

In the Caribbean, there exist some level of incentives for renewable energy production, yet only 9% of electricity generated is from these technologies (Caricom, 2013). Jacobs et al. (2013) performed an analysis of renewable energy incentives in the Latin America and Caribbean region and found there were no supporting policies promoting investments in renewable energy production in these countries. According to Jacobs et al., the rates associated with feed-in-tariffs (FITs) were unattractive to investors. Jacob et al. recommended that future research focus on examining the tariffs in other countries to provide a comprehensive understanding of the effectiveness and use of FITs in promoting developments in renewable energy production. Based on this review of literature the perceived economic advantage of adopting renewable energy technologies depends primarily on the ability of managers in electric utilities to overcome cost barriers and reduce investment risks associated with these technologies. In addition, and supported by Berg (2013), the presence of effective incentives and the absence of regulatory barriers could encourage managers of electric utilities to invest in renewable energy technologies.

Market opportunities. In some countries, there is a market for renewable electricity. For example, Delmas and Montes-Sancho (2011) found that more customers are willing to pay for green electricity as the installed capacity of renewable energy increases. Other researchers found there is a niche market for electricity supplied from renewable energy sources. For example, Oliver, Volschenk, and Smit (2011) performed a quantitative study to examine the consumers in Cape Town South Africa's willingness to pay a premium for green electricity. Using telephone interviews for data collection from a sample of 405 participants, Oliver et al. (2011) found higher income earners were willing to pay a premium for electricity.

Similarly, Kim, Park, Kim, and Heo (2013) performed a quantitative study in the Republic of Korean to examine customers' willingness to pay for renewable energy as a differentiated good to fossil fuel. Kim et al.'s (2013) sample included 495 randomly selected heads of households between the ages of 20 to 65. The results from Kim et al.'s study indicated that customers were willing to pay a premium for renewable electricity.

In Germany, Gerpott and Mahmudova (2010) performed a quantitative study to explore the level of price mark ups that customers in Germany will be willing to pay for green electricity. Gerpott and Mahmudova conducted telephone interviews with 238 key decision makers in the household between the ages of 18 and 65. The level of price markup used within the study was 0.5% to 10% on a consumer's monthly bill. The results from the study indicated that 54.3% of the participants were willing to pay a mark-up for green electricity, and 26.1% of them were willing to pay a price mark up between 5% and 10% of their monthly electricity bills.

D'Este et al. (2012) noted that the presence of market barriers deter investments in renewable energy technologies. In summary, market opportunities and considerations for the economic benefits or costs associated with producing renewable energy together influence the perceived advantage to implementing renewable energy technologies. The presence of a market for the supply of renewable electricity could encourage mangers of electric utility companies to invest in renewable energy technologies.

Business opportunities. The landscape of energy markets will transform over time with increasing developments and deployment of renewable energy technologies. Ratinen and Lund (2012) stated drivers for change in the electricity industry are because of the restructuring of electricity markets due to the introduction of government policies to liberalize the market and promote the use of renewable energy. Schleicher (2012) argued solar photovoltaic technologies would significantly disrupt and transform electricity markets in the future. The installations of customers' photovoltaic systems reduce the quantities of electricity needed from the utility (Kind, 2013). Schleicher predicted that by 2016, in Germany, it would be 40% less expensive for residential and commercial customers to own and operate a rooftop photovoltaic system than to purchase electricity from the utility. Schleicher further predicted that as captive power generation becomes cheaper customers would have the option of not having to purchase electricity from the utility.

Caribbean electricity markets are similarly transforming as Caribbean governments introduce policies to promote investments in renewables and encourage competition in the industry (Caricom, 2013). Richter (2012) noted managers of electric

utilities could ensure that utilities remain competitive by creating business opportunities from investing in renewable energy technologies and developing business models for these investments. Richter argued that electric utilities' market share would decline with increasing number of customers producing and selling their own electricity. Richter and Lehr (2013) suggested that managers of electric utility companies should not limit their investments to utility-scale renewable energy technologies but look to take advantage of the growth opportunities associated with investing in the customer-side of renewable energy technologies. Both Lehr and Richter noted that with supportive regulatory frameworks, managers of electric utility companies could change the business of models of utilities to derive opportunities from investing in the various types of renewable energy technologies. According to these authors' recommendations, electric utilities will continue to remain competitive as electricity markets transform if mangers of electric utility companies are able to harness the opportunities provided by customer-side renewable energy technologies.

The potential relative advantages to implementing renewable energy technologies to electric utilities are dependent on several factors. These factors include economic considerations for investing in these technologies such as the cost of these technologies and the resulting impact on electricity rates. However, the literature illustrates effective policy and regulations can result in positive economics for utilities adopting renewable energy technologies. In addition, based on the literature, there is an opportunity for growth and increase profitability for electric utilities if managers of these utilities are able

to develop strategies to harness the market and business opportunities associated with renewable energy technologies and reduce the risk in investing in these technologies.

Complexity. Rogers (2005) defined complexity as the perceived degree of difficulty in understanding and using the innovation by the potential adopter. Kapoor et al. (2014) found that the degree of complexity was one of the most widely used characteristics in influencing adoption. Kind (2013) described renewable energy technologies as disruptive and radical innovations that will pose significant challenges to electric utilities. Electric utility professionals have significant knowledge and expertise in fossil fuel technologies and will need to develop similar experience in renewable energy technologies.

Depending on the capabilities of the incumbents, gaining knowledge and expertise in innovations need not pose significant challenges. Bergek et al. (2013) performed a case study on the automobile industry and the potential disruptor of electric vehicles, and the gas turbine industry and the potential disruptor of micro turbines, to illustrate how disruptive and competence-destroying innovations were unsuccessful. Bergek et al. showed that that some companies have the ability to adopt new technologies and continuously improve existing capabilities and knowledge while producing new products and services. To transition to increasing renewable energy technologies will take time. Until such time, professionals in the electric utility field will need to build experience and knowledge in renewable energy technologies while maintaining their capabilities in operating fossil fuel technologies.

Masini and Menichetti (2013) stated there is a lack of research on the impact of non-financial behaviors on the decision to invest in specific renewable energy technologies. The results of Masini and Menichetti mixed study showed that lack of investors' knowledge of the operations of renewable energy technologies is a barrier to investing in these technologies in Europe. The results also showed that knowledge of the operational context of renewable energy technologies is associated with a higher share of investments in these technologies. Ratinen and Lund (2014) performed a case study to examine the growth strategies of electric utilities in Denmark, Spain, Finland, and Germany. Like Masini and Menchetti (2013), Ratinen and Lund (2014) found that inexperience with renewable power generation was one of the contributing factors to the slow rate of renewable energy technologies adoption amongst the utilities.

Further research suggests that utilities' failure to overcome knowledge barriers could have financial implications. Shah, Palacios, and Ruiz (2013) performed a case study to explore mangers of electric utility companies' rigidities to adopting renewable energy technologies. Shah et al. (2013) sought to examine what contributed to Iberdola's failure to maintain competitive advantage in renewable developments. The results from the study showed that the managers of the largest renewable energy developer and utility in Spain failed to embrace and gain knowledge in other renewable energy technologies. Shah et al. argued that utility professionals having gained expertise and competitive advantage in mature technologies are usually resistant to adopting other technologies.

Fossil fuel technologies are mature technologies to utility industries. The complexity due to the lack of knowledge in operating renewable energy technologies can

act as a barrier to implementing these technologies. To overcome this barrier, managers of electric utilities can employ the suggested strategy by Richter (2013a) and Shah et al. (2013) and form partnerships with other entities that have expertise in renewable energy technologies. If electric utility managers are able to form these partnerships, this will provide managers with a strategy to ensure that utility personnel gain knowledge and build expertise in renewable energy technologies.

Compatibility. The compatibility of an innovation is the perceived degree to which the innovation aligns with the past experiences, value system, and needs of the potential adopter (Rogers, 2005). Kappor et al. (2014) research showed that the more compatible an innovation is the more likely the adoption. It follows that the value system and past experiences of managers of electric utility companies influence their behavior towards investments in renewable energy technologies. Researchers have shown that the innovativeness of decision makers and their mindset toward radical innovations, such as renewable energy technologies, and the business sector in which the organization operates can retard the rate of decision-making (D'Este et al., 2012; Ganter & Hecker, 2013; Laforet, 2013). Rogers (2005) noted the need for an innovation may have some influence over the decision to adopt these technologies. Therefore, if managers of electric utilities foresee renewable energy technologies can meet the needs of the organization, this may influence their decision and mindset towards these technologies and encourage them to develop strategies to implement these technologies.

Need for cheaper and cleaner generating technologies. Niles and Lloyd (2014) studied the impact of peak oil prices and climate change on the Caribbean. Niles and

Lloyd found that there is an urgent need to transition to the use of renewable energy technologies to generate electricity, to reduce the dependency on fossil fuel technologies, and to reduce the impact of the highly volatile fuel prices on the economic activities of these countries. Electricity rates in the Caribbean region are some of the highest in the world (Shirley & Kammen, 2013), so there is a need in the Caribbean for cheaper and more stable electricity rates.

Despite the debates on the economic benefits of adopting renewable energy technologies, there is a consensus as it relates to the cleanliness of using these technologies in comparison to fossil fuels. The Caribbean governments support the need for cleaner technologies in electricity generation (Caricom, 2013). In contrast to using fossil fuel technologies for electricity generation, renewable energy production does not result in emissions that adversely affect air quality or have a negative impact on human health (Smith, Kern, Raven, & Verhees, 2014). Even though electric utility managers may understand the economic and environmental challenges associated with fossil fuel use for electricity generation, these managers have the choice of replacing fossil fuels with other cleaner and cheaper technologies than renewable energy technologies.

Another alternative fuel source for electricity generation is natural gas. Natural gas technologies are cheaper than renewable energy technologies and cleaner than fossil fuel technologies (Severance, 2011). However, Severance noted that natural gas depletes like fossil fuels, and thus using natural gas for electricity generation will be a short-term solution for electric utilities. Therefore, using renewable energy technologies provide a

longer-term solution to address the economic and environmental challenges associated with fossil fuel generation.

Renewable energy technologies provide a solution to the issue of energy poverty in Haiti and the CARICOM Secretariat's goal to eradicate energy poverty by providing all citizens with access to affordable electricity (Caricom, 2013). Ruggiero, Onkila, and Kuitten (2014) similarly supports that developments in renewable energy provides a solution to eradicating energy poverty. Therefore, the need to implement renewable energy technologies extends beyond the environmental and economic challenges fossil fuel use brings and extends to the social opportunities these technologies can fulfill.

Electricity is a commodity, therefore, the society commonly share in the need for cheaper and cleaner technologies for electricity generation. Given the commonality of this goal, research has shown that stakeholder engagement is key to developments in renewable energy (Batel & Devine, 2014; Martin & Rice, 2015; Ruggiere, Onkila & Kuitten, 2014). Batel and Devine (2014) illustrated the importance of understanding people's response to renewable energy technology. Martin and Rice (2014) showed the importance of engaging with stakeholders in planning the implementation of renewables. Ruggiere, Onkila, and Kuitten (2015) showed the need to involve stakeholders and create champions for renewable developments. Electric utility managers also need to be aware of the role of stakeholders in the transition to providing affordable electricity rates using renewable energy technologies.

