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City of Raleigh
Renewable Energy Overview

Background, Assessment & Recommendations

NC SUSTAINABLE
ENERGY ASSOCIATION

CITY OF RALEIGH
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NORTH CAROLINA

City of Raleigh Renewable Energy Overview

Background, Assessment & Recommendations

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NC Sustainable Energy Association (NCSEA) is the leading 501(c)(3) non-profit organization dedicated to driving public policy and market development that creates clean energy jobs, economic opportunities and affordable energy to benefit all of North Carolina.

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Executive Summary

To ensure that Raleigh meets its growing needs, it is vital that the city maintain a robust and stable infrastructure and economy in the face of steadily increasing energy costs. The City's energy expenses are the second largest operating cost – behind only personnel costs. Energy used in this sense is both energy used to generate electricity for lighting and buildings, and energy used as a fuel for transportation. This overview serves as an assessment of the City's current energy operations and focuses primarily on the potential incorporation of renewable energy resources to improve operational resilience and provide lifetime cost savings to the City. This assessment does not provide analysis of alternative fuels and transportation opportunities for the city fleet.

Section 2 explains the historical background and most of the fundamental aspects of the modern electricity system, which is needed to properly consider or undertake the integration of renewable energy systems in Raleigh. A timeline of developments as the electricity system expanded from a patchwork of a few small generating stations to a nationwide system delivering power to nearly every home and business in America is also provided. Section 2.2 provides insights into the complicated process of utility billing. Understanding the available options in rates will help the City optimize its energy use and minimize payment.

Section 3 looks at how recent technological advancements, production scale-up, and increased investment are making renewable technologies more affordable and efficient options for energy production. This section includes information on types of generation that are considered renewable, the specific technical aspects of these systems, the terminology frequently used to describe them, and the benefits they can provide to Raleigh and the larger electricity system. Also included in Section 3 is an assessment of the financial considerations the City must take into account when evaluating renewable energy systems such as price hedging, state and federal tax laws, and utility commission regulations. Total cost of ownership and business case evaluations of renewable energy projects may result in long-term savings in operating and capital budgets.

Section 4 reviews potential opportunities for renewable energy systems to provide savings, reduce its dependence on fossil fuels, and significantly lower carbon emissions for the City of Raleigh. This section details how the current state of the City's energy operations was assessed and gives the findings from this assessment.

Section 5 provides specific recommendations on how to maximize the operational efficiency of City resources through data, planning, communication, and partnerships. The overall goal is to improve the energy planning process and increase opportunities for the use of renewable energy in the City of Raleigh's Municipal Operations.

1. Introduction

The City of Raleigh's second largest operating expense is energy. Judicious use of all energy resources – including renewable energy – may yield long-term operating and capital budget savings for Raleigh's citizens and taxpayers.

The City of Raleigh is one of the fastest growing cities in America, attracting new citizens, businesses, and economic opportunities. Ensuring that Raleigh meets its needs as a growing city will involve maintaining a robust and stable infrastructure and economy when energy costs have steadily increased over time.

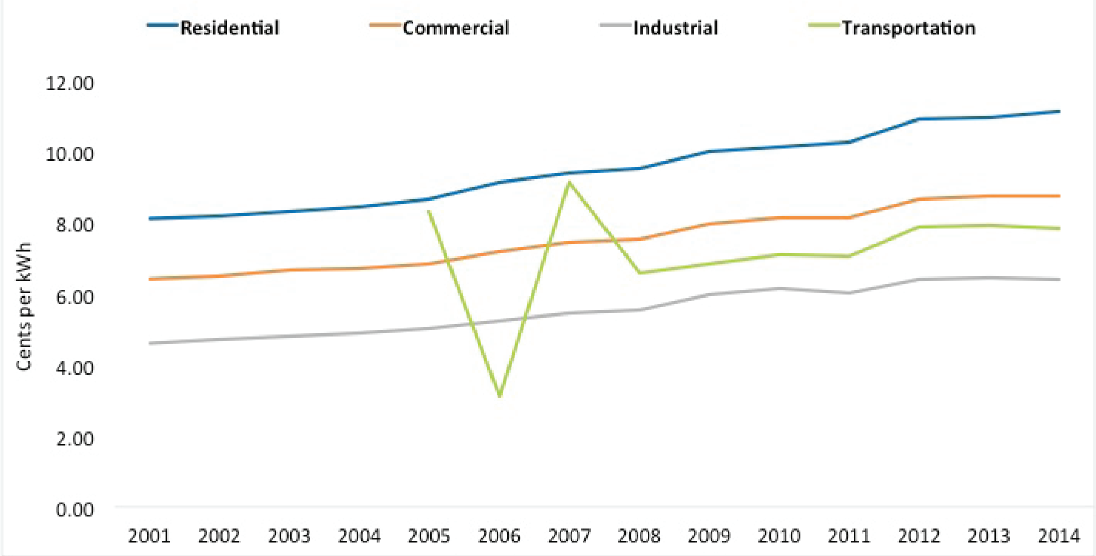

Figure 1[1]

North Carolina Average Retail Price of Electricty

The City of Raleigh has experienced this same trend in energy expenses. Long-term savings in operating and capital budgets may result from total cost of ownership and business case evaluations of renewable energy projects.

Source: U.S. Energy Information Administration Electrity Data Browser

To capitalize on the opportunity afforded by clean energy, the City of Raleigh developed "A Roadmap to Raleigh's Energy Future: The Climate and Energy Action Plan (CEAP)" to guide the responsible and practical implementation of carbon-reduction strategies, suggest ways to maximize the operational efficiency of City resources, and provide renewable energy opportunities. The plan, which was adopted by the City Council in 2012, identified the following:

> Energy insecurity from our dependence on foreign oil and environmental and human health concerns have created a new set of challenges. However, these challenges are coupled with tremendous opportunities to rethink energy usage, protect environmental and human health all while expanding the local economy through energy efficiency and innovation. The reliance on fossil fuels for energy may change as energy interdependence and energy security become more important. This has also come at a time when the entire infrastructure in this country must be updated and improved. [2]

The emergence of smart grid, distributed energy, demand response and other technologies

1 Forbes. America's Fastest Growing Cities. (2015).

2 City of Raleigh Climate and Energy Action Plan. A Roadmap to Raleigh's Energy Future. (2012).

will only hasten the need for energy innovation, which will also require collaboration and education across the entire organization. Incorporating clean energy technologies into city operations can help the City of Raleigh achieve the goals established by the CEAP. These technologies encompass both renewable energy and energy efficiency. Renewable energy resources, such as solar, wind, hydropower and geothermal generate electricity with lower carbon emissions when compared to traditional fuels, while energy efficiency measures reduce energy consumption. Recent advances in technology, increased investment, and enhanced deployment of clean energy have made systems more affordable and easier to use. Clean energy could provide the City with not only long term cost savings, but also reduce its dependence on fossil fuels and significantly lower its carbon emissions. These economic, environmental, and social benefits extend beyond City operations to the larger community, where residents and businesses would benefit as well.

Raleigh has long been recognized as a national leader in renewable energy. The City is also an established global hub for several clean energy industry clusters and has a mission statement of being a "21st Century City of Innovation focusing on environmental, cultural, and economic sustainability". Energy, however, is a complex topic and understanding it on a broad scale is useful for successful management of resources. With the City having more than 900 electric utility accounts and many different rates available to each of these accounts, the objective of optimizing use can become very complex.

In order to move forward with the goal of implementing a renewable energy plan for the City set forth by the CEAP, it was first necessary to acquire an understanding of broad energy topics and their relation to the City's needs. Further, a familiarity with the current state of energy use, resources, and planning within the City needed to be developed. This assessment of the City's energy operations focuses primarily on the potential incorporation of renewable energy resources to improve operational resilience and provide lifetime cost savings to the City.

2. The Energy Picture

Customers in the US have nearly unlimited access to electricity due to a complex infrastructure system put in place over the last 100 years. Now, new technologies and policies are changing the way we use energy.

While customers in the US have come to expect electricity to be available whenever they want it, the system of production, transmission, and delivery of electricity in the US is exceedingly complex. Electricity is produced by traditional resources such as coal, oil, natural gas and uranium, along with renewable resources such as solar, wind and biomass. The energy produced is then transmitted over wires for many miles to be utilized by countless processes. Figure 2 shows the current mix of generating resources in North Carolina. This already complex system is further complicated by the nature of electricity and the fact that it is not currently stored in large quantities. This means that supply and demand must be matched exactly at all times and in all locations. The following section provides background information on how the modern electricity system was formed and how that may limit the integration of renewable energy systems in Raleigh.

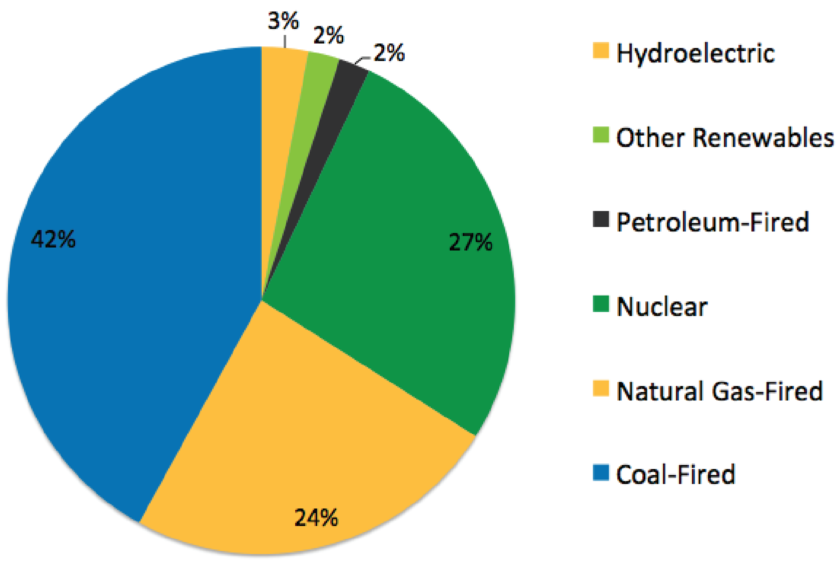

Figure 2. North Carolina electricity generation by fuel type

Source: U.S. Energy Information Administration. "North Carolina Profile." February 2015

2.1 The Electricity Grid

The National Academy of Engineering has referred to the intricate network of power plants, high-voltage transmission lines, transformers, substations, and other equipment known as the US electricity grid (Figure 3) as the greatest engineering achievement of the 20th century.[3] Over the past 100 years, the grid has expanded from serving just a few small clusters of customers near urban generating stations to a nationwide system delivering power to nearly every home and business in America.

