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City of Raleigh Renewable Energy Overview

Background, Assessment & Recommendations

NC SUSTAINABLE ENERGY ASSOCIATION

CITY OF RALEIGH
ESTABLISHED 1792
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

As energy costs steadily increase over time, it is vital that Raleigh continue to maintain and further enhance its robust and stable infrastructure and economy to meet its growing needs. In addition, the City of Raleigh's Strategic Plan points toward maintaining and improving the qualities that make Raleigh an outstanding city. The City's energy expenses for electricity and fuel are its second largest operating cost behind only personnel costs.

Section 1 provides an introduction to the overview and assessment of the City's current energy operations. 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. This assessment does not provide analysis of alternative fuels or transportation opportunities for the City's 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. The timeline of developments shows how the electricity system expanded from a patchwork of a few small generating stations to a nationwide network delivering power to nearly every home and business in America. Section 2.2 provides insight into the complicated process of utility billing. Understanding the available electricity rates helps the City optimize its energy use and minimize its power bills.

Section 3 looks at how recent technological advancements, production improvements, and increased investments continue to make 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. Section 3 also includes an assessment of the financial considerations the City takes into account when evaluating renewable energy systems, such as price hedging, state and federal tax laws, and utility 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 dependence on fossil fuels, and significantly lower carbon emissions for the City of Raleigh. This section also details how the current state of the City's energy operations were 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. These recommendations encourage continued collaboration in the overall energy planning process.

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. [1] Ensuring that Raleigh meets its needs as a growing city will involve maintaining a robust and stable infrastructure and economy as energy costs steadily increase over time.

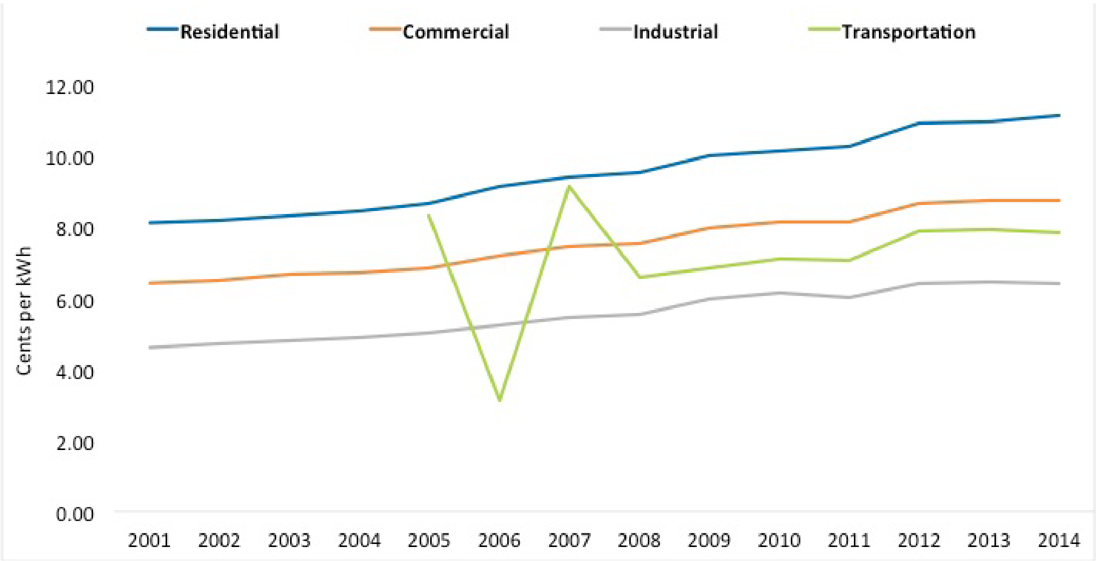

Figure 1 Average Retail Price of Electricity in North Carolina

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 Electricity Data Browser. 2014

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, and 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]

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

The emergence of smart grid, distributed energy, demand response, and other technologies will only hasten the need for energy innovation, and 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. Clean energy technologies encompass both renewable energy and energy efficiency. Renewable energy resources such as biomass, geothermal, hydropower, solar, and wind generate electricity with lower carbon emissions compared to traditional fuels, while energy efficiency measures reduce energy consumption. Recent advances in technology, investment, and 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 a reduced dependence on fossil fuels and significantly lower carbon emissions. These economic, environmental, and societal benefits extend beyond City operations to the larger community, where residents and businesses will profit as well.

Raleigh has long been recognized as a national leader in renewable energy. The City is 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". However, because energy is a complex topic, understanding it on a broad scale is useful for successful management of resources. With the City having more than 900 different electric utility accounts, optimizing energy use can be very complicated.

In order to move forward with the goal of implementing a renewable energy plan for the City set forth by the CEAP, it is first necessary to acquire an understanding of broad energy topics and their relation to the City's needs. The City has had a long-term commitment to review utility rates and consumption patterns in municipal operations. In addition, continued attention to renewable energy, current energy use, resources, and planning within the City is needed. 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 U.S. have nearly unlimited and immediate access to electricity due to the complex infrastructure system developed over the last 100 years. Now, new technologies and policies are changing the way we use energy.