Value systems and past experiences. The characteristics of the electricity sector could be a potential change barrier. Worch, Truffer, Kabinga, Eberhard, and Markard

(2013) proposed a capability framework to explain the deficiencies in performance of electric utilities. Worch et al. (2013) used the characteristics of infrastructure sectors to illustrate the difficulty managers in this sector experience in diversifying the core business activities of the organization. According to Worch et al., these sectors have capital-intensive assets with long payback periods, and the specificity of the assets make them unusable for other purposes. Additionally, these sectors provide basic services, which cannot be easily withdrawn, and usually have to meet political and regulatory objectives. Worch et al. concluded that because of these characteristics capability gaps would emerge due to changes in policies, introduction of new technologies, or shifts in regulations.

Based on the research conducted by Worch et al. (2013), it is reasonable to assume that managers of electric utilities are uncertain about adopting renewable energy technologies. However, regulators and policy makers are demonstrating their commitment to transforming the electric industry by continually instituting goals and policies to encourage investments in renewable energy technologies (Caricom, 2013; Helm, 2014; Schaffer & Bernauer, 2014). As stated by Wustenhagen and Menichetti's (2012) the choice to invest in renewable energy technologies is strategic with far reaching implications.

Wustenhagen and Menichetti (2012) noted that researchers examining what drives investments in renewable energy technologies usually exclude cognitive factors such as prior investment experience. Wustenhagen and Manichetti suggested that cognitive factors such as path dependence could influence decision-making. Therefore, some

managers of electric utility companies accustomed to investing in fossil fuel generation may find it challenging to switch towards investing in renewable energy technologies. These managers may perceive the risks in investing in renewable energy technologies as higher and continue to see opportunities in fossil fuel investments.

Some researchers have examined the influence of a priori beliefs on renewable energy investments. For example, Masini and Menichetti (2012) performed a mixed method study to examine how a priori beliefs in renewable energy and technological risk attitude influences willingness to invest in renewable energy technologies, and the impact this has on the performance of the investment. Masini and Menichetti conducted a series of interviews with industry experts and generated a set of hypotheses for econometric analysis. The results from the study highlighted that higher shares of renewable energy technologies in the investment portfolio resulted in investors' higher propensity to invest in a radically new technology. The results also indicated that investors' a priori beliefs have a positive influence on their willingness to invest.

Some managers of electric utility companies have made the decision to implement renewable energy technologies but path dependencies and a priori beliefs have influenced their selection of the type of investment: utility-scale, combination of utility-scale and customer-side. Richter (2013b) proved that German utility managers experienced difficulties understanding the opportunities associated with investing in customer-side renewable energy technologies. Managers of German utility companies reported similarities in the decision-making for utility-scale renewable energy technologies and fossil fuel investments (Richter, 2013b). Richter concluded that customer-side renewable

energy investments required a significant change in business logic and thinking by managers of electric utility companies in Germany.

In Germany, managers of electric utilities continue to lose market share by refusing to change the utility business models while competitors successfully enter these electricity markets with customer-side renewable energy business models (Richter, 2013a). Koen, Bertels, and Elsum (2011) sought to understand why established firms, which dominate a market, allow other companies with business model innovations to acquire market share or limit their growth. Koen et al. (2011) found that business model innovation requires a new value network. The perceived degree in which investing in renewable energy technologies aligns with the past experiences, value system, and needs of the electric utility is dependent on the behaviors of managers of electric utility companies towards these investments. According to Richter (2013b), managers of electric utilities should form new business units to overcome the challenges that past experiences may pose on implementing these technologies. Richter noted that these business units should be separate from the fossil fuel operations of the utility; managers of these units should focus on creating business models and strategies to operationalize on these technologies.

Observability. Observability is the degree in which the experiences and results of an innovation is visible by others (Rogers, 2005). Past innovation researchers have often found the observability to be insignificant to adoption or non-applicable to the study (Kappor et al., 2014). In the context of CARICOM electric utilities, given the capital-intensive nature of the renewable energy technologies coupled with limited (9%) installed

renewable generation capacity in the region (Caricom, 2013), the observability factor is worth exploring in this study.

The few studies found on electric utility leaders' experience with implementing renewable energy technologies indicated mixed results. For example, Huijben and Verbong (2013) found that there continues to be growth in photovoltaic (PV) markets despite the effects of the global recession and subsidiary cuts for renewable energy production in Netherlands. Huijben and Verbong performed a qualitative study to examine the reasons contributing to growth in PV markets in Netherlands. The results from the study indicated that customer-owned renewable energy business models in which utilities are in the business of selling, installing, and monitoring customer PV systems were responsible for the growth. In this study, the managers of electric utilities adopted and implemented renewable energy technologies and successfully changed their business models. These managers were able to operationalize on the growth opportunities offered by these technologies.

Some managers of electric utility companies have successfully implemented renewable energy technologies without significantly changing the utility's business models. Richter conducted a series of studies on German utility managers and their barriers to implementing renewable energy technologies (Richter 2013a, 2013b). In 2012, German utilities accounted for 80% of the country's electricity generation and only 3% of the PV market (Richter 2013a). Richter (2013a) conducted a qualitative study to explore the threats and opportunities of distributed photovoltaic systems for electric utilities in Germany by interviewing 20 utility managers. The results from the study indicated

managers of electric utilities were willing to invest in large-scale renewable energy technologies but did not see any opportunities or threats associated with investing in customer photovoltaic technologies. Unlike the managers of electric utilities in Netherlands, although experiencing a decline in market share, German utility managers saw no opportunities in changing their utilities' business models by investing in customer-side photovoltaic systems.

There may be some technical limitations to observing the impact of implementing renewable energy technologies in regions outside the Caribbean. Electricity from renewable energy sources are intermittent, Germany and other utilities within the United States have the benefits of accessing electricity from other states due to grid interconnections. Unlike electric utilities in larger countries, there are no interconnections between Caribbean utilities. One of the Secretariat's goals is to interconnect electricity grids in the Caribbean region (Caricom, 2013). The low uptake of renewables in the Caribbean makes it difficult for managers of electric utilities to draw on the experiences of other member states, in implementing renewable energy technologies. Therefore, in developing strategies to implement renewable energy technologies managers of electric utility not only need to consider the lessons learned from other utilities but need to develop strategies suited to the context in which the utility operates.

Trialability. Trialability is the degree in which a potential adopter can experiment with an innovation for a limited time (Rogers, 2005). Kappor et al. (2014) found that trialability is another attribute receiving limited attention from researchers. Rogers (2005) noted that trialability reduces uncertainty in an innovation. Rogers also noted that in some

cases it might not be possible to try an innovation, which is the case with renewable energy technologies. Depending on the innovative nature of the potential adopter, Rogers also noted that the technical inability to try an innovation could influence the decision to adopt an innovation.

Electricity is a commodity (Ratinen & Lund, 2012). Traditionally, managers of electric utility companies focused on maintaining a reliable and stable electricity supply. Thus managers of electric utilities tend to invest in products and technologies that are mature and proven (Shah et al., 2013). Therefore, the inability to experiment with renewable energy production, primarily due to the high capital costs of renewable energy technologies, may influence the time it takes managers of electric utilities to develop strategies to implement these technologies.

Literature Review Summary and Potential Study Themes

Based on the literature there exist some advantages and disadvantages to adopting renewable energy technologies. An exploration of the -relative advantage, complexity, compatibility, trialability, and observability of renewable energy technologies have highlighted some potential barriers and facilitators to adopting these technologies. There should therefore be a link between these barriers and facilitators and the resulting strategies mangers of electric utility companies use to implement these technologies.

Assessing barriers is typical of organizations adopting an innovation; D'Este et al. (2012) performed a quantitative study to examine the relationship between firms' engagement in innovation and their assessment of the barriers to innovation. D'Este et al. assessed four types of barriers: cost, knowledge, market, and regulation barriers. In their

survey of 16,445 firms within the European Union, these authors found that regardless of the innovativeness of the firm, cost and market related barriers deterred engagement in innovation activities. In this literature review, cost, market, regulation, and knowledge factors emerged as some possible barriers and facilitators to adopting renewable energy technologies.

Some potential themes for this research study include strategies to reduce the complexity of renewable energy technologies by gaining knowledge and expertise in these technologies, strategies to ensure that renewable energy technologies are compatible with the operations of the utilities, and strategies to reduce the risk in investing these technologies and commercialize on the growth opportunities provided by these technologies. Managers of electric utility companies could also use the lessons learned from other utilities to assist with creating strategies to implement renewable energy technologies but need to consider the context in which these electric utilities operate. Additionally, these strategies and the lessons learned from observing other utilities should reduce any uncertainties mangers of electric utilities have because of the inability to experiment with these technologies.

Transition

In Section 1, I identified a specific business problem that some managers of electric utility companies in the Caribbean lack strategies to implement renewable energy technologies. The purpose of this exploratory single-case study was to explore strategies managers of a Caricom electric utility used to implement renewable energy technologies. The overarching research question was as follows: What strategies can managers of an

electric utility use to implement renewable energy technologies? To reduce the burden of high-energy costs in the region, inter alia, the CARICOM Secretariat has set a regional goal of 47% of electricity generation from renewable sources by 2029. In addition, the Secretariat is encouraging investments in renewable energy by other entities than utilities and encouraging its members to demonopolize the power industries. Therefore, the findings from this study may assist other managers of electric utilities with creating strategies to implement renewable energy technologies to ensure that the utility remains profitable.

The conceptual framework for this research study was Roger's diffusion of innovation theory. The constructs of Roger's theory provided a comprehensive framework to explore strategies utility managers used to implement renewable energy technologies. An examination of the relative advantage, compatibility, complexity, trialability, and observability of renewable energy technologies highlighted some possible barriers and opportunities to adopting these technologies. These barriers and opportunities revealed some possible strategies managers of electric utility companies could use to implement renewable energy technologies, resulting in some potential themes for this research study. This study filled the gap of research on the strategies some managers of Caribbean electric utilities use to implement renewable energy technologies.

Section 2 includes information on the role of the researcher, description of the participants, and justification of the research method and study for this research study. This Section also includes a description of the population and sampling, information on conducting ethical research, discussion on data collection and analysis procedures, and

concludes with a discussion on reliability and validity. Section 3 will include a presentation of findings and the application for professional practice. It will also include information on implications for social change, recommendations for action and further research, reflections, conclusion, and appendices.

Section 2: The Project

In this section I discuss my research design and procedures for collecting quality information for this study. I restate my purpose statement, discuss my role as researcher, and justify my selection of a qualitative method and exploratory, single-case study design for this research. I also describe my study population and sample, commitment to performing research in an ethical manner, data collection instruments and techniques, data analysis procedures, and strategies for achieving reliability and validity within this research study.

Purpose Statement

My purpose in conducting this exploratory case study was to explore the strategies that managers of an electric utility used to implement renewable energy technologies. Three managers, all of whom have experience with the implementation of renewable energy technologies and who all work in the same electric utility company located in one of the CARICOM member states, participated in semistructured interviews. My findings might contribute to social change in the region as a successful transition to renewable energy technologies may result in economic growth and development in the region, creation of employment opportunities, and cleaner and healthier environments.

Role of the Researcher

I strove to design and follow a structured and defined process in collecting and analyzing data. In qualitative research, the researcher plays a role in the process because the researcher is the main instrument of data collection (Bansal & Corley, 2011). My

decisions influenced the quality of the research conducted. In this research study, I adhered to the Belmont report and maintained a high standard of ethical conduct to ensure that my research did not cause harm to my participants.