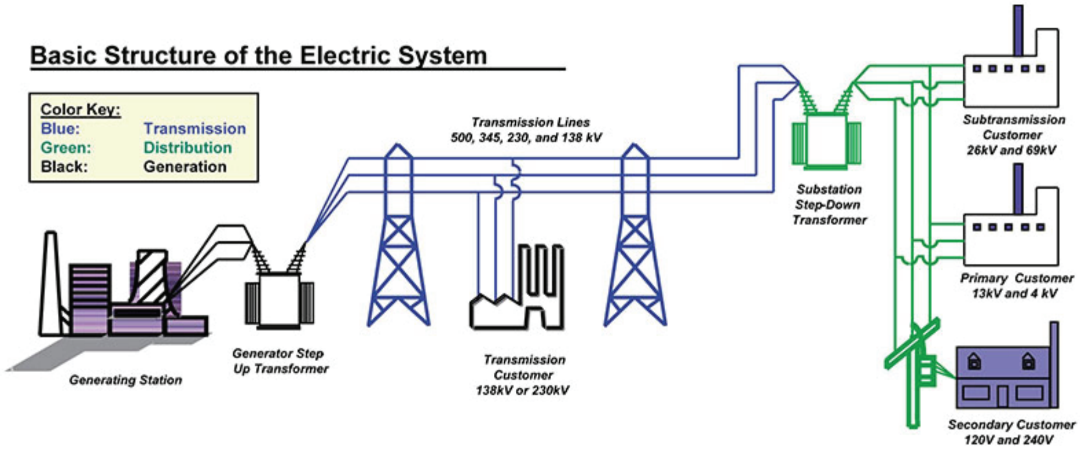

Figure 3. The electric grid consists of an intricate network of generation, transmission, and distribution. Customer's supply and demand for power must match exactly since energy storage is not currently cost-effective.

Source: How the Electricity Grid Works." Union of Concerned Scientists. 18 Feb. 2015. Web. 30 Nov. 2015

3 National Academy of Engineering. Century of Innovation: Twenty Engineering Achievements that Transformed our Lives. (2003).

Timeline for the Development of the Electric Grid

1882 - 1899 On September 4th, 1882, Thomas Edison's Pearl Street Station in Manhattan began producing electricity, becoming the first central power plant in the U.S. The plant provided direct current (DC) electricity to 400 nearby lamps. While the station was very successful and quickly expanded its number of customers, competing technologies began gaining ground. George Westinghouse touted his alternating current (AC) system for its ability to transmit power more efficiently over greater distances with less losses compared to Edison's DC generators which needed to be located within a mile of their load. The installation of a hydroelectric plant at Niagara Falls that sent AC electricity directly to Buffalo, NY 20 miles away, signaled its success in becoming the predominate technology.

1900 - 1928 In the early part of the 20th century, privately owned and un-regulated electric companies began developing around major cities and towns throughout the country. These companies realized that economies of scale enabled large centralized power plants to operate more efficiently and with lower costs than smaller diverse resources and therefore looked for locations capable of serving as many customers as possible with minimal infrastructure.[4] While urban areas enjoyed a competitive electricity market, most rural areas of the country still had very limited access due to the high costs of running wires through sparsely populated areas.

1929 - 1944 During the Great Depression, the electricity industry experienced considerable changes. In an effort to stimulate the economy and provide jobs, President Franklin D. Roosevelt enacted the New Deal policies, some of which aimed to bring power to a greater percentage of Americans through the construction of new infrastructure in rural areas. Since there were not enough benefits to be gained from competition in building multiple sets of power distribution lines, electricity companies were granted monopoly status in certain territories. These public utilities were owned by shareholders and incented to make investments in infrastructure by being guaranteed a reasonable rate of return. In turn, they were responsible for following state regulations and ensuring a reliable supply of electricity for all citizens. These companies still persist today and the City of Raleigh is within the territory of Duke Energy Progress, one of the investor-owned utilities (IOU) that has monopoly rights to sell electricity in North Carolina.

1945 - 1975 Much of the infrastructure that makes up the grid was installed by these companies during the "golden-age of electricity", from 1945 to 1975.[5] Because there was a financial incentive for building more power plants and transmission lines, the electricity industry experienced tremendous growth and substantially increased the availability of power to rural areas.

1976 - 1980 The energy crisis of the 1970s led to the emergence of environmentalism and precipitated the adoption of new regulations for the electric utility industry. In an effort to encourage the use of efficient cogeneration - using waste heat to generate electricity - and small scale renewables, the federal government passed the Public Utilities Regulatory Policies Act of 1978 (PURPA). PURPA requires utilities to purchase power from qualifying facilities (QFs) and allows states to set the price these generators receive for selling their power to the utility at the avoided cost rate – the cost the utilities would otherwise incur to produce the power themselves. [6]

4 Institute for Energy Research. History of Electricity. (2014).
5 Understanding Electric Power Systems: An Overview of the Technology and the Marketplace. (2003)
6 The avoided cost rate is equivalent to the marginal cost to the utility of producing electricity.

1981 - 1999 Following the deregulation of the airline, telecommunication, railroad, and natural gas industries in the 1980s, the US electric market underwent restructuring during the 1990s and early 2000s to undo the vertically-integrated, regulated monopolies that had formed in an attempt to lower electric rates. In 1992, the Federal Energy Regulatory Commission (FERC) began requiring open access to electric transmission lines. Additionally, FERC encouraged the formation of third-party Independent System Operators (ISOs) and Regional Transmission Organizations (RTOs) to optimally coordinate generation and transmission of power within regions.

2000 - 2007 Once again, rising energy prices and a dependence on foreign oil led to changes in energy policy. The passage of the Energy Policy Act of 2005 allowed alternative energy sources and innovative technologies that reduce greenhouse gas emissions to be more competitive in electricity markets. Then in 2007, to further promote the development of renewable energy within the state, North Carolina became the first Southeast state to adopt a Renewable Energy and Energy Efficiency Portfolio Standard (REPS). This requires investor-owned utilities to generate 12.5% and municipal utilities and electric cooperatives to generate 10% of electricity needs with eligible renewable energy resources or energy efficient measures by 2021.

Although the construction and operation of the electricity grid was a profound achievement of engineering and economics, the grid is aging. New technologies are being developed to improve its reliability, efficiency, and resilience, but large scale investments will be needed moving forward to effectively meet the changing demand for energy in the 21st Century.

2.2 Electricity Rates and Billing

Utility billing is complicated, making it difficult for customers to optimize their energy use and minimize payment. IOU electricity customers in North Carolina pay rates that are set by regulators at the North Carolina Utilities Commission (NCUC). Rates, also called tariffs, are the price each customer pays for a unit of electricity. The amount of electricity a consumer uses over a billing period is measured using the kilowatt-hour (kWh), which represents one kilowatt working for one hour. The NCUC reviews rates for necessity and appropriateness and must approve a requested rate change before the utility may implement the new rate. In addition to recouping the utilities' operating costs, the approved rates allow utilities operating in North Carolina to earn a certain rate of return.

Electric utilities group their customers into market segments using similar characteristics, such as quantity of power needed, voltage requirements, and accounting preferences. Houses and apartments make up the residential segment, businesses; such as stores and offices, make up the commercial/general segment; and manufacturers and other large users make up the industrial segment. The City of Raleigh has electricity accounts in all three market segments.

In many cases, electricity customers pay the same price per kWh used during a billing period regardless of when they use the electricity during that period. The utilities, however, are subject to changing costs for delivering electricity that are not reflected in fixed rates. Customer demand rises and falls throughout the year and even during the day (Figure 4). While spring and fall typically have lower demands for electricity, the extreme heat and cold of the summer and winter can generate high levels of demand for heating and cooling. Additionally, demand is often lower in the nighttime hours while businesses are closed and customers are sleeping, but higher in the afternoon when people are most active.

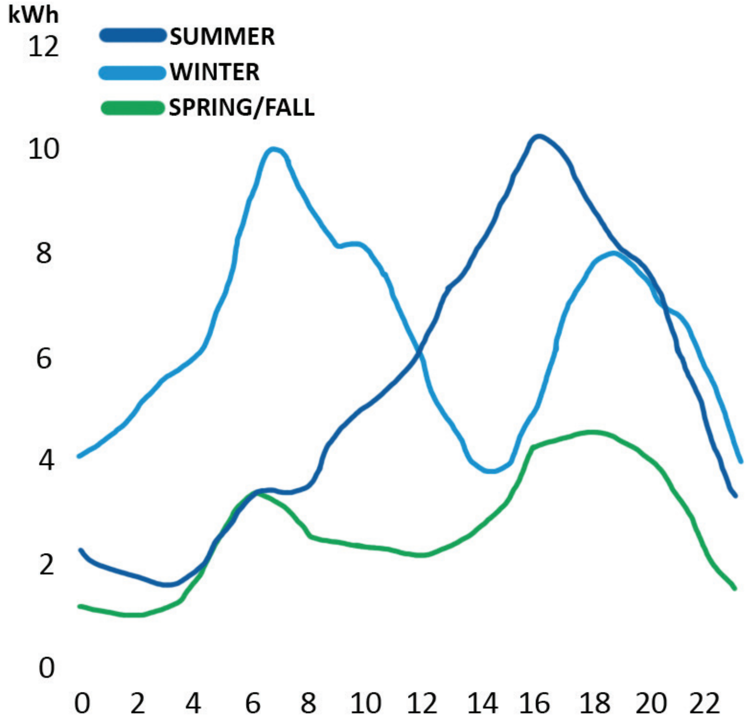

Figure 4. Seasonal Electricity Demand

Source: US Energy Information Administration, "Residential EnergyPlus Output: Raleigh, NC," accessed June 2015

Utilities must call upon different generating facilities to ramp up or down in response to these changes in demand. These facilities have differing characteristics that determine their individual costs of producing energy (Figure 5). The power plants that are used to meet the continuous level of demand, known as the baseload, are often nuclear and coal plants that are inexpensive to run for long periods of time. Intermediate generators such as combined cycle natural gas and solar photovoltaics take less time to come online, but are slightly more expensive and can be difficult to ramp down. These plants operate seasonally, while most expensive peaker plants such as those that burn fuel oil and some natural gas turbines can ramp up and down quickly but operate only during the few hours of highest demand throughout the year.