While customers in the U.S. have come to expect electricity to be available whenever they want it, the system of production, transmission, and delivery of electricity in the U.S. is exceedingly complex. Electricity is produced by traditional resources such as coal, oil, natural gas, and uranium, as well as renewable resources, such as solar, wind, and biomass. The electricity is then transmitted over wires for many miles to be utilized for countless processes. 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 shows the current mix of generating resources in North Carolina.

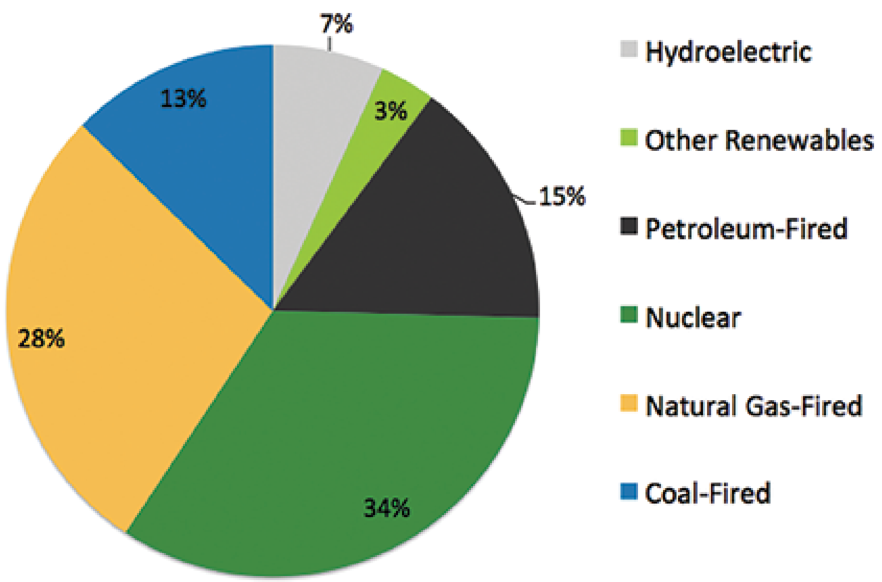

Figure 2. North Carolina electricity generation by fuel type

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 U.S. 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.

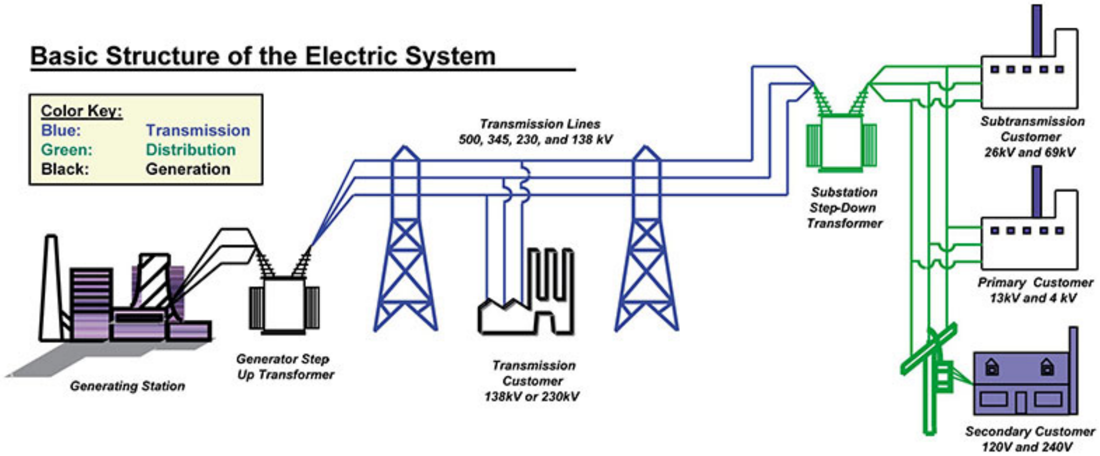

Figure 3. The electric grid consists of an intricate network of generation, transmission, and distribution. Customers' supply and demand for power must match exactly since energy storage is not currently widely available.

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

AC Emerges (1882 - 1899) On September 4, 1882, Thomas Edison's Pearl Street Station in Manhattan began providing direct current (DC) electricity to 400 nearby lamps, becoming the first central power plant in the U.S. 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 and with less losses compared to Edison's DC generators, which needed to be located within a mile of their load. When the hydroelectric plant at Niagara Falls began sending AC electricity to Buffalo, NY, 20 miles away, AC power became the dominant technology.

Urban vs. Rural (1900 - 1928) In the early part of the 20th century, privately owned and unregulated electric companies developed around major cities and towns throughout the country. These companies realized that large centralized power plants operated more efficiently than smaller resources and that urban locations allowed them to serve as many customers as possible with minimal transmission infrastructure.[4] While urban areas enjoyed a competitive electricity market, rural areas had limited access due to the high cost of running wires through sparsely populated areas.