I work as an engineer at a Caribbean electric utility company. Several managers of electric utility companies within the Caribbean, including the utility at which I work, are in the process of devising and implementing strategies for renewable energy technologies. However, I am not a member of the management team involved in creating these strategies. My work related to this topic has been limited to providing engineering expertise to assist with the implementation of these technologies at the utility.

Pettigrew (2013) noted that qualitative researchers have a significant influence over the research process and should articulate their biases and experiences. Chenail (2011) also observed that researchers may introduce personal biases to a study if they have some affinity with the participants or are members of the study population, as these biases could limit the scope of inquiry. To eliminate any personal biases that may have arisen from studying my workplace, I chose to study an electric utility company other than the one for which I work and located in a different Caribbean country. However, I must note that I have a working relationship with some of the participants in this research study. The companies at which my participants and I respectively work are owned by the same parent company.

I used several strategies to mitigate the impact of any personal biases I have on data I collected and analyzed. I used an interview protocol (see Appendix A) as a tool to assist with reducing biases and achieving consistency when performing interviews. An

interview protocol is a comprehensive instrument that researchers use to assist with data collection (Jacob & Furgerson, 2012). The protocol included interview questions along with procedural guidelines, which assisted me in conducting the interview from the beginning to end. To further minimize bias and to ensure accurate documentation of participant responses, I audiotaped interviews and transcribed verbatim. Collectively, these strategies helped me to mitigate personal biases that I may have added to this research study.

Participants

Participant selection is a key and complex component of the research process (Reybold, Lammert, & Stribling, 2012). Researchers form conclusions from the data collected from participants and therefore participant selection can greatly influence the quality of the study (Reybold et al., 2012). O'Reilly and Parker (2012) noted that the qualitative researcher aims for data richness and therefore the researcher needs to select participants who can provide the necessary information to assist them with adequately answering the research question. Another critical criterion that influences the rigor of qualitative research and involves participants is data saturation, the point at which there is diminishing returns in collecting more data (Marshall, Cardon, Poddar, & Fontenot, 2013). To ensure alignment with the research question, I only selected participants who were managers and who had experience creating strategies to implement renewable energy technologies in an electric utility.

After identifying my case site, I wrote a letter to the managing director of the utility and received permission to use the utility for my study (see Appendix B). I

outlined by participant selection criteria and the managing director provided a list of possible participants for this study with their email addresses. I then emailed potential participants and asked them to volunteer to participate in this research study. The email included information on the purpose of the study and indicated to participants that the face-to -face interviews would take between 45 to 60 minutes in duration. I set this time limit following Walker's (2011) advice for gaining the participation of busy executives (i.e., to explain the purpose of the research and to limit interview time to one hour). I attached a copy of the consent form (see Appendix C) to the email and referenced to assure the participants of the confidentiality of the research process. Additionally, I informed participants that their participation might benefit managers of other Caribbean electric utilities as I intend to share the findings of the study by writing an article for the Caribbean Association of Electric Utilities (CARILEC) magazine.

Research Method and Design

Research Method

After considering the three research methods (quantitative, qualitative, and mixed methods), I deemed qualitative methods as most appropriate for my research study. A quantitative researcher uses statistical methods to explain and, sometimes, predict the occurrence of a phenomenon (Marais, 2012). However, statistical predictions do not allow the researcher the opportunity to engage with participants to gain their perspectives on a phenomenon (Bansal & Corley, 2011; Petty, Thomson, & Stew, 2012a). My intention in conducting this research was to gain rich and in-depth insight about the strategies that managers of electric utility companies use to implement renewable energy

technologies. Given that the focus of my study is to add insight into as opposed to predicting the outcome of a phenomenon, this discount the suitability of the quantitative method in fulfilling the research purpose. Because I deemed quantitative methods as inappropriate for my study purpose, I decided not to use a mixed method approach, which is based on the use of both quantitative and qualitative methods (Azorin & Cameron, 2012).

The qualitative researcher plays an integral role within the research process. The role of the qualitative researcher is to engage with participants who experience the phenomenon. The researcher and participant together construct the reality of the phenomenon under study (Petty et al., 2012a). Additionally, the qualitative researcher uses a variety of data sources in order to understand the phenomenon under study (Bansal & Corley, 2011). Researchers conducting studies on utilities and renewable energy technologies have employed qualitative methods (Huijben &Verbong, 2013; Ratinen & Lund, 2014; Richter 2013a, 2013b). Because I wanted to perform an in-depth exploration of the strategies managers in a Caribbean electric utility use to implement renewable energy technologies, I chose the qualitative method.

Research Design

Petty, Thomson, and Stew (2012b) defined research design as a strategy of inquiry, which follows a particular process. I chose an exploratory single-case study design to identify the strategies that managers of an electric utility use to implement renewable technologies. A case study allows for an in-depth exploration of a contemporary phenomenon within its context (Taylor, Dossick, & Gavin, 2011). A case

study design allows a researcher to use multiple sources to data collection such as interviews, document reviews, archival records, observations, participant-observation, and physical artifacts to explore a phenomenon (Yin, 2014). I used interviews and document reviews to collect data for this research study.

Three primary types of case studies are exploratory, descriptive, and explanatory. A descriptive case study was inappropriate for this research study as the focus of this study was not to describe a phenomenon (Yin, 2014). An explanatory case study was inappropriate, as the focus of this research study was not to explain the causal relationships of a phenomenon (Yin, 2014). An exploratory case study was most appropriate, as the focus of this research study was to gain new information and insight into a phenomenon (Yin, 2014). According to Richter (2013a), research in the field of renewables and electric utilities is in the infancy stage. Therefore, by using an exploratory case study, I was able to generate information and gain insight into the strategies those managers of a Caribbean electric utility use to implement renewable energy technologies.

Researchers can either choose to study a single or multiple cases to explore a phenomenon (Baxter & Jack, 2008). In deciding to use a single case, the researcher must be able to gain an in-depth understanding of the phenomenon (Baxter & Jack, 2008). Baxter and Jack (2008) recommended that researchers using a single case design select a unique or extreme case to ensure that there is enough information to fulfill the purpose of the research. I selected this single case for this research study because of the environment in which the managers of this electric utility have created strategies for implementing

renewable energy technologies. The country in which this utility operates does not have a strong regulation governing electricity provision. It also lacks incentives for implementing renewable energy technologies. Yet, managers of the utility are focused on implementing renewable energy technologies. Studying the strategies managers of this single electric utility use to implement renewable technologies provided rich and in-depth information, which assisted with answering the research question.

In deciding on a case study design, I opted not to use other common qualitative research designs, including phenomenology, ethnography, and narrative analysis. A phenomenological researcher studies the lived experiences of persons (Sebastian et al., 2011). A phenomenological researcher seeks to understand the meaning that participants give to an experience (Grossoehme, 2014). A narrative researcher studies the experience of an individual (Bold, 2012). The narrative researcher seeks to understand or explore a phenomenon by using the stories told by a participant about themselves and their experiences with the phenomenon (Paschen & Ison, 2014). An ethnographic researcher studies the culture of groups (Van Maanen, 2011). The ethnographic researcher often uses participant observations to collect data and to experience the culture of the group (Longhofer & Suskewicz, 2014). If I had studied the culture or lived experiences of these utility managers it would not have provided insight into the strategies that managers of electric utilities use to implement renewable energy technologies. The unsuitability of these other designs made the case study more appropriate for this study.

Walker (2011) defined saturation as a tool that researchers can use to ensure that they collect adequate and quality data. Data saturation occurs when no new themes or

information emerges from the research (Marshall et al., 2013; O'Reilly & Parker, 2012). I conducted semistructured interviews, performed document reviews, and performed follow-up interviews as part of my data collection and verification and clarification procedures until no more themes or new information emerge.

Population and Sampling

My study population consisted of electric utility managers with experience implementing renewable energy technologies. I interviewed a management team comprised of three managers, all of whom have created strategies for implementing renewables at the electric utility at which they worked. After obtaining permission to conduct this research study at the utility (see Appendix B), I emailed the Managing Director and obtained the list of managers who have created strategies for implementing renewables at the utility. All the potential participants were above 18 years of age. I used a purposeful sample to choose participants. Purposive sampling is the strategy of achieving the best fit data to answer the research question, making best use of resources, and completing the study with resources available (Reybold et al., 2012). In purposive sampling, the participants selected have information that is relevant to the study (Petty et al., 2012b). The sample for this research study was the three managers who have created strategies to implement renewable energy technologies within a single electric Caribbean utility.

Selecting a sample size hinges on the need to reach data saturation, the point at which there is diminishing returns in collecting more data (Bowen, 2008; Marshall et al., 2013). Marshall et al. argued that although sample size is a quality indicator, the

determination of an adequate sample size in qualitative interviews appears to be arbitrary. O'Reilly and Parker (2012) argued that the point of saturation is not necessarily applicable to qualitative research and that sample size determination should not be based on quantity but on depth and breadth of data. Similarly, Bowen (2008) added participants who have the best knowledge to provide the depth and breadth of information to answer the research question should determine the sample size. This purposeful sample of three electric utility leaders have experience in creating strategies for implementing renewable energy technologies and were able to provide relevant and pertinent data which assisted with answering the research question.

Some researchers have been able to reach saturation with a small sample size. For example, Moola, Fusco, and Kirsch (2011) performed a grounded theory study to examine the perceptions of caregivers toward physical activity and health in youth with congenital heart disease. Moola et al. (2011) were able to reach data saturation in seven interviews from their sample of seven participants. However, Walker (2011) posited that achieving saturation is specific to the qualitative method. There was no guarantee that this approach worked for a case study.

Walker (2011) showed that researchers have reached saturation with varying sample sizes and quantities of interviews depending on the type of qualitative methodology. Using a case study design Callary, Worthner, and Trudel (2013) and Bouges (2013) were able to reach data saturation with less than four participants. Bouges used a combination of semistructured interviews, archival records, and member checks to reach data saturation; Bouges had three participants in his doctoral study. To reach data

saturation with one participant, Callary et al. (2013) used four semistructured interviews and member checks. To reach data saturation in this research study, I performed semistructured interviews, transcribed audio recordings, interpreted the transcripts and produced a summary for each interview question, and corroborated information from transcripts with information from reviewing documents until no new information or themes emerged. I reached data saturation after performing the third semistructured interview.

I choose to travel to conduct face-to-face interviews with these participants. Travelling to these participants provided me with the opportunity to gain access to documentation that provided information, which assisted with conducting the study, which would have been difficult to access otherwise. Also given the potential participants were all busy executives, guided by Harvery (2011), I conducted the face-to-face interviews lasting no longer than 60 minutes in a conference room at the utility. Jacob and Fergusson (2012) and Doody and Noona (2012) recommended that researchers conduct interviews in a quiet and private location to minimize distractions, to allow for clear and audible recordings on the recording device, and to ensure data confidentiality during data collection.

Ethical Research

It was important that I maintained ethical conduct while conducting research to protect the rights of the participants and I have completed ethical training by the National Institute of Health. I received permission to conduct research at the utility and had access to the participants (see Appendix B) and all participants were over the age of 18 years.

There was no conflict of interest with the participants, as none of the potential participants was my subordinates. Jacob and Fergusson (2012) noted that a researcher should not conduct research without acquiring consent from participants. Jacob and Fergusson added that using consent forms helps to build trust between researcher and participants, as the consent form is a written affirmation and indication on the confidentiality of the research process.