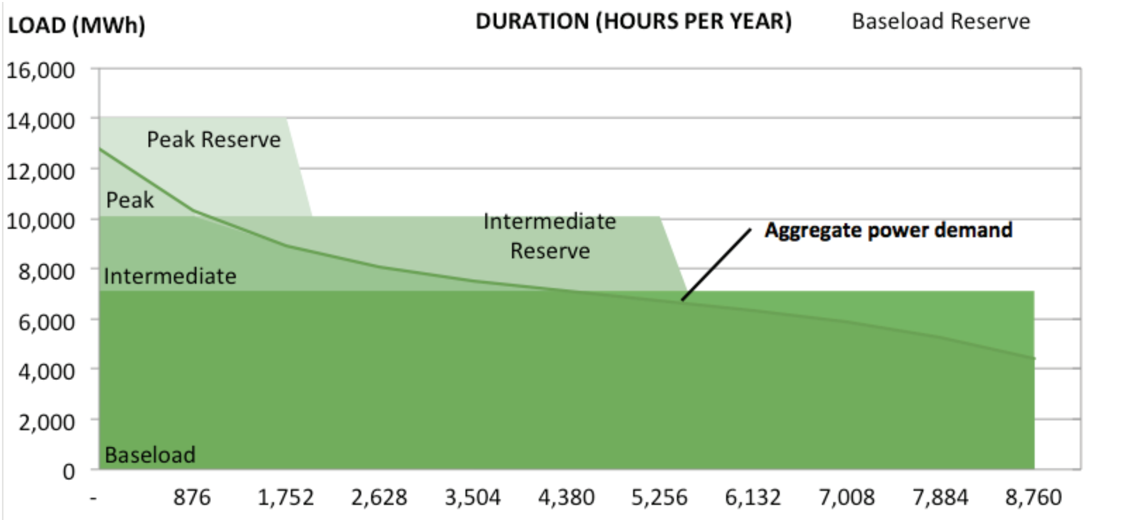

Figure 5. Aggregate electricity demand the utility must supply throughout a year. In North Carolina, utilities must meet customers' electricity demands, plus retain 15% reserve generation capacity.

Source: Based on Duke Energy Progress, "Integrated Resource Plan," NC Utilities Commission Docket E-100 Sub 141, September 2014

Types of Time Variant Pricing

Real-time pricing (RTP): Price per kWh varies in real time with the utility's actual power production costs.

Time-of-use (TOU) pricing: Price per kWh varies in seasonal and hourly blocks such as summer and winter peak, and off-peak hours.

Critical peak pricing (CPP): Price per kWh spikes dramatically when qualifying critical events occur; the utility notifies customers at least one hour in advance, giving customers time to reduce their energy use before high rates begin.

As mentioned previously, because electricity is not stored, supply and demand must be balanced at all times, and fluctuations in demand lead to differences in the way electricity is generated. Time variant pricing reflects the different costs of supplying electricity through prices that change throughout the day and year, but many customers are still on fixed rates that offer no price signals.

Rates, however, are only one aspect of a customer's electricity bill. There are additional charges that are included to adequately repay the utility for reliably meeting demand. Because the utility is responsible for building adequate generation capacity to meet the highest levels of demand, even if some power plants operate only a few hours a year, larger consumers often pay demand charges that reflect the cost of additional investments needed to meet their load that are based on the peak demand of these customers during a billing period. A customer's electricity bill also includes riders or charges approved by the utilities commission to reflect additional expenses incurred by the utility.

All of these aspects come together in a wide variety of rate schedules that are available to customers of different types.

Common Electricity Riders

Cogeneration / small power producer: Per PURPA, this rider allows QFs to sell power to the utility at the avoided cost rate.

Net-metering: This rider allows customers to receive a bill credit for the electricity that they add to the grid. Any electricity the customer generates onsite, such as with a solar PV system, but cannot immediately be used, is transferred to the utility in exchange for a reduction in the customer's electricity bill.

Curtailable / interruptible service: This rider provides customers a bill credit for decreasing energy use during critical peak periods.

3. Factors Affecting Renewable Energy Deployment

A safe, reliable, and affordable supply of electricity will allow the City of Raleigh to provide the services needed for its local economy to grow and thrive. Renewable energy can help the City achieve these goals. This section of the report defines for the City of Raleigh what is to be considered a renewable energy resource and describes the effects and considerations of incorporating these into municipal operations. In addition, the technical and financial considerations associated with these renewable resources are also discussed.

3.1 Definition of Renewable Energy

Renewable energy is derived from natural processes that are regenerative over short periods of time, or, for all practical purposes, cannot be depleted. The most common renewable energy resources are biomass, geothermal, hydropower, solar, and wind, which are defined below.

Biomass – Relates to the combustion of organic and waste materials, or their conversion to biofuels, such as methane. These organic and waste materials include plant-based sources, municipal wastewater, and municipal solid waste.

Geothermal – Includes both Geothermal Energy and Ground Source Heat Pump (GSHP) technology. Geothermal Energy utilizes the thermal energy (heat) stored in the Earth to generate electricity, while GSHP are a central heating and cooling system that transfers heat to or from the ground.

Hydropower – Converts the force of falling or flowing water, including marine waves, for useful purposes such as generating electricity or creating mechanical force.

Solar Photovoltaic (Solar PV) – relates to the direct conversion of sunlight into electricity through photovoltaic cells.

Solar Thermal – Harnesses sunlight to meet thermal requirements for residential, commercial, or industrial processes. This technology concentrates the light from the sun to create heat energy used to generate electricity.

Wind – Relates to the harnessing of wind energy. This includes, but is not limited to, wind turbines for the creation of electricity and windmills for mechanical power.

3.2 Technical Considerations of Renewable Energy

Recent technological advancements, production scale-up, and increased investment continue to improve the position of renewables in the energy landscape, making renewable technologies more affordable and efficient options for energy production. When considering the use of renewable energy systems in city operations, it is helpful to understand the specific technical aspects, the terminology frequently used to describe them, and the benefits they can provide to the electricity system.

Creating a more reliable energy source for the City of Raleigh is one of the several benefits that renewable energy systems can offer. A reliable energy source is one that experiences fewer and shorter periods of unavailability.

Renewables in Relation to the Grid

Renewable energy projects are unique in their ability to be located very close to the load they serve, producing energy on-site or at the point of consumption. These systems are known as distributed generation (DG), distributed resources (DR), or distributed energy resources (DER). Traditionally, combustion generators made up the majority of this type of generation, but several renewable energy resources, such as solar power, wind power, biomass, geothermal power, and small hydro, can fill this role as well. Rooftop solar panels providing electricity to the building on which they are located would be considered a form of distributed generation. Distributed energy generation would provide a benefit to the City in terms of long term resiliency. An example of DER would be mobile generating stations that can be used to charge cellphones and laptops for citizens in the event of a grid outage. Additionally, as electric vehicles become more prevalent in Raleigh, for both citizens and municipal vehicles, charging stations powered by solar panels will allow for continued operation regardless of grid operations. These systems represent a shift away from the common model of transmitting electricity from large centrally located generating stations to load centers miles away, and its incorporation is creating the need for more advanced grid infrastructure.

Due to economies of scale and the electric utility industry history (discussed in Section 2.1), the electric grid consists predominantly of a few very large, centralized, baseload generation facilities with smaller, decentralized, intermediate and peak generation facilities. Distributed generation refers to energy produced on-site, nearest to end uses (energy consuming customers and equipment). Figure 6 shows the difference between these terms.

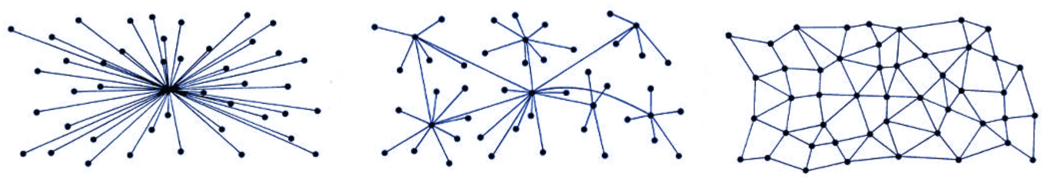

Figure 6. Energy System Characteristics

In a centralized system, electricity is provided by a single generating facility. In a decentralized system, smaller, more dispersed facilities connected to the central facility operate closer to consumers. Distributed generation produces electricity at or near the point of consumption and is connected to the utility distribution system.

Source: "The Law of Rule: Centralized, Decentralized and Distributed Systems." Canada Foundation for Napal. 3 Apr. 2009. Web. 1 Dec. 2015

A more advanced electricity grid is often referred to as the smart grid, which actually represents the collection of different technologies that are helping to automate and modernize the electricity grid (Figure7).

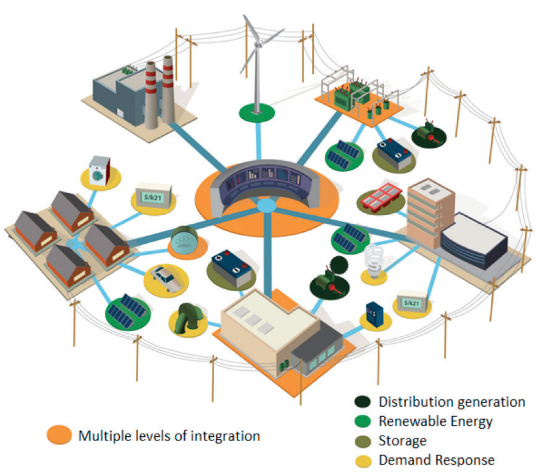

Figure 7. Aggregate electricity demand the utility must supply throughout a year. In North Carolina, utilities must meet customers' electricity demands, plus retain 15% reserve generation capacity.