After receiving approval from the Walden Institutional Review Board (IRB), I emailed participants requesting their permission to take part in the study. The consent form (see Appendix C) was attached to the email and participants were informed that they could contact me via email or telephone to discuss or ask any questions pertaining to the contents of the form. Given that I travelled to these participants, participants were informed that they could indicate their willingness to participate in the study by responding to the email stating, "I consent to participate in this research study". Interviews were conducted after receiving consent from participants. I informed participants that they were free to withdraw from the study at any point of time during data collection and that their decision will not negatively affect our working relationships. Additionally, participation in this study was voluntary and there were no incentives offered to participants.

Whiting (2007) noted that the ethical researcher maintains strictest confidentiality by ensuring there is no link between the participant's identity and the data they provide. The measures used to protect the identity of participants and the organization was explained to each participant. To maintain confidentiality, I replaced the participant

names with codes P1, P2, and P3 and used the generic term “electric utility” to refer to the organization. To similarly protect the confidentiality of participant data, Whiting recommended that the researcher include a strategy to destroy all interview transcripts and recordings on completion of study. I have stored audio recordings and transcripts in a password-protected database on my computer and printed data have been stored in a locked container at my residence. After five years, all printed data will be shredded and discarded; all audio recordings, transcripts, and other interview data will be deleted from my computer.

Data Collection Instruments

The researcher is the main instrument of data collection in qualitative research (Bansal & Corley, 2011). Qualitative researchers frequently use interviews to gain in-depth experiences or views of a phenomenon (Petty et al., 2012b). I used semistructured interviews as the primary form of data collection for this research study. With semistructured interviews, the interviewer prepares questions to elicit information on the phenomenon from the participants (Qu & Dumay, 2011). Qu and May suggested that interviewers utilize semistructured interviews as a conversational guide for discourse between interviewer and interviewee on a complex phenomenon. Dicicco-Bloom and Crabtree (2006) noted that semistructured interview questions should be open-ended and predetermined but other questions may emerge from the discussion. An interview protocol is a procedural guide for conducting interviews (Jacob & Furgerson, 2012). This guide provides researcher with a tool to assist with achieving consistency with each interview by performing each interview the same way (Jacob & Furgerson, 2012). In this

research study, I used the interview protocol attached in Appendix A, which includes a list of open-ended questions, which assisted with performing the semistructured interviews.

There are several techniques to ensure reliability and validity of data collected from the interview process. One technique is to audio record interviews; Whiting (2008) suggested that researchers audio record interviews to ensure that they have accurately captured the responses of participants. Another technique to improve reliability and validity in qualitative research is through member checking (Jacob & Furgerson, 2012; Nelson, 2008; Petty et al., 2012b; Yin, 2014). After transcribing the audiotaped interviews, I utilized member checking to allow the participants to verify a summary of their interview.

Data Collection Technique

After receiving IRB approval, I followed the procedures outlined in the interview protocol (see Appendix A) to conduct face-to-face interviews with the participants. The interview script for this study contains an introductory script, prompts to discuss the informed consent process and allow participants to ask questions, prompts to obtain the necessary permission to audiotape interviews, and closing remarks for the interview. To ensure maximum privacy and confidentiality of the data collected, I utilized a conference room at the utility to conduct the face-to-face interviews. In addition, given that these were busy executives, interviews were limited to a maximum of 60 minutes; Harvey (2011) noted that business executives usually refuse to participate in interviews lasting more than one hour. I employed a technique similar to Synder (2012) and emailed

participants the interview questions two days before the interview. Participants were emailed the interview questions to remind them of the interview, to reduce their anxiety by giving them an opportunity to review the interview questions, and to give them assurance that the interview would not extend beyond the time previously indicated.

I audio recorded interviews and limited note taking during the interviews. Jacob and Fergusson (2012) recommended that researchers limit note taking during interviews to maintain eye contact with participants. Doody and Noona (2012) suggested taking notes could distract the interviewer from actively listening which could result in the researcher missing key information that is critical to the study. However, using audiotapes does not allow the researcher to capture observations and thoughts. Therefore, I employed Doody and Noona's suggestion of jotting down key phrases to assist with making reflective notes after the interview, and Whiting's (2008) suggestion of writing these reflective notes as quickly as possible after the interview while the thoughts were fresh.

An audio recorder is a piece of equipment, and equipment can fail without warning. Jacob and Fergusson (2012) suggested that researchers ensure that the recorder is working before conducting interviews. In addition, Jacob and Fergusson suggested the researcher has back up batteries, tapes, or cassettes in preparation for any technical glitches that may occur during the interview. Failure to prepare for these situations can result in having to reschedule interviews, which can be an inconvenience to bother interviewer and interviewee. I used two recording devices during the interviews to reduce the probability of equipment failure affecting the interview process.

I transcribed interviews verbatim using Dragon transcription software within the same day of completing each interview. Owens (2014) noted that an advantage of using audio recordings is researchers can use the slow and normal play back speeds to accurately transcribe interviews. The time between interviews was spent analyzing and corroborating data from interviews and document reviews. I interpreted the transcripts and provided a summary of each interview question to facilitate member checking. Follow up interviews for member checking were conducted via face-to-face.

There are some advantages and disadvantages associated with using interviews as a source of data collection. Interviews allow researchers to capture data not previously recorded (Yin, 2014), it provides researchers with an opportunity to observe as well as listen to participants (Doody & Nooona, 2013), and it provides researchers with the opportunity to retrieve rich data (Qu & Dumay, 2011). Some disadvantages of interviews are interviews require time to travel to participants, time to do post interview transcriptions, and time to analyze interview data (Petty et al., 2012b). I selected a time to travel based on the time that all participants were available for interviews. To effectively utilize time, directly after completing each interview the audiotaped interviews were transcribed verbatim and interview summaries were created for each question. After all semistructured interviews were completed, follow up interviews for member checking were conducted face-to-face.

Other widely noted disadvantages of interviews are the assumption that participants are competent to answer the questions and will answer truthfully, and that researchers can influence participants' responses (Doody & Noona, 2013; Qu & Dumay,

2011; Yin, 2014). Using multiple sources of data allows for the verification of the accuracy of responses from participants (Yin, 2014). To avoid influencing participant's response while conducting interviews, I used Jacob and Fergusson's (2012) suggestion of following the interview protocol, and Qu and Dumay's (2011) recommendation of refraining from giving opinions and using neutral and precise language.

Yin (2014) suggested there are six sources of case study evidence that includes documentation, archival records, interviews, direct observations, participant observations, and physical artifacts. Within the framework of using multiple sources of evidence, I performed document reviewing. These documents included the parent company's clean energy strategy for the group and the utility's integrated resource plan, which identifies the type of generation the utility plans to invest in between 2015 and 2025. In addition, travelling to the utility to conduct interviews provided me with the opportunity to easily access documents from participants.

There are some advantages and disadvantages associated with document reviewing. Riege (2003) noted that researchers could use document reviews method to corroborate data collected, but Yin (2014) noted authors write documents to serve specific purposes and researchers should exercise care when reviewing. Triangulation is the process of evaluating multiple sources of data (Kanfush, 2014). Bowen (2008) noted that using other sources of data combined with interviews could assist researchers with achieving data saturation .Yin (2014) proffered those findings in which researchers collaborate data from multiple sources to ensure the data converges are more convincing and accurate. I corroborated and verified the data from semistructured interviews and

document reviews. Additionally, follow up interviews for member checking facilitated the opportunity to verify data collected.

Data Organization Technique

I used a case study database to store the data collected in this study. Yin (2014) recommended the creation of a case study database in data collection to store the information collected. Data collected was stored to maintain an audit trail, which increases the reliability and validity of research (Nelson, 2008; Riege, 2003; Yin, 2014).All field notes, transcripts, and study documents are stored on a password-protected database on my computer in which I have sole access.

The case study database for this research study has two main folders. The participant interview folders contain each participant's audio recording and interview transcripts. Each file follows a standard naming convention of *participant code_ file type_ date*. For example, the naming conventions for transcripts are *P1_transcript1_date*. The second folder in the database stores the documents reviewed. The naming convention for these documents is *Document type title_ date*. The database is password protected and will be stored on my computer for 5 years. After 5 years, all raw data stored and collected will be deleted from each of the files within the case study database. All printed documents are stored in a locked container at my home residence and after 5 years, these documents will be shredded and discarded.

Data Analysis

The analysis of qualitative data can be overwhelming to the researcher if the researcher lacks an analytic strategy. Yin (2014) noted that qualitative researchers are

often overwhelmed with the quantity of data collected and are often unsure what to do with the data if a prior plan for analysis was not established. Petty et al. (2012b) noted that the analysis of qualitative data is usually time consuming as the researcher usually accumulates large quantities of text for interpretation and analysis. Yin (2014) and Petty, et al. (2012b) suggested researchers include a plan for data analysis in the planning stages of the research projects.

Researchers use multiples sources of data collection to ensure confirmation and completeness of data and to assist with reducing biases (Casey & Murphy, 2009). Denzin and Lincoln (2011) defined within methods triangulation as the use of more than one method of data collection from the same design to explore a phenomenon. Kanfusch (2014) used interviewing, member checking, and analyzing documents to obtain data in his qualitative case study. Similarly, I analyzed data from the semistructured interviews, document reviews, and member checks, to produce the research findings for this study.

Yin (2014) recommended that researchers determine an analytic strategy and techniques for analyzing case study data. Yin (2014) and Petty et al. (2012b) noted that the qualitative researcher continually moves between data collection and data analysis. The steps to obtain data for coding, which included some preliminary analysis were: (a) transcribing the interview data verbatim, (b) reading printed interview transcripts and placing notes in the margins, (c) creating a summary of each interview question, (d) performing document reviews and comparing review data with data from transcripts, and (e) performing follow up interviews for member checking which allowed participants to verify interview data and clarify any discrepancies. I was able to reach data saturation

after the third semistructured interview with participant P3 and was able to verify and clarify data collected by conducting follow up interviews for member checking with each participant.

On completion of member checking I employed the strategy of working with the data collected to develop codes and themes for final interpretation. Other researchers have used a similar approach (e.g. Cole & Harbour, 2015; Synder, 2012). Cole and Harbour (2013) developed codes by reading interview transcripts repeatedly and attaching colored post-it notes with chunks of data in the margins of the transcripts. Synder (2012) developed codes by physically cutting and sorting data from transcripts. I designed an Excel spreadsheet with rows for the various participants and columns for each question and entered all transcribed data in the relevant cells. The responses from each question were read multiple times, one participant at a time, and key phrases were highlighted in color. The key phrases, guided by Carayannis, Clark, and Dora (2012), were segments of text that I deemed assisted with answering the research question. This process was repeated for each question. In addition, I similarly highlighted key phrases from the two documents (clean energy strategy and integrated resource plan).Petty, Thompson, and Stew (2012b) stated that the most common method used to analyze qualitative data is through thematic analysis. I used Attride-Stirling's (2001) thematic approach as a guide and created global themes from comparing and combining the codes developed from the key phrases obtained from the interview and document review data. Some of the interview questions (see Appendix A) originated from the constructs of the diffusion of innovation theory, which is the conceptual framework guiding this research

study. I therefore compared the final themes with the constructs from the conceptual framework and with the literature in the review to complete the analysis.

Reliability and Validity

Reliability

There are several measures to assess the rigor of qualitative research. Reliability is such a measure, Poortman and Schildkamp (2012) defined reliability as the measure of how replicable the research findings are independent of the researcher and instrument. To achieve reliability, I employed various measures throughout the research process. Poortman and Schildkamp noted using a tool such as an interview protocol (see Appendix A) increases the reliability of research. According to Poortman and Schilkamp, the documented systematic steps and procedures for data collection found in the protocol allows for consistency across interviews. Member checking is another technique used to improve reliability during data collection (Harper & Cole, 2012). After performing semistructured interviews with the three participants, I performed follow up interviews for member checking with each participant, which allowed participants to verify an interpreted summary of their interview .Yin (2014) suggested that using multiple sources of data such as semistructured interviews and document reviews improves the reliability of a case study. In this research study, in addition to performing semistructured interviews, I reviewed the documents provided by participants as an additional data collection technique.

Validity

Credibility, dependability, confirmability, and transferability measures are used to judge the rigor and therefore validity of qualitative research (Lincoln & Guba, 1995). Lincoln and Guba defined credibility as a measure of the value and believability of the study findings. Houghton, Casey, Shaw, and, Murphy (2013) noted using triangulation can improve the credibility of the research findings. Triangulation involves the uses of various data sources to ensure that the data converges (Denzin & Lincoln, 2011). Using methodological triangulation, I compared the findings from semistructured interviews, member checks, and document reviews and checked for validity and consistency.

Dependability is a measure of the stability of the data while confirmability is a measure of the accuracy of the data (Lincoln & Guba, 1995). Houghton et al. (2013) stated that the strategies used to achieve these two measures are similar. Houghton et al. noted that maintaining an audit trail and reflexivity are strategies for maintaining dependability and confirmability. Establishing audit trail and a chain of evidence for others to follows increases the dependability of the study data (Petty et al., 2012b; Lincoln & Guba, 1985; Yin, 2014). I established an audit trail and maintained a chain of evidence by using a case study database to store interview transcripts, audio recordings, and consent documents.

Transferability refers to the extent at which the results from the study are applicable to another context (Houghton et al., 2013). Rich and thick descriptions during the various stages of the research allow the reader to determine how transferable the study and its finding are to their context (Lincoln & Guba, 1995; Petty et al., 2012b;

Riege, 2003). In addition, I used a thematic approach for coding and analysis: According to Riege (2003), specific procedures for coding and analysis increase the transferability of the study.

Data saturation, the point in which further data results in diminishing returns, is another measure used to judge the quality of qualitative researcher (Marshall et al., 2013; Walker, 2011). Collecting data until there are no more themes or new information indicates that the researcher exhausted data collection and has rich information for analysis (Walker, 2011). This study had a small sample size of utility managers with experience in implementing strategies for renewable energy technologies. The strategy for reaching and confirming data saturation included using semistructured interviews, reviewing documents, and performing follow up interviews for member checking. I was able to use information from the parent company's clean energy strategy and the integrated resource plan to supplement, verify, and corroborate data from the interview process. I reached data saturation after the performing the third semistructured interview, this was confirmed as the follow up interviews with each participant to facilitate member checking revealed no new themes or data.

Transition and Summary

The purpose of this exploratory single-case study was to explore strategies electric utility managers use to implement renewable energy technologies. In this section, I discussed my role as a researcher and some of the strategies employed to mitigate any biases, which may have originated due to having a working relationship with some of the participants. The suitability of an exploratory single-case study design for this research

project was discussed. The population for this research study was defined and the sample was determined to be a purposeful sample of three mangers that have created strategies for implementing renewable energy technologies at an electric utility. This section also includes information on how I used semistructured interviews, member checks, and document reviews to reach and confirm data saturation. Additionally, a discussion on the procedures for data collection and analysis was provided and I concluded with a discussion on some strategies used to meet the academic quality indicators of reliability and validity within this research process.

In Section 3, I will present the findings of the study, discuss the applications of the findings to professional practice, and provide the implementation of the findings for social change. Section 3 will also include recommendations for actions, recommendations for further study, and reflections. Section 3 will include a summary and a study conclusion.

Section 3: Application to Professional Practice and Implications for Change

Introduction

My purpose in carrying out this exploratory, case study was to explore the strategies that managers of electric utilities use to implement renewable energy technologies. In analyzing my data, I identified three themes, which I believe can form the basis for possible recommendations that can assist managers of electric utilities with guidelines to implementing renewable energy technologies. The first theme is that managers need to develop and integrate renewable energy technologies into utility operations. To develop these technologies, managers can use the lessons learned from other utilities to assist with implementing and building knowledge and expertise in the technologies. If managers are able to integrate these cleaner technologies into utility operations, they may be able to help create opportunities for not only the utility but also its customers and the society.

The second theme is that managers should avoid further investments in fossil fuel generation. Managers can leverage technologies and create innovative approaches to avoid fossil fuel investments until renewable energy technologies become more mature and cost effective. The third theme is that managers should engage key stakeholders such as customers, regulators, and government officials in their transition to implementing renewable energy technologies. By engaging key stakeholders in the transition to renewable energy technologies, electric utility managers may be able to build a community of support for the technologies. This support may help utility managers in successfully developing and integrating renewable energy technologies.

Presentation of the Findings

Using Attride-Stirling's (2001) protocol, I created thematic networks and developed basic themes from the interview text and the document reviews. I later categorized the basic themes into 14 organizing themes, which I later reduced into three global themes. The first global theme is that electric utility managers need to develop and integrate renewable energy technologies into utility operations. The second theme is that electric utility managers should avoid future investment in fossil fuel technologies. The third theme is that electric utility managers should engage key stakeholders in the transition to renewable energy technologies. I will the findings and themes, consider how my findings relate to my conceptual framework, and compare my findings to my literature review.

Theme1: Develop and Integrate Renewable Energy Technologies into the Utility Operations.

Figure 2 illustrates the thematic network supporting this theme. Under this theme, there are six organizing themes: an approach to reducing fossil fuel dependency, protecting revenue requirements, demonstrating renewable leadership to stakeholders, reducing the complexity of the technologies, exploring industry best practices, and creating opportunities with the technologies. Developing and integrating renewable energy technologies into utility operations provides utility managers with opportunities to reduce fossil fuel dependency while protecting revenue requirements and demonstrating renewable leadership to stakeholders. In developing and integrating renewable energy technologies into utility operations managers may also create opportunities with the

technologies. Utility managers may also explore industry best practices to assist with developing and integrating the technologies into the operations. I will now discuss each of these organizing themes.

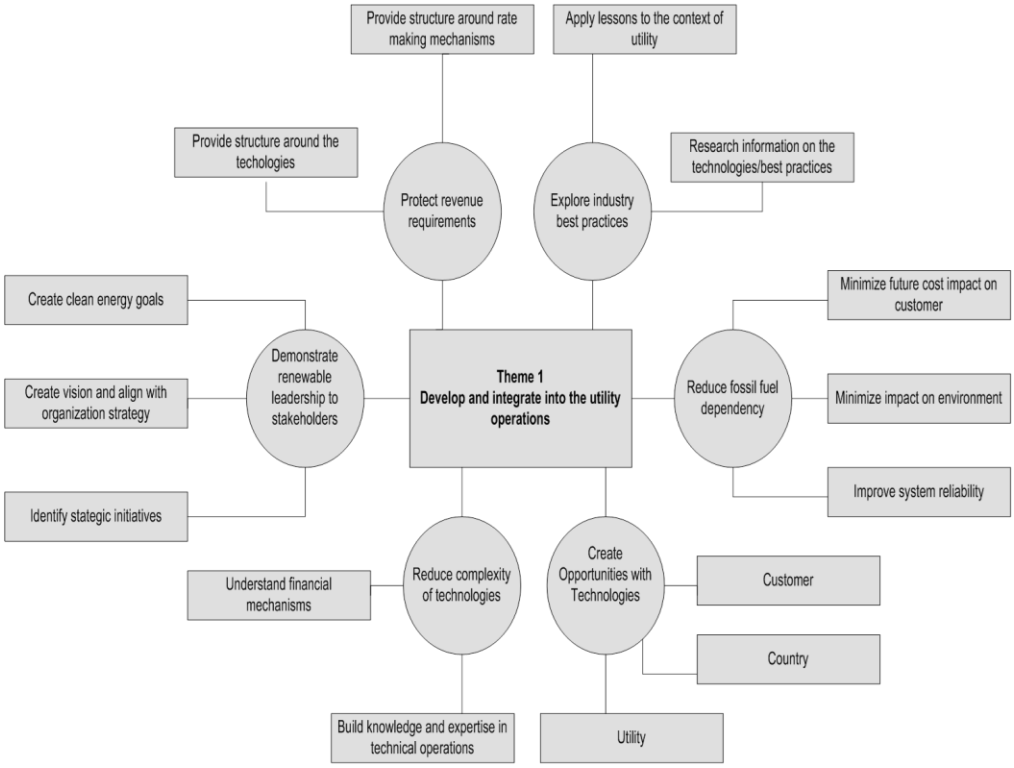

Figure 2: Thematic network 1: Develop and integrate renewable energy technologies in utility operations.

Reduce complexity of technologies. Participants unanimously agreed that piloting the various renewable energy technologies will provide them with the knowledge on the technical operations of the technologies and assist them with developing financial mechanisms for the technologies. The utility managers classified the planned solar farm as a pilot because of the scale of the implementation. The scale of the implementation is such that there is minimum impact on electricity rates to customers while the utility is

able to gain knowledge of the operations of the technology in preparation for larger scale implementation of these technologies in the future. Mansini and Menchetti (2013) showed that a lack of understanding of renewable energy technologies was a significant barrier to adopting these technologies in Europe. Shah et al. (2013) showed that managers of electric utilities are reluctant to implement renewable energy technologies because of the knowledge barriers associated with these technologies. Therefore, participants of this study used the piloting of the technologies to gain an understanding of the technologies to build the necessary expertise for the future.

Study participants are using a strategy different to that of Shah et al. (2013) and Richter (2013). They are using the pilot to reduce the complexity and uncertainty associated with these technologies. Shah et al.'s and Richter's strategy included forming partnerships with others who have experience in renewable energy technologies in order to reduce knowledge barriers. Rogers's (2005) complexity construct (i.e., the difficulty in understanding an innovation) may be a barrier to implementing renewables.

In addition, Rogers's (2005) noted that the ability to trial a technologies increases the likelihood of adoption. Because of the cost factor, it is not financially feasible for managers to experiment with renewable energy technologies for a short period as Rogers's suggested in his definition of the trialability characteristic. But, piloting the technology does allow utility managers to gather information and share a methodology for developing future electricity rates with regulators. The managers of the utility also noted that experimenting with the various technologies and building expertise around these technologies is critical to meeting the utility's goal of 100% electricity generation

from renewable sources.

Reduce fossil fuel dependency. Managers of this electric utility are implementing renewable energy technologies to reduce the utility's dependency on fossil fuels. As illustrated in Figure 2, in reducing the dependency on fossil fuels the utility may be able to minimize the future impact on electricity rates, minimize impact on the environment, and improve the reliability of the system. Niles and Lloyd (2014) recommended that decision makers in Caribbean countries quickly transition to using renewable energy for electricity generation because of the volatility of fossil fuel prices. Similarly, Shirley and Kammen (2013) recommended the transition to renewable energy to stabilize some of the highest electricity rates in the world experienced in the Caribbean. In addition, researchers have found that renewable energy production does not result in emissions, and it does not have a negative impact on human health like fossil fuel generation (Smith, Kern, Raven, & Verhees, 2014). The findings of research conducted in the Caribbean (Auth et al., 2013; Blechinger et al., 2014; Shirley& Kammen, 2013) support the approach taken by these utility mangers of implementing renewables to minimize the impact of fossil fuel dependency.