Source: "South Korean Nuclear facilities hacked — Will there be a shutdown on Christmas?," Wyly Wade. December 2014

These technologies can include power meters, voltage sensors, fault detectors, and more. They are generally characterized by an ability for two-way communication between the device and power supplier. This flow of information allows the supplier to automate control and make adjustments to the network of devices that make up the grid. This provides for a more efficient, reliable, and resilient distribution of electricity. Smart grid technology has the unique ability to "self-heal", meaning the system can monitor itself to identify and react to system disturbances and initiate mitigation efforts to correct problems.[7]

Therefore, power supplied by the smart grid tends to have fewer and briefer interruptions compared with conventional technology. Smart grid technologies enable customers to see detailed information about their electricity usage. Usage information then may be used to make cost-effective decisions regarding energy efficiency measures, self-generation with renewable energy, the evaluation of utility programs and rate schedule options, and the identification of opportunities to adjust energy consumption behavior. Smart grid technologies are also being equipped with cyber security to help protect the grid against data breaches and other forms of attack. [7]

One of the reasons balancing the grid is such a complex activity is that electricity is a unique commodity that must be generated at the same time and in the same amount that it is needed to meet fluctuating demand. Generators must be ramped up and down to meet rising and falling load, but cannot do so immediately. Technology that allows electrical energy to be stored so it can be available to meet demand whenever needed has the potential to significantly increase the efficiency of the grid. **Energy storage** helps balance generation and load, smooth power output from variable resources such as solar and wind, and provide a variety of services to the grid such as frequency regulation and load following.[8]

Emerging technologies, such as **microgrids,** are integrating distributed generation resources with advanced smart grid technologies and energy storage to enhance the reliability of the facilities or areas they serve. Microgrids are smaller, localized electricity grids that are typically connected to the distribution grid, but have the ability to disconnect and operate independently from outside resources.[9] This ability to operate independently of the grid, known as islanding, enables microgrids to provide reliable power when the electricity grid is unavailable, such as during an extreme weather event.

Renewables in Relation to Resilience

Renewable energy can also improve the resilience of energy operations in the City. Resilience refers to a community's ability to bounce back stronger from adverse events and chronic stressors, such as economic recessions or climate change. **Resilience** incorporates sustainability and emergency management principles — relying on many of the same conservation, efficiency, and localization tactics as sustainability while remaining mindful that too much streamlining or localization makes a community more vulnerable to disruptions. The goal of resilience is to achieve an electricity system where critical infrastructure and services can be maintained despite adverse conditions. This is particularly valuable to the City's critical facilities where energy must always be available. Solar-powered water purification and personal communication systems are some of the many innovations that can be applied in emergency situations. Most renewable energy systems do not require inputs of fuel and therefore supply cannot be disrupted by adverse conditions affecting roads or pipelines. Renewable energy systems, energy efficiency measures, and demand management programs may help the City diversify its energy resources. Should one resource become scarce or unavailable, having the ability to substitute an alternate enhances system resilience.

7 U.S. Department of Energy. Office of Electricity Delivery and Energy Reliability. Smart Grid.
8 National Renewable Energy Laboratory. The Value of Energy Storage for Grid Applications. (2013).
9 U.S. Department of Energy. Office of Electricity Delivery and Energy Reliability. The Role of Microgrids in Helping Advance the Nation's Energy Systems.

Renewables contribute to grid efficiency, but they also offer the extended benefit of solving a wide range of operational challenges. Rooftop solar photovoltaic panels are often valued for their ability to reduce cooling demands by absorbing sunlight that would otherwise heat the building they are located on.[10] In other instances, floating solar panels can reduce algae formation on open pools of water and therefore reduce costs of water treatment.[11] Additionally, waste or wastewater can be used to directly produce methane for energy production or be applied to biomass or other crops as fertilizer.[12] Other wastes, such as fats, oils, and greases (FOG) created by the food industry, can also be converted to fuel rather than needing to be disposed.

Renewables in Relation to Economic Growth

In addition to making the City more reliable and resilient in terms of energy access, renewable energy has provided economic growth to the Raleigh area. The City is already home to the development, production, and distribution of many renewable energy technologies. The City of Raleigh can help to ensure minimal barriers to operating renewables at homes and businesses. The City of Raleigh's adopted Unified Development Ordinance already defines "Sustainable Energy Systems" and favorably addresses solar systems within City regulations to streamline the process for citizens wanting to install renewable energy on their properties.

Incorporating renewable energy into city operations is consistent with the City's rising prominence as a global hub for smart grid, solar, and energy research. Raleigh boasts more than 100 firms involved in the clean energy industry that employ 1,400 full-time workers and generate $440 million in revenues.[13] Using renewable energy in city operations can have direct, positive economic impacts on job creation related to installation, development, and maintenance. Money is spent on manufactured materials – often produced regionally – and on construction labor. This keeps the investments in North Carolina, spurring the state and local economy. Between 2007 and 2014, annual clean energy development investments in North Carolina increased nearly 20-fold, from $48 million per year to more than $900 million annually.[14] Partnering with business in the region will help demonstrate and promote their technologies and signify the City's commitment to innovation and growth of the local economy, as well as establish an environment consistent with the corporate sustainability goals of today's leading employers, including both Duke Energy and North Carolina State University.[15]

3.3. Financial Considerations of Renewable Energy

One of the most compelling reasons for incorporating renewable energy into the City's energy management plan is enhanced fiscal resilience.

Renewable energy systems can provide savings to the City through offsets in electricity purchases and peak demand charges, as well as act as a **hedge** against volatility in the prices of traditional generation fuels. There are a variety of factors that must be considered when attempting to finance and own renewable energy projects in North Carolina. State and federal tax laws, utility commission regulations, and even specific rate schedules all influence the costs and returns of a system.

10 Solar Energy. Effects of Rooftop Photovoltaic Panels on Roof Heat Transfer. (2011).
11 SPG Solar, Inc. Floatovoltaics Solar Power System: Overview and SPG Solar Statement and Qualifications. (2010)
12 The New Alchemy Institute. Methane Digesters for Fuel Gas and Fertilizer. (1973).
13 NC Sustainable Energy Association. 2014 North Carolina Clean Energy Industry Census. (2015).
14 RTI International, "Economic Impact Analysis of Clean Energy Development in North Carolina—2014 Update," NC Sustainable Energy Association (April 2014).
15 NC Sustainable Energy Association. Apple, Google, Facebook Urge North Carolina Legislators of Maintain Clean Energy Policies. (2015).

The prominent financial considerations for the City to take into account when developing renewable energy projects are provided below.

Total cost of ownership

When evaluating the installation of renewable energy systems, it is important to use a total cost of ownership approach. Most renewable energy systems do not have the associated fuel and maintenance costs associated with traditional generators and therefore **levelized cost of electricity (LCOE)**, or the average cost of electricity produced by the system over its lifetime, is the most appropriate way to compare its costs to those of traditional generation resources such as diesel generators or electricity purchased from the grid.[16] On an LCOE basis, renewable resources—such as wind, solar, geothermal, hydro, and biomass—are much closer to the costs of conventional electricity generation resources than if only capital expenditures are considered (Figure 8).

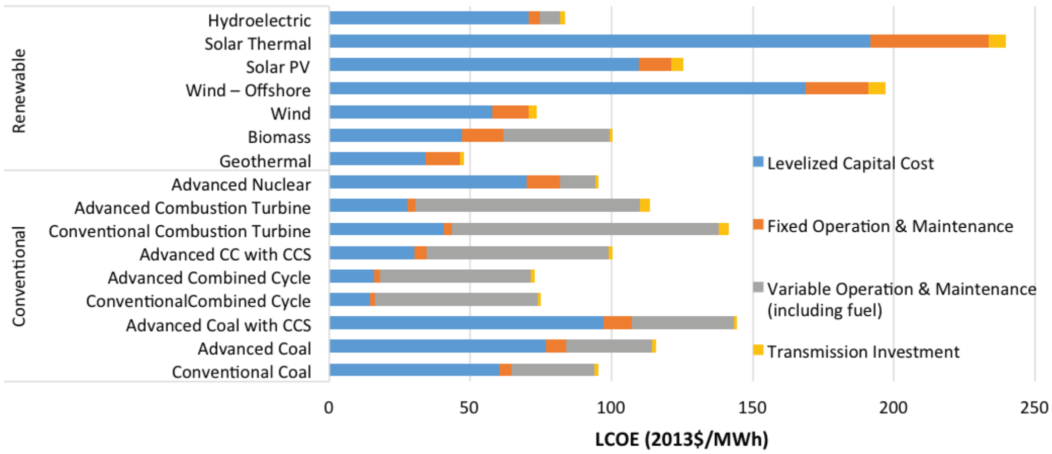

Figure 8. Estimated LCOE of US plants entering service in 2020.

Source: U.S. Energy Information Administration. Annual Energy Outlook. Levelized Cost and Levelized Avoided Cost of New Generation Resources. 2015

Additionally, costs of renewable energy systems have been falling steadily since their first deployment more than 40 years ago. Figure 9 shows the costs of solar PV panels over time.

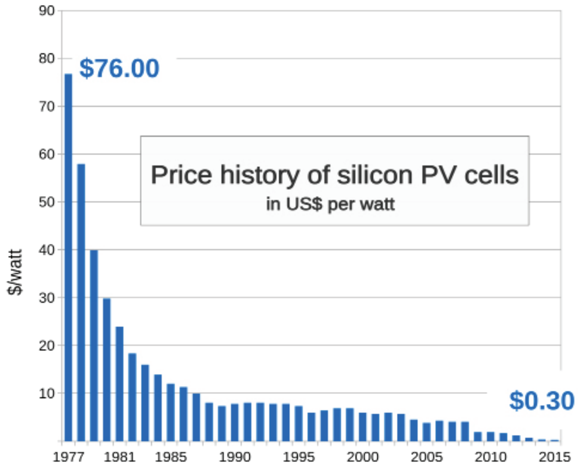

Figure 9.
The cost of silicon solar PV panels from 1977 to 2015. Prices for solar PV panels have decreased more than 99% since 1977 and 95% in the past 15 years.

Source: Bloomberg New Energy and Finance

16 U.S. Energy Information Administration. Annual Energy Outlook. Levelized Cost and Levelized Avoided Cost of New Generation Resources. (2014).

The levelized cost of electricity highlights the price hedging provided by renewables, as the cost of electricity produced is known preemptively for the 20+ year lifetime of the system, while costs of fuel dependent technologies are likely to vary widely over that time frame. Figure 10 shows the price of natural gas and petroleum over the last 20 years.

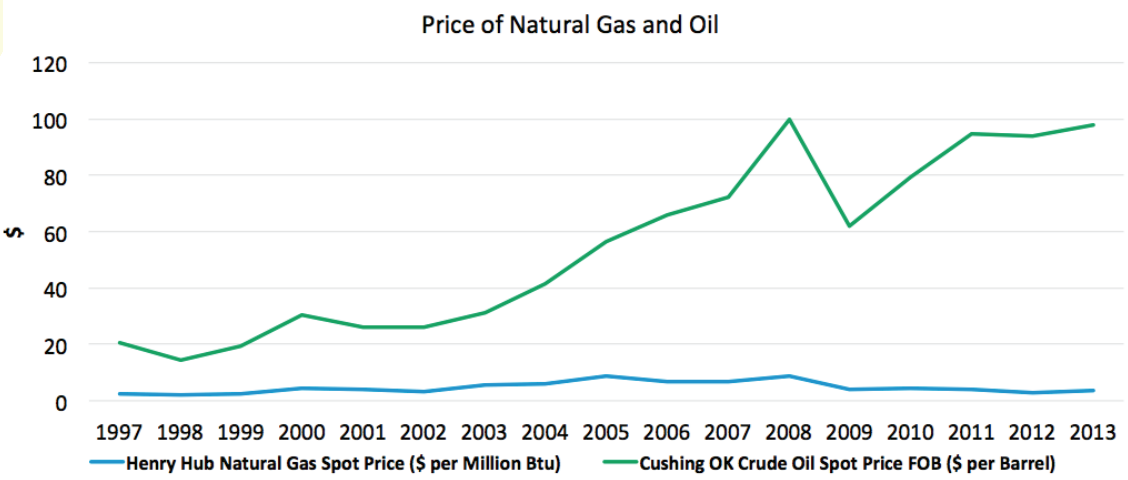

Figure 10. Price of Natural Gas and Oil

Source: U.S. Energy Information Administration Spot Prices

Distributed generation resources can also be used to offset utility demand charges and peak pricing costs at particular facilities. Large electricity customers are typically billed a demand charge each period based on their highest average electricity consumption over a fifteen minute period during the cycle. Renewable energy resources such as solar are able to produce the most energy during mid-afternoon hours, which is also when energy use may be the highest and demand charges are incurred. Figure 11 shows the energy production curve for solar PV systems. By offsetting some energy use during these high-use times, renewables can decrease the demand charges a customer must pay. Most utilities offer Time of Use (TOU) rates, where the price paid for electricity fluctuates depending on the hour of the day. These TOU rates reflect the higher costs for the utility of producing electricity during the periods of highest demand, such as hot summer afternoons, when they must deploy more expensive peak generation.

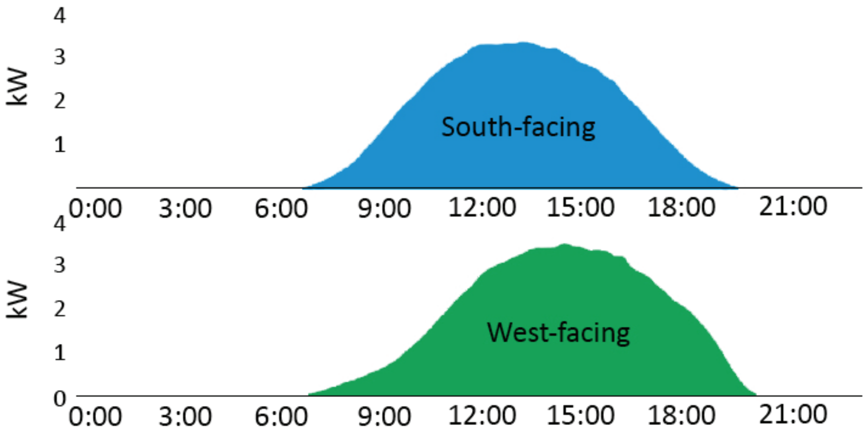

Figure 11. Average daily generation profile of rooftop PV systems

Source: Pecan Street Research Institute. 2013

Peak production for renewable energy systems such as solar PV often coincide with these times of high prices and can therefore offset utility energy purchases when it is most expensive, effectively lowering the rate paid for electricity from the grid.[17]

Net-metering

It is also important for the City to consider that current **net-metering** rules for North Carolina's public utilities (NCUC Docket No. E-100, Sub 83) allow for unused electricity generated by customer owned systems to be sold back to the centralized grid in exchange for a credit on their utility bill (Figure 12). Owners receive benefits from the energy produced by an on-site system even if the energy cannot be used by that location at a given time. Owners are credited the full retail rate of any net-excess generation on their ensuing month's electricity bill, but any remaining carry-overs are forfeited to the utility at the end of the year. Net-metering is offered to customers on all rate schedules, but the provisions can differ for customers on TOU rates. Additionally, **net-metering** is limited to projects of 1MW of capacity or less.

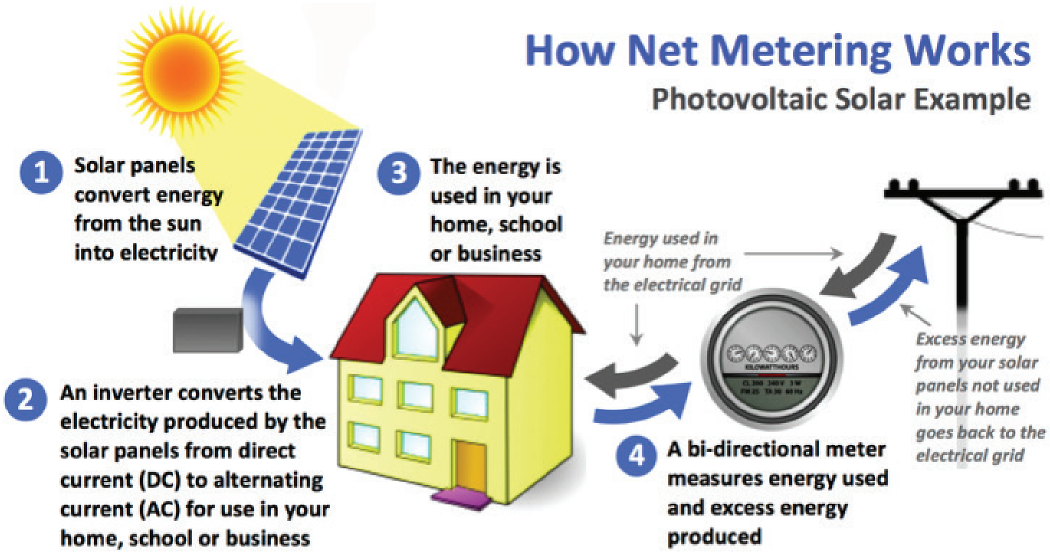

Figure 12. Flow of electricity for a residential rooftop solar PV system with net-metering

Source: Our Power Campaign

Larger systems are also eligible to sell their power back to the distribution grid. Under PURPA, owners of QFs, including renewable energy projects such as solar, wind, hydro, and landfill methane, are allowed to sell their electricity to the utility at the **avoided cost** – which is estimated as the cost utilities would incur to produce the power themselves. In North Carolina, these facilities must meet **interconnection standards** in order to connect to the grid. Avoided cost rates are recalculated by the utilities every two years in a proceeding before the NCUC.

Ownership Structures

City Owned

The financial benefits of a renewable energy system are dependent on their ownership structure. These structures range from outright City ownership, which allows the city to place the system on its property and utilize the produced power to the City only leasing space for another entity to generate the electricity and sell directly to our IOU, Duke Energy Progress. City-owned renewable energy systems can and do also participate in net-metering with the utility, by which the city would receive bill credits for the excess energy

17 Pecan Street Research Institute. (2013).

produced by the system. Ownership could also allow for city renewable energy systems to be used in conjunction with other technologies to create an islandable microgrid that could provide power during times it is unavailable from the utility.

Tax Credit

While renewable energy systems can certainly be large investments, there are currently federal tax credits (26 USC § 48) available to help offset the costs. These credits can be applied to the capital expenditures made in installing solar, fuel cells, small wind, and other renewable energy projects for up to 30% of the capital cost depending on the type of system. The City of Raleigh, however, is a non-taxed entity, and therefore cannot realize the benefits of these credits. Nevertheless, the city does have the option of utilizing novel financing structures to pass the incentives to federal tax-equity investors, known as "third parties" who have the appropriate tax appetite. These credits are scheduled to sunset December 31, 2016 with some technologies receiving a reduction in the eligible percentage of capital costs and others expiring completely.

North Carolina has offered both a personal and corporate Renewable Energy Investment Tax Credit (REITC, NC General Statue § 105-129.15 et seq.) to individuals and businesses who invest in specified renewable energy technologies. These credits have equaled up to 35% of the eligible property and cover many of the same technologies as the federal credit. The North Carolina REITC will expire December 31, 2015, since the NC General Assembly decided not to extend or gradually reduce this credit as a part of its 2015 budget.

Third Party Purchasing

The city may receive benefits from others owning and operating renewable energy systems on city property. This occurs when the city and a third party enter into an agreement by which that third party leases city property and then designs and installs a renewable energy system. The power produced by the system is then sold to the electric utility via a Power Purchase Agreement and payments are made to the third party owner and operator of the system. The city receives lease payments from the third party owner, but would not receive the electricity produced by the system and therefore the benefits provided by onsite generation.