Managers of this electric utility are aware of the need to address the economic and environmental challenges associated with the use of fossil fuel in electricity generation. According to the definition of Rogers's (2005) compatibility characteristics, if electric utility managers are able to understand the need for renewable energy technologies they will be willing to implement the technologies. Developing and integrating renewable energy technologies into the utility operations provides utility managers with an

opportunity to reduce dependency on fossil fuel technologies. This opportunity aligns with Rogers's compatibility attribute. The need of managers to reduce the impact of fossil fuel technologies is a driver for them to develop and implement renewable energy technologies.

Explore industry best practices. Managers of the electric utility are exploring utility best practices by researching the technologies and applying lessons learned to the context of the utility. Rogers (2005) noted that the ability to observe innovations increases likelihood of adopting. Aligning with Rogers's observability attribute the managers of this electric utility are able to apply the observations from other utilities to assist with developing the various pilots to begin implementing the technologies.

Protect revenue requirements. Managers of this electric utility recognize that they need to protect the utility's revenue requirements. These managers are seeking to provide a structure around the technologies to support customer interest in implementing the technologies and also develop rate-making mechanisms and tariffs to support the integration of customer technologies into the utility operations. Jacob et al. (2013) suggested that the tariffs around renewable energy technologies in the Caribbean region were ineffective. According to participants, developing a pilot to allow a few customers to install renewables will provide the utility with the opportunity to experiment with the setting of tariffs.

Additionally, the managers of this utility recognized that customers express an interest in installing the technologies because of increased marketing of renewable energy technologies. The managers are, thus, being proactive and, in the absence of regulations,

are working with the regulator to create mechanisms around the customer solar installations. Kind (2013) noted that the installation of customer PV systems is reducing the utility's market share. Richter (2012) noted that utilities' market share is decreasing due to increasing customer uptake of photovoltaic systems, and that utility managers do not see opportunities in investing in customer-side of renewable energy technologies. Similarly, the participants of this study do not see the need to invest in customer-side renewable energy technologies. Participants expressed confidence that they can protect the utility's revenue stream by creating a suitable structure to integrate customer's renewable energy technologies into the utility operations.

Demonstrate renewable leadership to stakeholders. The parent company created a clean energy strategy with a stated goal of 100% renewable generation, which aligns with the global drives towards renewable energy (Fernandez, Ortiz, & Bernat, 2013; Jenner, et al., 2012; Matthews, 2013). The managers of this electric utility have identified strategic objectives of piloting the various technologies in order to meet the future clean energy goals of the utility. The choice of which technologies to use was strategic because biofuel technology was not part of the integrated resource plan; officials selected it because of the employment benefits it will bring to the island. Therefore, by developing plans resulting in the implementation of these technologies, the utility will be able to demonstrate renewable energy leadership to its stakeholders.

Electricity is an essential service, and regulators and governments are promoting the use of renewable energy sources for electricity generation in the Caribbean (Caricom, 2013). However, globally, utilities are already operating in an environment where they

have legally binding targets for renewable energy (Fernandez, Oritz, & Bernat, 2013). In the absence of legally binding targets and incentives, managers of this utility are developing strategies to implement renewable energy technologies. The aim is for the CARICOM and its member states to be global leaders in sustainable energy development (Auth et al., 2013). The CARICOM aim is to diversify the energy sector and encourage renewable energy (Caricom, 2013). Their proactiveness in creating a vision and goals for renewable energy and subsequently implementing various renewable energy technologies demonstrates these managers' leadership.

Create opportunities with the technologies. Rogers (2005) stated that the relative advantage of an innovation significantly influences its adoption. Managers of the electric utility were able to identify benefits to the utility, country, and customers from implementing renewable energy technologies. The managers identified that implementing solar could be an economic benefit to the utility even in the absence of incentives for renewable energy. Researchers have shown that incentives for renewables are necessary in order to promote investments in these technologies (Berg, 2013; Lehr, 2013; Nagar, 2011***).*** The managers indicated that biofuels may possibly create a new industry and thus create employment for people within the country. Kelly et al. (2014) noted that some economic benefits to countries for increased renewable energy implementation is an opportunity for new sectors to develop. In addition, participants also identified how the pilots could directly benefit the customer through lease arrangement for customer land for solar.

Even though the integrated resource plan indicated that the costs of investing in

renewable energy technologies were higher in comparison to the costs of investing in fossil fuels technologies, these managers were able to identify benefits to investing in the technologies. To overcome the frequently cited costs and barriers to implementing these technologies (Frankfurt School of Finance & Management, 2015; Kalnins, 2011; Marques & Fuinhas, 2013; Vithayasrichareon, 2014), and to minimize the possibility of escalating electricity rates to customers (Moorey & Kirsch, 2014; Sood, 2013), the managers of this utility indicated that they will begin by implementing the technologies on a small scale. Implementing the technologies on a small scale allows these managers to pilot the technologies, and reduces investment risk while producing benefits to the utility, customer, and country.

Theme 2: Avoid Future Investments in Fossil Fuels.

Figure 3 illustrates the thematic network supporting this theme. Under this theme, I found four organizing themes supporting the drive for managers of electric utilities to avoid future investments in fossil fuel generation. Two organizing themes are that by avoiding investments in fossil fuel it provides economic benefits to the county and demonstrates environmental stewardship. The other two organizing themes are that avoiding future investments in fossil generation allows managers of electric utilities to balance investment uncertainties and therefore these managers are creating innovative approaches by using peak shaving techniques and leveraging technologies as strategies to avoid these investments.

Provide economic benefits to country. According to Caricom (2013), Caribbean governments spend significant foreign exchange in importing fossil fuel for electricity

generation. From the company's integrated resource plan the prediction is that there is limited growth in electricity sales but the utility still needs to invest in generation to meet this growth. Shirley and Kammen (2013) reported that the Caribbean has some of the highest electricity rates in the world. Therefore, by avoiding investments in fossil fuel the managers of the electric utility are providing economic benefits to the country by minimizing future expenditure in fossil fuel and the costs impact to customers due to increasing quantities of fossil fuels for electricity generation.

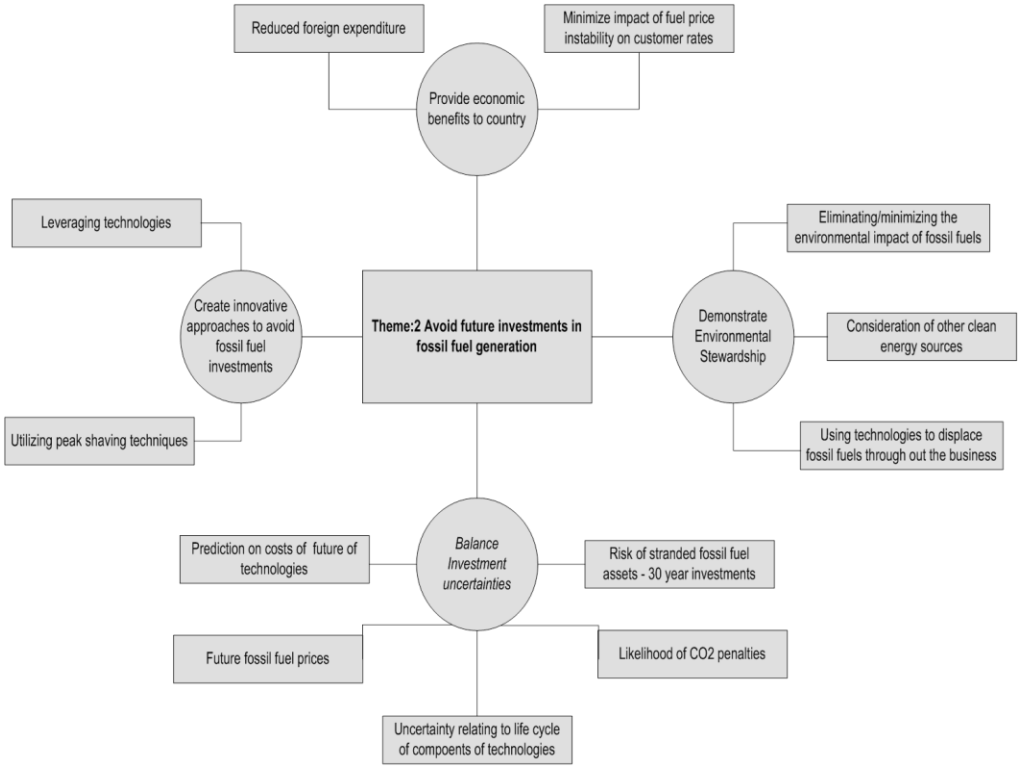

Figure 3: Thematic network 2: Avoid future investments in fossil fuel technologies.

Demonstrate environmental stewardship. Massyluk and Dharmaratna (2013) noted that developing countries, similar to those found the Caribbean, do not contribute significantly to carbon-dioxide emissions. However, within this electric utility's clean

energy strategy one of the key goals is to reduce the carbon footprint of the utility. The managers of the utility are also aware of the global drive to reduce fossil fuel use. In addition, the managers identified the need to replace fossil fuel to avoid the risk of oil spills in the ocean. Further demonstration of environmental stewardship is the utility managers are piloting other renewable energy technologies, which will displace the use of fossil fuel in the utility's fleet. Furthermore, the utility is considering other clean energy sources such as compressed natural gas, which demonstrates the intent to avoid fossil fuels. In summary, the managers of the utility are demonstrating environmental stewardship by employing various plans to displace fossil fuel throughout the business.

According to Severance (2012), utilities are considering natural gas as this fuel source is cheaper than renewables and it is a cleaner technology than fossil fuels. However, Severance also noted natural gas should be a short-term strategy, as natural gas similarly depletes like fossil fuels and is not clean as renewable energy technologies. The parent company's clean energy included natural gas an alternative source of electricity with less of an environmental impact than fossil fuel. Even though natural gas may be seemed as a short-term strategy, the utility is cognizant of the resulting costs of electricity to its customers as it transitions to using clean energy sources. Thus if natural gas becomes more cost competitive than renewable energy technologies, the managers of the utility are willing to implement this type of technology.

Balance investment uncertainties. There are certain risks and hence uncertainties associated with making future investments in either fossil fuel or renewable energy technologies. The electric utility industry is a capital-intensive industry and as

indicated by Worch et al. (2013) the long pay back periods for the assets in these infrastructure sectors cause managers to be hesitant to make investments outside of core activities. However, the participants in this study indicated that fossil fuel investments are 30 year investments. Participants predicted solar will become costs competitive in the future and therefore they are avoiding the risk of stranded fossil fuel assets. Researchers have similarly predicted that the cost of renewable energy technologies will become cost competitive with fossil fuel within the next 10 years (Kalninis, 2011; Matthews, 2013; Reichesten & Yorston, 2013). In addition, the participants indicated that there is also the possibility of upcoming penalties for carbon emissions. This follows from the CARICOM secretariat's plan to institute targets for carbon-dioxide emissions (Caricom, 2013). The managers of this electric utility are being proactive and are avoiding future investments in fossil fuels, given the investment uncertainties. Nevertheless, in Lativa, Kalnins (2011) researchers found that electricity using fossil fuel technologies was still cheaper than that using renewable energy technology, even with the introduction of penalties for carbon-dioxide. However, this is dependent on the penalties associated with carbon-dioxide and the introduction of targets for renewable energy technologies. This utility does not currently have any targets for renewable energy.