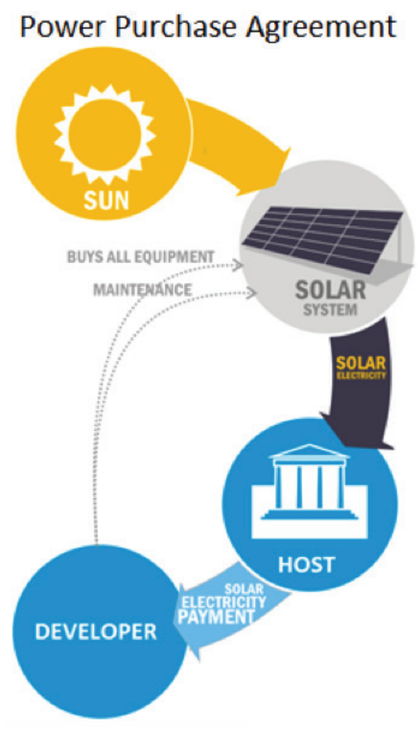

Figure 13.
A power purchase agreement is a contract between a developer & a host customer for electricity
Source: K12Solar

Third Party Sales

Third Party Sales are not currently allowed in North Carolina, but legislation to approve third party sales of electricity was introduced but not finalized or approved in 2015. Power Purchase Agreements and Third Party Financing are also models that can be used by other customers. These two primary models through third party sales, customers can use to contract with third party developers to finance, install, maintain and operate renewable generating projects: power purchase agreements (PPA) and third party financing. In both cases, the developer owns the system, while the host enters into a Power Purchase Agreement (PPA) to purchase the electricity directly from the developer thereby enjoying power from on-site generation and low, stable electricity prices over the period of the contract. A PPA consists of a developer constructing a renewable energy system on a customer's property at no cost (Figure 13). The power generated by the renewable energy system offsets the customer's utility electric bill, and power is purchased from the developer at a fixed rate that is generally lower than what is available through the utility. At the end of the PPA, the customer is often given the option of extending the contract or even purchasing the system.

Third Party Financing

The second type of third party financing is a lease model where a developer installs a renewable energy system on the customer's property and the customer leases the system for a period of years. Leases may be structured so that customers pay little or no upfront costs, and may include an option to purchase the system before the end of the lease term. This is similar to leasing models in other industries such as automobiles. This financing option is currently available in North Carolina, but generally precludes either party from utilizing applicable tax-credits towards capital expenditures.

4. City of Raleigh Renewable Energy Assessment Findings

Potential opportunities for renewable energy systems to provide savings, reduce its dependence on fossil fuels, and significantly lower carbon emissions for the City of Raleigh may exist.

The NC Sustainable Energy Association (NCSEA) partnered with the City of Raleigh's Office of Sustainability to develop this Renewable Energy Overview to address the objectives of increased operational resilience, lifetime cost savings, and economic development for both the city and its citizens. NCSEA provided technical expertise assessing the qualitative and limited quantitative data necessary and accessible for developing a comprehensive and actionable plan for deployment of renewable energy resources.

Methodology

NCSEA took a two-pronged approach to assess the City's status in implementing renewable energy projects. First, NCSEA conducted individual and group interviews with a broad array of City of Raleigh staff members to gain insight into their respective roles, previous and upcoming renewable energy projects, available sources of data, and desired outcomes pertaining to the project. Interviewees from various City of Raleigh departments and divisions answered a variety of questions about their roles in City operations and how they relate to renewable energy development. Respondents also provided feedback on what they believe are changes the City could make to encourage renewable energy development, and how they would measure the success of the Renewable Energy Plan. Second, NCSEA staff performed research on best practices by municipal governments for managing their energy resources.

The information provided during the interviews, as well as independently collected data, was used to determine the following findings about the City's situation regarding renewable energy. The summarized findings of the interviews identified strengths, weaknesses, opportunities, and challenges related to renewable energy implementation in City operations

The City of Raleigh is already a recognized leader in sustainability practices aimed at improving the quality of life for all residents, promoting emerging technologies, creating new job opportunities, and cultivating local business and entrepreneurs. Previous efforts and initiatives, including the completion of several renewable energy projects, have led to numerous awards for their success. With the stage set for further renewable energy development, this assessment is the next step in developing a long-term and comprehensive plan for incorporating renewable energy in municipal operations.

City of Raleigh Sustainability Accolades:

- 2013 NC Sustainable Energy Association Community Leadership Award
- Six 2012-2013 Public Technology Institute Solutions Awards
- 2012 Environmental Defense Fund National Climate Corps Award
- 2012 Community Champion for Plug-In Electric Vehicle Readiness
- Named Nation's Most Sustainable Midsized Community in 2011 by the U.S. Chamber of Commerce and Siemens

Knowledge of outside market and policy factors, as well as the state of energy operations within the City itself, is beneficial for planning future renewable energy projects. This assessment provides the foundational knowledge about trends in renewable energy, as well the North Carolina energy policy landscape, and has aggregated information about City energy processes from those involved. This information is valuable for shaping clear renewable energy objectives moving forward, something that multiple interviewees noted as not presently being in place.

Findings

Energy Consumption and Performance Information Not Readily Available

The most evident finding of this assessment was a lack of widely available information on the City's energy use and performance. While the City has already accomplished much in the way of improving energy consumption, interviewees mentioned that it was not possible for them to holistically assess energy use across the city without a central hub for data on fuel expenditures, traditional electricity purchases, and distributed energy production. Baseline measurements are a key component in the development of objectives for renewable energy implementation and this scarcity of data makes it difficult to measure the impact of existing policies and assess opportunities for the future.

Energy Planning Process

It was also discovered that the energy planning process in the City is not well organized, making informed renewable energy integration difficult. City staff mentioned during their interviews that there is a lack of structure for the systematic implementation, ownership, measurement, and communication of renewable energy projects. The current process for realizing renewable energy projects is very opportunistic, with the genesis for most ventures being an available funding opportunity.

Resources

Additionally, it was found that funding sources for renewable energy projects were limited. While the City's Sustainability Fund has provided the capital to develop small renewable energy projects in the past, there is not a dedicated resource for funding more installations moving forward.

Communication

Finally, it was noted by several interviewees that the City could improve upon its ability to communicate, both internally and externally, the benefits of increased renewable energy implementation. Raleigh has been, and will continue to be, a leader in sustainability and renewable energy, but there are gaps in the understanding of both citizens and City employees about the potential for reduced costs, decreased environmental impacts, and enhanced performance afforded by increased renewable energy utilization in municipal operations.

5. City of Raleigh Renewable Energy Recommendations

The following information will help the city maximize the operational efficiency of resources through data, planning, communication, and partnerships based on the findings and will increase the deployment of renewable energy resources within the City of Raleigh.

Energy Performance Measurements

Energy use is a critical consideration for nearly all City operations. A proactive and organized approach will systematically incorporate renewable energy while maintaining financial responsibility. Accurate, meaningful, and thorough measurement of all City energy use and production across all fuel types is essential to understanding the existing energy situation and identifying areas for further improvement. Data is the basis for the establishment of specific goals for improving energy performance in the City of Raleigh. An actionable renewable energy plan will then include benchmarks and timelines for the realization of these goals. Meaningful measurement tools will take into account variables for increased population and energy intensity of the City as it grows, and be regularly reviewed and reassessed to determine best practices.

Energy Planning Process

For Raleigh to continue to be a leader in renewable energy integration, a greater amount of organization around energy use and procurement in general is important to consider. Maintaining communication throughout project planning and management, involving the appropriate parties in identifying opportunities, designing projects, and optimizing operations is key to future success of renewable energy projects. Open interaction during the planning process will ensure appropriate staff are active participants from the onset of projects. Additional education for those involved in the budgeting, design, construction, and operations processes may be necessary to realize the maximum potential from available opportunities. Specifically, it will be advantageous to update business case evaluations for renewable energy projects to account for total cost of ownership rather than being limited to capital requirements. Further, the City can benefit from recognizing the accomplishments of the energy management program internally, as well as promoting them externally.

Financing Strategies

Future renewable energy investments will require funding for capital expenditures. Renewable energy systems often benefit from having no associated fuel costs, but are typically very capital intensive, with most of the costs incurred during the construction and installation of the project. Proper budget allocation to initiate projects will make it possible to realize new renewable energy integration in a systematic manner moving forward. Suggested strategies for financing models include public-private partnerships, creating an affiliated nonprofit entity, or developing a specific revolving loan fund for renewable energy projects. An increase in available money for renewable energy would indicate significant commitment toward achieving related goals.

Communication and Education

Better communication of the benefits and successes of renewable energy integration by the City is also valuable. By understanding renewable energy goals, actionable directives will provide guidelines for success. It will be useful for the City to have open communication with the staff who will be involved in the operation and maintenance of the project on a daily basis.

Partnerships

Raleigh could also benefit from establishing working relationships with those organizations attempting to bring new renewable energy technologies to market. These include the many local colleges and universities, local companies, and even the electric utility. Partnerships with these firms can allow the City to implement new technologies at little or no cost and foster the development of economic growth in the region by incubating products on their way to maturity. Duke Energy has partnered with the City of Raleigh on a number of renewable projects and continues to be a supporter of these projects. Additional partnership opportunities may encourage the use of renewable energy by citizens and allowing them to benefit from lessons learned through municipal implementation. By educating the public about the benefits and lessons learned from projects the City has already undertaken, they can inspire greater adoption of renewables in the area.

Policy Changes

The City of Raleigh currently has a variety of options for implementing renewable energy in municipal operations. The City has the opportunity to become an active participant in shaping the renewable energy landscape by engaging in the process of developing new rules and regulations for renewables in North Carolina. Groups such as the North Carolina League of Municipalities, the North Carolina Metropolitan Mayors Coalition, and NCSEA are advocates for effective renewable energy regulations that help make the benefits discussed above available to all consumers. The City can engage with these organizations, and support their efforts at the North Carolina General Assembly and the NCUC.

Conclusion

This assessment has shown that energy is both a substantial expense to the City and a vital component of day to day operations; therefore, it is worthy of careful consideration. This report outlines the intricacies associated with energy planning, but also highlights the important opportunity presented by renewable energy systems to lower costs and increase resiliency for the city.

While the City of Raleigh has shown leadership in sustainability and made improvements in the efficiency of buildings and operations, this assessment found that it is lacking readily available energy-use data and a clear plan for its energy future. Building on the fundamental understanding of the energy landscape provided in this report, the City has the opportunity to establish metrics to track its energy performance, as well as outline an actionable path toward well-informed objectives that account for advances in technology and policy.

Lowering costs and increasing resilience will require that the City take a proactive and long-term approach when considering its energy needs. While renewable energy systems can be capital intensive, a total cost of ownership approach that includes analyses of price hedging, state and federal tax laws, and utility commission regulations will most accurately represent the value of any investment. Further, fostering partnerships with both public and private organizations may lead to additional opportunities to implement new technologies at the best possible cost.

Finally, because energy is a highly regulated industry and subject to political intervention, it is critical that the City actively track developments in laws, policies, and regulation related to energy, as any change can have a significant impact on the cost and function of City operations. The City has the opportunity to shape North Carolina's energy landscape by supporting the development new rules and regulations that allow renewables to compete on price and quality with traditional generation.

Glossary of Terms

Aggregate power demand	The total amount of electricity utility customers consume within a period
Alternating current (AC)	Type of current in which the flow of electric charge reverses direction frequently, allowing the voltage to change
Avoided cost rate	The cost utilities would otherwise incur to produce the power obtained from qualifying facilities
Baseload	The continuous level of electricity demand that is often met with nuclear and coal plants that take time to come online and are inexpensive to run for long periods of time
Biomass	Combustion of organic and waste materials (e.g. plant-based sources, municipal wastewater, and municipal solid waste), or their conversion to biofuels, such as methane
Cogeneration	Use of waste heat to generate electricity
Commercial/general	Utility market segment that includes businesses, such as stores and offices
Critical peak pricing (CPP)	Utility pricing that spikes dramatically when qualifying critical events occur
Curtailable/interruptible service	Electricity rider that provides customers a bill credit for decreasing energy use by a certain amount during critical peak periods
Demand charges	Charges to larger utility consumers that reflect the cost of additional investments needed to meet their load that are based on the peak demand of these customers during a billing period
Direct current (DC)	Type of current in which electrical charge flows in one direction
Distributed generation (DG)	Power generation located close to the load they serve to produce energy on-site or at the point of consumption
Distributed resources (DR) Distributed energy resources (DER)	Energy resources that are able to be located close to their point of consumption (e.g. rooftop solar panels)

Energy Policy Act of 2005	U.S. bill that provide tax incentives and loan guarantees to allow alternative energy sources and innovative technologies that reduce greenhouse gas emissions to be more competitive in electricity markets
Energy resources that are able to be located close to their point of consumption (e.g. rooftop solar panels)	The collection of different technologies (power meters, voltage sensors, fault detectors, and more) generally characterized by an ability for two-way communication between the device and power supplier to help automate and modernize the electricity grid
Energy storage	Storage of electrical energy that is available to meet demand whenever needed
Federal Energy Regulatory Commission (FERC)	U.S. federal independent agency that regulates interstate transmission of electricity, natural gas, and oil
Geothermal	Use of thermal energy (heat) stored in the Earth to generate electricity (Ground Source Heat Pump (GSHP) technology is used as a central heating and cooling system to transfer heat to or from the ground)
Hedge	Investment strategy intended to reduce or offset potential losses from other investments
Hydropower	Conversion of the force of falling or flowing water, including marine waves, for useful purposes such as generating electricity or creating mechanical force
Independent System Operators (ISOs)	Independent, federally regulated entities established to coordinate regional electricity transmission in a non-discriminatory manner and ensure the safety and reliability of the electric system
Industrial	Utility market segment that includes manufacturers and other large users of electricity
Interconnection standards	Requirements for connecting electrical generation systems to the grid

Intermediate	The load between baseload and peak load met with generation that takes less time than baseload generators to come online, such as combined cycle natural gas and solar photovoltaics
Investor-owned utilities (IOU)	Privately-owned electric utilities whose stock is publicly traded and rate regulated and authorized to achieve an allowed rate of return
Islanding	The ability of a generator to operate independently of the grid
Levelized cost of electricity (LCOE)	The average cost of electricity produced by a system over its lifetime
Market segments	Utility customer groups (residential, commercial/general, industrial) based on similar characteristics, such as quantity of power needed, voltage requirements, and accounting preferences
Microgrid	Smaller, localized electricity grids that are typically connected to the distribution grid, but have the ability to disconnect and operate independently from outside resources
Net-metering	Billing mechanism that allows the unused electricity generated by customer owned systems to be sold back to the utility in exchange for a credit on their utility bill
North Carolina Utilities Commission (NCUC)	North Carolina agency that regulates rates and services of all public utilities in the state
Peak	The highest demand of electricity within a period that is usually met with the most expensive generation plants, such as fuel oil and natural gas turbine, that can ramp up and down quickly
Power purchase agreement (PPA)	A financial agreement in which a developer installs, operates, and maintains an electrical system on a customer's property at little to no cost in return for the customer purchasing the power generated at a fixed rate for a predetermined period

Price hedging	Investment strategy intended to reduce the risk of adverse price movements in the market
Public Utilities Regulatory Policies Act of 1978 (PURPA)	Policy that requires utilities to purchase power from qualifying facilities and allows states to set the price these generators receive for selling their power to the utility at the avoided cost rate
Qualifying facility (QF)	A small power production facility (80 MW or less) or cogeneration facility that meets status requirements under PURPA and part 292 of FERC Regulations
Rates	Price each customer pays for a unit of electricity (based on both quantity and time)
Real-time pricing (RTP)	Utility pricing that varies in real time with the utility's actual power production costs
Regional Transmission Organizations (RTOs)	Independent, federally regulated entities established to coordinate regional electricity transmission in a non-discriminatory manner and ensure the safety and reliability of the electric system
Reliable	Characteristic of energy source that experiences fewer and shorter periods of unavailability
Renewable Energy and Energy Efficiency Portfolio Standard (REPS)	North Carolina bill passed in 2007 that requires investor-owned utilities to generate 12.5% and municipal utilities and electric cooperatives to generate 10% of electricity needs with eligible renewable energy resources or energy efficient measures by 2021
Residential	Utility market segment that includes houses and apartments

Resilience	Resilience refers to a community's ability to bounce back stronger from adverse events and chronic stressors, such as economic recessions or climate change. Resilience incorporates sustainability and emergency management principles — relying on many of the same conservation, efficiency, and localization tactics as sustainability while remaining mindful that too much streamlining or localization makes a community more vulnerable to disruptions
Riders	Changes to a tariff approved by the utilities commission to reflect specialty services or additional expenses incurred by the utility
Solar photovoltaic (Solar PV)	Direct conversion of sunlight into electricity through photovoltaic cells
Solar Thermal	Harnessing of sunlight to meet thermal requirements for residential, commercial, or industrial processes through concentration of light from the sun to create heat energy used to generate electricity
Supplementary/standby service	Electricity rider for large customers that require the utility to build and hold spare generation capacity in reserve
Tariffs	Utility market segment that includes manufacturers and other large users of electricity
Time variant pricing	Utility pricing that changes to reflect the different costs of supplying electricity throughout the day and year
Time-of-use (TOU) pricing	Utility pricing that remains constant within seasonal and hourly blocks
Unified Development Ordinance	Ordinance adopted by City of Raleigh that defines "Sustainable Energy Systems" and favorably addresses solar systems within City regulations to streamline the process for citizens wanting to install renewable energy on their properties
Wind	Harnessing of wind energy that includes, but is not limited to, wind turbines for the creation of electricity and windmills for mechanical power

Appendix A: City of Raleigh Staff Interviews with NCSEA

Assistant City Manager (Services)
Date: 10/28/2014
Time: 1:00 PM – 2:00PM
Location: City of Raleigh Offices, 222 Hargett Street, 2nd Floor
City of Raleigh Personnel: Tansy Hayward
NCSEA Personnel: Robin Aldina, Elizabeth DeMarco

Construction Management
Date: 7/30/2014
Time: 10:00am – 11:00am
Location: City of Raleigh Offices, One Exchange Plaza, 8th Floor
City of Raleigh Personnel: Richard Kelly, Danny Bowden
NCSEA Personnel: Robin Aldina, Elizabeth DeMarco

Facilities and Operations
Date: 8/7/2014
Time: 10:00 AM – 11:15AM
Location: City of Raleigh Offices, 222 Hargett Street, 6th Floor
City of Raleigh Personnel: Billy Jackson, Suzanne Walker, Willistine Hedgepeth
NCSEA Personnel: Robin Aldina, Elizabeth DeMarco

Finance
Date: 7/15/2014
Time: 3:00 pm – 3:30 pm
Location: City of Raleigh Offices, 222 Hargett Street, 1st Floor
City of Raleigh Personnel: Allyson Wharton
NCSEA Personnel: Robin Aldina, Elizabeth DeMarco, William Supple, Ellis Baehr

Legal
Date: 7/31/2014
Time: 10:30AM – 11:45AM
Location: City of Raleigh Offices, One Exchange Plaza, 10th Floor
City of Raleigh Personnel: Carolyn Bachl, Dan McLawhorn
NCSEA Personnel: Robin Aldina, Elizabeth DeMarco

Public Utilities
Date: 8/6/2014
Time: 11:30AM – 1:00PM
Location: City of Raleigh Offices, One Exchange Plaza, 6th Floor
City of Raleigh Personnel: Kenny Waldroup, Aaron Brower, TJ Lynch, Michele Mallette
NCSEA Personnel: Robin Aldina, Elizabeth DeMarco

Solid Waste Services
Date: 7/22/2014
Time: 4:00pm – 5:00pm
Location: Wilder's Grove Solid Waste Services Facility, 630 Beacon Lake Drive, Raleigh
City of Raleigh Personnel: Fred Battle, Andrew Martin
NCSEA Personnel: Robin Aldina, Elizabeth DeMarco

Sustainability (Hinson/Prosser)
Date: 7/11/2014
Time: 11:00 am – 12:45 pm
Location: NCSEA Offices, 1111 Haynes Street, Raleigh
City of Raleigh Personnel: Robert Hinson, Julian Prosser
NCSEA Personnel: Robin Aldina, William Supple, Ellis Baehr

Sustainability (Thomas/Holmes)
Date: 7/31/2014
Time: 12:00pm – 1:30pm
Location: City of Raleigh Offices, 222 W Hargett Street, 3rd Floor
City of Raleigh Personnel: Paula Thomas, Cindy Holmes
NCSEA Personnel: Robin Aldina, Elizabeth DeMarco, Ivan Urlaub

Transportation
Date: 9/10/2014
Time: 12:00pm – 1:30pm
Location: City of Raleigh Offices, 222 W Hargett Street, 3rd Floor
City of Raleigh Personnel: Mike Kennon
NCSEA Personnel: Robin Aldina, Elizabeth DeMarco

Appendix B: City of Raleigh Energy Roles

Assistant City Manager

The Office of the City Manager is responsible for the administration of the City of Raleigh. Along with the City Manager, three Assistant City Managers are responsible for the operations of the City. The Services Manager oversees Public Utilities, Public Works, Solid Waste Services, Sustainability, and Internal Audit. This role is responsible for developing the policies that will lead to the optimal utilization of renewable energy across multiple departments.