Create innovative approaches to avoid future investments in fossil fuel.

Managers of this electric utility have created innovative strategies to avoid making future investments in fossil fuel generation. The utility managers are leveraging technologies and using rate-making mechanism to shave the peak they predict will occur in the future. Managers of this electric utility are creating a rate to buy electricity generated from other

customers who have generators. Sait and Hussain (2015) identified having contractual agreements with customers to provide generation as part of an energy conservation strategy to reduce the need to increase fossil fuel generation. Similar, to the managers of this electric utility, Sait and Hussain noted that increasing fossil fuel generation causes customers to be susceptible to the volatility of fossil fuel prices.

Another strategy used by managers of this utility includes investing in technologies such as advance metering infrastructure and LED street lighting. Researchers indicated that these technologies provide the utility and its customers with a mechanism to manage the use of electricity, and it provides utilities with a tool to integrate renewable systems into the grid operations (Clastres, 2011; Cowan, 2013). By investing in these technologies, electric utility managers are not only avoiding fossil fuel generation, but the utility mangers are being proactive and focusing on technologies that can assist with the full scale integration of renewable energy technologies into the utility operations.

Theme 3: Engage Key Stakeholders in Transition to Renewable Energy Technologies.

Figure 4 is an illustration of the thematic network supporting this theme. Under this theme, I found four organizing themes supporting the need for managers of electric utilities to engage key stakeholders in the transition to renewables. Martin and Rice (2015) found that “deep engagement with stakeholders” is critical to achieve developments in renewable energy. The four organizing themes are that managers need to promote stakeholder advocacy, create a community to support renewables, manage

stakeholders' expectations, and educate stakeholders about renewable energy technologies and its impact.

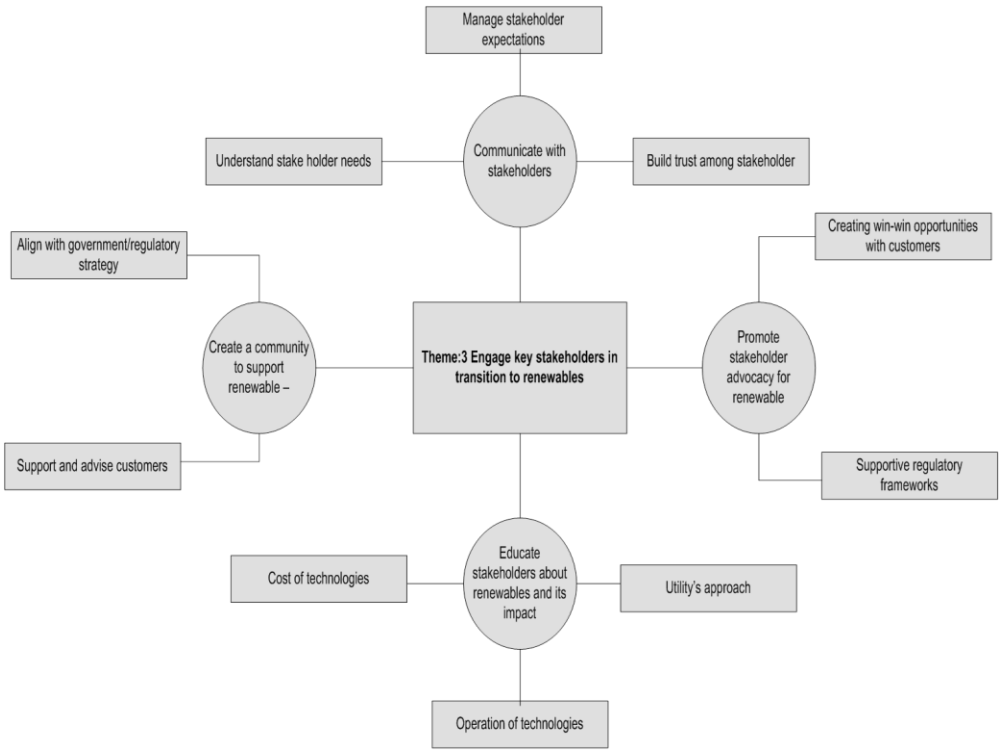

Figure 4: Thematic network 3: Engage key stakeholder in the transition to renewable energy technologies.

Promote stakeholder advocacy for renewables. The participants noted that customers have a great influence over the regulators. To promote support for renewables the managers of the electric utility are engaging in projects that have mutual benefits to the customer and the utility. Similarly, the utility is also working with the regulators to create a supportive regulatory framework the implementation of customer and utility owned renewable energy technologies. Fagianni et al. (2013) found that Spanish energy companies were able to receive benefits from implementing rate-making mechanisms for renewables. In other countries, the rate-making mechanisms resulted in increased

electricity rates for customers (Morey & Kirsch, 2014; Sood, 2013). Morey and Kirsch and Sood noted that a supportive regulatory framework is critical to encourage utilities to invest in renewable energy. Managers of this utility understand the importance of having support from regulators and customers and hence they deemed engaging with key stakeholders to be important to build this support.

Create a community to support renewables. Globally, government, regulators, and legislators are using goal setting to promote investments in renewables and the CARICOM secretariat are similarly aligning themselves with global strategies for renewable energy. The CARICOM secretariat is in the process of setting targets for renewable energy for its members (Caricom, 2013), and although this island utility has a unique regulatory structure and are yet to identify targets for renewable energy, the participants indicated the importance of aligning with government and regulatory strategy. The theme for creating a community to support renewable energy emerged as participants indicated the increasing interest of customers in implementing renewable energy technologies, the utility managers are willing to work with and advise customers to assist them with making good purchasing decisions. Schleicher (2012) and Kind (2013) argued that customers generating their own electricity would have a significant impact on electric utilities. Managers of this electric utility believe if they are able to build a community of support with its key stakeholders and create structure around the technologies, the utility and its stakeholders will benefit from the transition to implementing renewable energy technologies. The managers of this electric utility are therefore aligning with regulatory and government strategies, and supporting and

advising customers to build a community support for renewable energy technologies.

Communicate with stakeholders. From the data collected utility mangers need to engage stakeholders through communication, to understand stakeholder needs, manage stakeholder's expectations, and build trust among stakeholders. Some of the key stakeholders include the customer, regulators, and governments. Batel and Devine (2015) suggested it was necessary to understand the range of stakeholders' attitudes and perceptions of renewable energy technologies. The managers of this electric utility are using the approach of direct conversations with stakeholders to understand their needs; it is through these conversations that stakeholder expectations can be managed leading to that level of trust being built between the utility and its stakeholders. As stated by Shirley and Kammen (2012), electricity rates in the Caribbean are some of the highest in the world and hence one of the common goals of key stakeholders of the island utility is for a reduction in electricity rates. The transition to implementing renewable energy technologies will take some time, and the managers of the utility deem it important to use communication as a strategy to engage and include stakeholders in their transitions to implementing renewable energy technologies.

Educate stakeholders about renewables and its impact. The managers of this electric utility understand that it is necessary to communicate with stakeholders to understand how to educate them. This approach is supported by Batel and Devine (2015), these authors suggested that communication with people can lead to the development of effective strategies to reduce barriers, such as people's perceptions of the technologies. The utility managers in this study indicated that some of the greatest barriers were related

to the customers and included: their high expectations, their lack of knowledge of renewables, and their perception that the utility is trying to protect its profit margin and discourage customers from investing in renewables.

Research has shown that investments in renewable energy technologies can have an adverse impact on the customer because of several factors, including the cost of the technologies and the mechanisms by which there are allowances for electric utility managers to make returns on their investments. In Europe, Marques and Finhas (2012) found that renewable energy investments resulted in high electricity rates. Vithayasrichareon (2014) stated utilities should gradually transition to implementing renewable energy technologies to manage the impact on electricity rates. One manager indicated that transitioning to renewable energy technologies use would be a *juggling act* to minimize the impact to the customer and still meet renewable energy goals. These utility mangers are using the approach suggested by Vithayasrichareon and are gradually transitioning to implementing the technologies to reduce the impact on stakeholders, but utility managers need to educate customers so that they can understand and support these strategies

Applications to Professional Practice

There is a global drive towards increased use of renewable energy technologies for electricity generation. The focus on business sustainability affects electric utilities mainly due to the dependency on fossil fuel for electricity generation. Sustainability includes environmental, social, and economic factors. Electric utilities, like other businesses, need to be profitable to survive. Electric utility managers need to make

investment decisions based on being profitable, providing affordable electricity rates, and generating electricity using cleaner technologies. The findings of this study will assist managers of electric utilities with information and guidance on how to create strategies to implement renewable energy technologies.

Under the first theme, mangers of electricity utilities need to develop and integrate renewable energy technologies into the utility operations. Vithayasrichareon (2014***)*** recommended the gradual transition to renewable energy technologies. The fact that fossil fuel prices are currently declining (Frankfurt School of Finance & Management, 2015) provides electric utilities with the opportunity to experiment with the technologies. The impact on electricity rates will be significantly less than trying to experiment with the technologies when the fossil fuel prices are higher. Beginning with a small-scale implementation of the technologies will allow utility mangers to build both expertise and knowledge in the technologies for future investments while minimizing the cost impact to customers. In addition, managers of electricity will be able to demonstrate renewable leadership to stakeholders and show that the utility is seeking to reduce its dependency on fossil fuels.

Under the second theme, managers of electric utilities should look for strategies to avoid future investments in fossil fuel generation. Avoiding investments in fossil fuel will demonstrate environmental stewardship and demonstrate commitment to supporting the economic development of the country by not contributing further to the economic challenges associated with importing fossil fuels. Some strategies include peak shaving techniques and leveraging technologies that would assist with integrating renewables into

the future grid of the electricity operations. These strategies will allow electric utility managers to meet electricity demands while renewable energy technologies become mature and cost competitive. As the technologies become mature this should reduce investment uncertainties and utility managers would be able to make investments in the technologies.

Under theme 3, utility mangers need to engage key stakeholders to successfully transition to renewables. If the utility is able to enlist the support of its key stakeholders – government, regulators, and customers – this will make the transition to renewables easier and successful. Utility managers need to create a community of support with its stakeholders, communicate with stakeholders to build trust, educate stakeholders on the technologies, share the utility's plan for renewables, and promote stakeholder advocacy by creating win-win opportunities where possible for stakeholders. To achieve theme 1 and theme 2 it will be necessary to obtain the support of key stakeholders thus making stakeholder engagement critical to the utility's transition to renewable energy technologies.

Implications for Social Change

There are several implications for social change associated with a successful or unsuccessful transition to renewable energy technologies. Electricity is a commodity and is critical to the social and economic development of any society. The findings from this research showed and supported Kelly et al.'s (2014) position that developments in renewable energy can provide some economic benefits with the creation of new sectors.

For example, the managers of this electric utility were able to create a new biofuel industry, which will result in the creation of employment opportunities for individuals.

The findings also showed that avoiding investments in fossil fuels and transitioning to renewable energy technologies could reduce the impact of high and unstable electricity rates. Electricity rates in the Caribbean are some of the highest in the world (Caricom, 2013; Shirley & Kammen, 2012). The findings from this study indicated that business owners noted that high electricity rates are negatively affecting the profitability of their businesses. High fossil fuel costs result in high electricity rates for customers, which could lead to not only the closure of businesses and increased unemployment but also the creation of energy poverty. Therefore, dependency on fossil fuel for electricity generations increases the customers' susceptibility to fluctuations in fuel prices. In addition, reducing foreign expenditure used to purchase fossil fuels could provide governments with the opportunity to assign resources to other sectors in the society in need of development. Finally, reducing fossil fuel use and increasing renewable energy technologies also contributes to a cleaner and healthier environment for all and contributes to the global goal of reducing greenhouse gas emission.