Construction Management

The Construction Management Division of the Public Works Department provides engineering and project oversight for the construction and renovation of all buildings owned by the City, excluding Public Utilities and Parks, Recreation, and Cultural Resources Department facilities. They ensure that renewable energy projects are considered during planning and design, and are implemented properly during construction of new city facilities.

Facilities and Operations

The Facilities and Operations Division of the Parks, Recreation, and Cultural Resources Department, Facilities maintains all of the city's facility assets, except Public Utilities and Convention Center. They also provide general specifications for utilities, rates and payment.

Finance

The City of Raleigh Finance Department provides a variety of services such as treasury, accounting, purchasing, revenue management, payroll, reporting, and risk management. They are responsible for evaluating the financial viability of renewable energy projects.

Legal

The City Attorney and Office provide legal advice to the Mayor, City Council, and other Departments, as well as represent the City of Raleigh's interests in Federal and State courts, the General Assembly, and other judicial bodies. They are responsible for developing contracts between the City, property owners, contractors, and private citizens in order to realize renewable energy projects.

Public Utilities

The Public Utilities Department is charged with providing safe, sustainable water services for approximately 500,000 customers in Raleigh and surrounding towns, while protecting public health and contributing to the economic, environmental and social vitality of our communities.

Solid Waste Services

The Solid Waste Services Department provides reliable waste collection and disposal, among other specialized services, in the City of Raleigh. They are charged with reducing waste and increasing recycling within the city.

Sustainability

The Office of Sustainability works across departments to protect fiscal and non-fiscal resources, promote social equity, and foster economic strength for the City of Raleigh through the use of innovative technology and thinking. They collaborate with many other departments to initiate renewable energy projects.

Transportation

The Transportation Operations Division of the Department of Public Works is responsible for managing the City of Raleigh's transportation and parking infrastructure and is broken down into three programs: Traffic Engineering, Parking Management and Transportation. They are responsible for integrating alternative fuel vehicles as well as renewable energy systems in Transportation infrastructure.

Appendix C: List of Existing Renewable Energy Projects

Alternative Fuel Vehicles

R-Line Buses: Hybrid

Size: 3 buses
Ownership Structure: City Owned
Parties Involved: City of Raleigh
Notes: These buses may be placed into regular CAT service at some point in the future.

Solar Photovoltaic

Raleigh Convention Center: Electric Vehicle Charging Station

Size: 3kW
Date Installed: 2011, repurposed in 2013
Ownership Structure: City Owned, Funded by Progress Energy
Parties Involved: City of Raleigh, Progress Energy Carolinas, NC State University
Notes: The City of Raleigh donated the charging station to The North Carolina State University FREEDM Center on NCSU's Centennial Campus where they will continue to be used for research and outreach.

Raleigh Convention Center: Rooftop

Size: 500 kW
Date Installed: June 2011
Ownership Structure: Third Party Lease
Parties Involved: City of Raleigh, FLS Energy, PowerWorks
Notes: City has the option to purchase the array beginning on June 29, 2018.

Annie Louise Wilkerson, M.D. Nature Preserve Park

Size: 2.5kW
Ownership Structure: City of Raleigh Owned
Parties Involved: City of Raleigh
Notes: This is a small system used principally for demonstration purposes at the park. At this point in time the array is directly connected to the site lighting bollards and car charging station

Brentwood Road Operations Center

Size: 29.61kW
Date Installed:
Ownership Structure: City of Raleigh Owned (Parks and Recreation)
Parties Involved: City of Raleigh
Notes: Issues with the array went undiagnosed for a number of months.

EM Johnson Water Treatment Plant

Size: 250kW
Date Installed: December 2009
Ownership Structure: Third Party Lease
Parties Involved: City of Raleigh, Carolina Solar Energy
Notes: Carolina Solar Energy holds a 20-year lease, but the City of Raleigh has an option to purchase the system beginning on the first day of the seventh year (December 31, 2016).

Wilder's Grove Solid Waste Services Center

Size: 73.5kW
Date Installed:
Ownership Structure: City of Raleigh Owned
Parties Involved: City of Raleigh

Notes: A 50kW array is mounted to the Solid Waste Administration Building and an additional 25kW array is mounted on the Vehicle Wash Facility. The two arrays meet approximately 12.5% of the facilities electricity needs, and are on a net-metering rate schedule with Duke Energy.

Neuse River Waste Water Treatment Plant

Size: 1,300kW
Date Installed: 2011
Ownership Structure: Third Party Lease
Parties Involved: City of Raleigh, NextGen, Southern Energy Management
Notes: The City of Raleigh is leasing approximately 9 acres of land at the Neuse River Waste Water Treatment Plant. NextGen financed and developed the projects, which was installed by Southern Energy Management. The City has the option to purchase this array on the first day of the 7th year of the lease (December 23, 2018).

Capital Area Transit (CAT) Operations and Maintenance Facility

Size: 5.26kW (22 240W DC panels)
Date Installed: May 2011
Ownership Structure: City of Raleigh Ow ned and on a net metering schedule with Duke Energy.
Parties Involved: City of Raleigh, ARRA Grant Funding, Rebark Enterprises
Notes: System is net-metered at the CAT O&M Facility

Bus Stops at Capital Blvd and Spring Forrest Road

Size: Two solar powered real time passenger information signs using one panel each to power an LED sign inside the shelters.
Ownership Structure: City of Raleigh Owned

Solar Thermal

City of Raleigh Municipal Building
In 1985, the City of Raleigh installed a solar thermal system on the roof of the Municipal Building located at 222 West Hargett Street.

Fire Stations Number 1, 6, 9, 15, 16, and 17

Solar thermal hot water heating systems supplement natural gas units at some of the City's Fire Stations. Installed solar collectors on top of the stations' roofs provide hot water for station needs.

Solar LED Lights

Campbell University Parking Lot
Ownership Structure: City Owned
Parties Involved: City of Raleigh, Campbell University School of Law

Raleigh City Plaza

Ownership Structure: City Owned
Notes: The City of Raleigh was the first NC municipality to install solar-powered LED street lights.

Marsh Creek Park Operations Facility

Size: 1,300kW
Date Installed: June 2011
Ownership Structure: Third Party Lease
Parties Involved: City of Raleigh

Biofuels

Neuse River Wastewater Treatment Plant Biofuel Processor

Size: 3,000 gallons/year
Date Installed: Scheduled completion in October 2015
Ownership Structure: City of Raleigh
Parties Involved: City of Raleigh, N.C. Department of Agriculture, NCSU
Notes: The City of Raleigh received a $100,000 grant from the Biofuels Center of North Carolina (BCNC) to build facilities to produce biodiesel from sunflowers grown at the Neuse River Waste Water Treatment Plant. The BCNC was defunded in 2013, but the grant remains and now resides with the Department of Agriculture. The 3,000 gallons of biofuels produced annually are used in the City of Raleigh Fleet Operations and at the Waste Water Treatment Plant.

Methane Recovery

Wilders Grove Solid Landfill

Date Installed: 1989
Ownership Structure: City Owned
Parties Involved: City of Raleigh, Ajinomoto Amino science LLC
Notes: The system was originally privately owned, and then purchased by the City in 2004. It generated up to $10,000/month in revenue depending on methane production levels. Current levels have decreased as the landfill has aged.

Geothermal

Capital Area Transit (CAT) Operations and Maintenance Facility

Size: 150 wells, each 300' deep
Date Installed: May 2011
Ownership Structure: City Owned
Parties Involved: City of Raleigh, Talbott and Associates
Notes: 29,000 sq. ft. Administrative building and cooling and radiant heating of Maintenance Building. Capital cost of approximately $720,000 with a payback period of just over six years.

Wilder's Grove Solid Waste Services Center

Size: 60 wells, each 330' deep
Date Installed: March 2012
Ownership Structure: City Owned
Parties Involved: City of Raleigh
Notes: 24,000 sq. ft. Administrative Building. Estimated annual savings of 30% HVAC and 20% Hot Water. Estimated payback period of six years.

Pullen Park

Howell Lake now includes a submerged Lake Plate Heat Exchange Geothermal heating and cooling system for the historic carousel building. The system utilizes the constant water temperature of the lake demonstrating the use of modern green technology to preserve the historical and cultural heritage of the City.

Appendix D: Personnel Contacts

Provided below is a list of contacts for information regarding City of Raleigh renewable energy projects.

Kenny Waldroup
Department: Public Utilities
Information Description: Construction Management for Public Utilities

Suzanne Walker
Department: Parks, Recreation, and Cultural Resources
Information Description: Energy Usage and Production Data

Dick Bailey
Department: Parks, Recreation, and Cultural Resources
Information Description: Construction Management for Parks & Recreation

Roger Krupa
Department: Convention Center
Information Description: Performing Arts Center, Convention Center, Amphitheaters (Red Hat and Walnut Creek)

John Bove
Company: AECOM
Information Description: Wilder's Grove Methane Recovery Air Quality and Inventory Reports

Bill Black
Department: Construction Management
Information Description: Wilder's Grove Methane Recovery System

Kevin Adams
Department: Construction Management
Information Description: Wilder's Grove Methane Recovery System Meter Data