Recommendations for Action

The identification of themes from the data collected in this exploratory single-case study assisted with identifying some strategies that utility managers can use to start implementing renewable energy technologies. Under theme 1, the recommendations for actions are for the utility managers to create goals for renewables by creating a clean energy strategy, the next action will be to start begin with implementing the technologies

on a small scale by to build expertise and knowledge on how to operate and integrate the technologies into the utility operations. A further recommendation is that managers implement the technologies on a small-scale to reduce the impact on the customers. A further recommendation is for the utility managers to use the lessons learned by other utilities and research on the technologies and apply it to the context of the utility to assist with developing the implementation.

Another recommendation for action derived under theme 2 is to avoid future investments in renewables by creating some strategies to avoid having to add more fossil fuel generation. Some recommended strategies include implementing peak shaving techniques and investing in technologies to control load demands. A further recommendation is to select technologies that will also assist with integrating renewable energy technologies into the grid operations, for example advanced metering infrastructure.

The final recommendations for action, gauged from theme 3, are focused on creating a utility stakeholder team to engage customers, regulators, and government in the utility's implementation plans for renewables. Having a team focused on building stakeholder relationships will assist with achieving some of the recommendation for actions derived from themes1 to 2. The stakeholders are key to the successful transition to renewable energy technologies and the recommended objective of the stakeholder team will be to create stakeholder advocacy for renewables by creating a community of stakeholder support. The team should focus stakeholders on the benefits of working together to achieve a common goal of transitioning to renewable energy to reduce

dependency on fossil fuel, which will create some economic, social, and environmental benefits for the entire country.

There are several methods to disseminate the information from this study with the focus of providing information to encourage and assist managers of electric utilities in the Caribbean to begin the transition to renewable energy. The Caribbean Association of Electric Utilities (CARILEC) publishes quarterly journals and that is one guaranteed mode of reaching managers of Caribbean electric utilities. The CARILEC joins with other associations and have renewable conferences by which I can make presentations or participate in round table discussions.

Recommendations for Further Research

This study was an exploratory single-case study. Even though the findings of this study were able to provide insight into strategies electric utility managers used to implement renewable energy technologies, there is need to conduct further research on other utilities within and outside of the Caribbean region. The views of a small sample of managers provided the findings for this research. A recommendation is to repeat this research using a bigger sample of managers or leaders by conducting the research across multiple utilities not limited to the Caribbean region. Further recommendations are to repeat this research using other qualitative designs and research methods.

Future researchers could also focus on the strategies and regulatory support needed to avoid investments in fossil fuel technologies. Information from this research will be of significant benefit to utility managers and regulators. Information from this research may assist regulators in understanding the need to create supportive policies or

financial mechanisms to assist utility managers with avoiding investments in fossil fuel generation. This can also allow utility managers and regulators to maintain affordable electricity rates to customers until renewable energy technologies are cost competitive.

Reflections

I now have a full appreciation for the importance of having a well-planned doctoral study proposal. First, I had to travel to conduct interviews so all interviews were prescheduled for the week, all participants were available at scheduled times and fully participated in the interviews. The greatest challenge came with transcribing the interviews. Though I used transcription software, I had to listen to the audio recordings to make some corrections to the transcripts because the software had challenges recognizing some words due to the island accent of the participants. During the week visit, I was able to complete all semistructured interview with participants, corroborate the document reviews, prepare an interpreted summary of each participant interview, and visit each participant a second time to perform face-to-face follow up interviews for member checks. At the end of the week, I was exhausted and would not have been able to complete the data collection process, in such a short period, without the detailed plan to follow in my study proposal.

As it relates to the data collected, I was initially overwhelmed with the large quantities of data collected. It took me several days to find a method to break the data into to manageable chunks for analysis. My preference was to work with the data and not use any coding software. As an engineer, I am accustomed to analyzing data myself; therefore I was not comfortable with using software such as Nvivo to assist with data

coding. Even after going through this process, as rigorous, time consuming, and challenging, as it would have been, I felt very excited and satisfied with the final product. I feel intimately connected with my data and I am an expert on the research topic.

Finally, it was exciting for me to see new concepts emerging from the data collected. I was able to see the application of theory to practice as the first theme emerging from my research findings completely aligns with the constructs of the conceptual framework. In summary, this doctoral process presented its challenges, but it is truly rewarding to be able to contribute information to assist with the transition to renewable generation within the electric utility industry. It is rewarding that I can contribute knowledge to my field of practice, and rewarding that this research can affect social change. The successful transition to renewable generation has a global impact: It can contribute to the economic, environmental, and social development of a country.

Summary and Study Conclusions

The purpose of this exploratory, qualitative single-case study was to explore the strategies managers of an electric utility used to implement renewable energy technologies. The information from the participants assisted with developing some possible strategies. Three themes emerged:(a) develop and integrate renewable energy technologies into the operations of the utility, (b) avoid future investments in fossil fuel technologies, and (c) engage key stakeholders in the transition to renewable energy technologies. The in-depth exploration with participants revealed some recommendations for actions to assist managers of electric utilities with implementing the strategies.

Electricity is an essential service. The findings from this study indicated that a successful transition to renewable energy technologies could affect social change. Some tangible improvements include possible economic growth and development for the region due to reduced expenditure required to purchase the foreign based fossil fuel. Further possible tangible improvements include employment opportunities for individuals, a cleaner and healthier environment for all, and stable and affordable electricity rates for individuals and the members of the business community. The ability of electric utility managers to provide stable and affordable electricity rates could eliminate the creation of energy poverty and the occurrence of job losses due to the closure of businesses. In conclusion, as regulators and legislators introduce targets for renewable energy technologies and encourage other entities to generate electricity, the information from this research provides managers of electric utility with some strategies to implement renewable energy technologies and remain profitable.

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Appendix A: Interview Protocol

Interviewee Code Name: _____

Interview No: _____ Date: _____

Introduction:

Thank you for agreeing to this interview.

As indicated in the inform consent document this interview will be audio recorded. *(Start the tape recorder).*

Interview Questions:

As a member of the management team, why do you think this electric utility needs to implement renewable energy technologies in this utility?

What are some of the strategies your team is using to implement renewables energy technologies at this utility?

What you found to be some of the possible opportunities associated with implementing these technologies?

What have you found to be some of the significant challenges or barriers to implementing these technologies?

What strategies are you using to address these challenges or barriers?

How have you found the considerations for investing in renewable energy technologies to differ from those for investing in fossil fuels?

How have you used any lessons or observations from other implementation of renewable energy technologies in creating strategies for implementing these technologies at this utility?

Based on your experience thus far, what recommendations would you give to other managers in electric utilities to assist them with creating strategies to implement renewable energy technologies?

What additional information would you like to share on the strategies being used to implement renewable energy technologies in this utility?

Post Interview Comments:

I would like to thank you for participating in this interview. I will be transcribing the recording and providing a summary of this interview. Follow up interviews may be scheduled with you to verify the summary, ask any other follow up questions, and give you the opportunity to discuss anything else that will contribute to this study purpose. The follow up interview will lasts about 30- 45 minutes. Again, thanks for participating in the study.

Appendix B: Consent Letter

[redacted]

30th June 2015

Dear Nneka Archer,

I give permission for you to conduct your doctoral study entitled "*Strategies Utility Managers Use to Implement Renewable Energy Technologies in the Caribbean*" at [redacted] I am requesting a copy of your study on completion. Additionally, as a member of Caribbean Association of Electric Utilities (CARILEC), I approve of you using the results of this study in publications, such as the CARILEC magazine, for the benefit of fellow Caribbean utilities.

As the approved authorizing agent for [redacted] I confirm that the submitted plan complies with [redacted] organization policies. You have full endorsement to access and utilize any necessary information and to conduct interviews with members of the management team who are involved in creating and implementing strategies for renewable energy technologies at [redacted]. However, the interviews will be conducted at the managers' convenience and you are granted permission to use our conference facilities to conduct interviews. In addition, we reserve the right to withdraw from the study at any time if our circumstances change.

I also confirm that I understand that the data collected will remain entirely confidential. I also understand that the data provided will not be shared with anyone other than your supervising faculty/staff, without permission from the Walden University Institution Review Board.

We extend a warm welcome to you.

Sincerely,

[redacted]

Appendix C: Informed Consent

You are invited to take part in a research study regarding strategies managers of electric utilities use to implement renewable energy technologies. You were chosen to participate in this study because you work at an electric utility in the Caribbean, you have experience with creating strategies to implement renewable energy technologies in an electric utility, and you are over 18 years old. This form is part of a process called "informed consent" to allow you to understand this study before deciding whether to take part. The researcher, Nneka Archer, is a doctoral student at Walden University and is conducting this study. As you may be aware, I work as an engineer at an electric utility company, which is familiar to you, but my role as a researcher is separate as this research study is a requirement for partial fulfillment towards attaining my doctoral degree.

Background Information:

The CARICOM Secretariat devises strategies for renewables for the Caribbean community and individual state governments have identified targets for renewables within these individual countries. The purpose of this study is to explore the strategies managers of this electric utility use to implement renewable energy technologies.

Procedures:

If you agree to be in this study, you will be asked to:

- Participate in an initial interview lasting between 45-60 minutes
- Provide documentation e.g. clean energy strategy, and integrated resource plan.
- Give permission to audio record interview

- Participate in follow up interviews for verification and clarification either face-to-face or via Skype lasting 30 minutes

Voluntary Nature of the Study:

Your participation in this study is voluntary. The researcher will respect your decision of whether or not you choose to be in the study. If you refuse to participate in this study this will not affect our working relationship. If you decide to join the study now, you can still change your mind later. You may stop at any time.

Risks and Benefits of Being in the Study:

Interviews are expected to last a maximum of 60 minutes. The minimum risk is sitting for 60 minutes, which you may already do on a typical workday. This study will provide information that can assist other managers in the CARICOM with creating strategies to implement renewable energy technologies. The results from this study could possibly encourage other managers of electric utilities to begin their transition to using cleaner technologies for electricity generation. In addition, you can you indicate if you would like to receive a copy of this research study upon completion.

Payment:

No compensation will be offered to participants.

Privacy:

Any information you provide will be kept confidential and only the researcher and Walden faculty will have access to the study data. The researcher will not use your personal information for any purposes outside of this research project. In addition, the researcher will not include your or the organization's name or anything else that could

identify you or the utility within this study. Your name will be replaced by a code known only to the researcher and the organization will be referred to as the "electric utility". Data will be kept secure in password-protected folders on the researcher's computer and only the researcher will have access to this password. Any printed data shared or created will be kept in a locked container at the researcher's residence. Data will be kept for a period of at least 5 years, as required by the university.

Contacts and Questions:

You may ask any questions you have now or if you have questions later, you may contact the researcher via email at xxxxxxxxxxxxx. If you want to talk privately about your rights as a participant, you can call Dr. Leilani Endicott. She is the Walden University representative who can discuss this with you. Walden University's approval number for this study is **07-30-15-0419912** and it expires on **July 29,2016.** The researcher will give you a copy of this form to keep.

Statement of Consent:

I have read the above information and I feel I understand the study well enough to make a decision about my involvement. By responding in email stating, "I consent to participate in this research study", I understand that I am agreeing to the terms described above.