A New Deal (1929 - 1944) During the Great Depression, President Franklin D. Roosevelt enacted the New Deal policies to stimulate the economy and provide jobs. Some New Deal programs aimed to bring power to a greater percentage of Americans through the construction of electric power 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 their service territories. These public utilities were owned by shareholders and encouraged to make infrastructure investments 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 located within the territory of Duke Energy Progress, one of the investor-owned utilities (IOU) that has monopoly rights to sell electricity in North Carolina.

Golden Age (1945 - 1975) Most of today's grid infrastructure was installed 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.

A New Era (1976 - 1980) The energy crisis of the 1970s led to the emergence of environmentalism and 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. This price is known as the avoided cost rate or 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.

Deregulation (1981 - 1999) Following the deregulation of the airline, telecommunication, railroad, and natural gas industries in the 1980s, certain states deregulated their electric markets during the 1990s and early 2000s, undoing the vertically-integrated, regulated monopolies in an attempt to lower electric rates. In 1992, the Federal Energy Regulatory Commission (FERC) began requiring open access to electric transmission lines and encouraging the formation of third-party Independent System Operators (ISOs) and Regional Transmission Organizations (RTOs) to optimally coordinate generation and transmission of power within regions.

Energy Meets Policy (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 made alternative energy sources and innovative technologies that reduce greenhouse gas emissions more competitive in electricity markets. In 2007, to further promote renewable energy within the state, North Carolina became the first Southeast state to adopt a Renewable Energy and Energy Efficiency Portfolio Standard (REPS). This law requires investor-owned utilities to generate 12.5% of their electricity sales with eligible renewable energy resources or energy efficient measures by 2021. Municipal utilities and electric cooperatives must meet 10% of load within the eligible resources. North Carolina utilities are currently meeting the REPS requirements for renewable energy and energy efficiency, as well as carve-outs for solar energy, but have not yet satisfied set-asides for electricity generated swine and poultry waste.[7]

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.

7 North Carolina Utilities Commission. Annual Report Regarding Renewable Energy and Energy Efficiency Portfolio Standard in NC, October 1, 2015.

2.2 Electricity Rates and Billing

Utility billing may be complicated, making it difficult for customers to optimize their energy use and minimize payment.

Customers of investor owned electric utilities pay rates that are set by regulators at the North Carolina Utilities Commission (NCUC). Rates 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). The NCUC reviews rates for necessity and appropriateness and must approve requested rate changes before the utility may implement a new rate. In addition to recouping utilities' operating costs, approved rates allow utilities to earn a reasonable 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 regardless of when they use the electricity. The utilities, however, incur different costs for delivering electricity based on the time of day and the time of year when it is generated, which are not reflected in fixed rates. Customer demand for electricity 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 create high levels of demand for heating and cooling. Demand is lower in the nighttime hours when businesses are closed and customers are sleeping, but higher in the afternoon when people are most active.

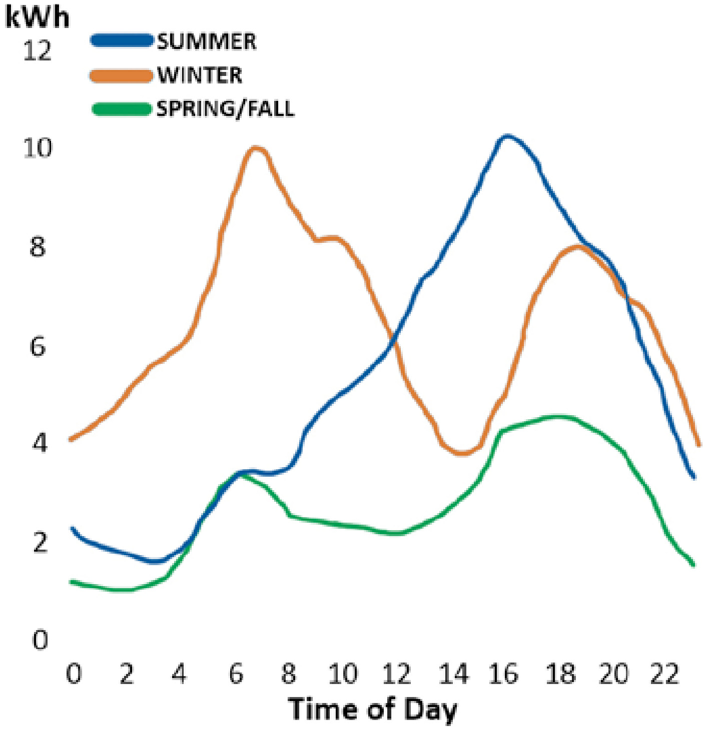

Figure 4. Seasonal Electricity Demand

Source: U.S. Energy Information Administration, "Residential Energy Plus 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). As previously mentioned, 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. The nuclear and coal power plants that are used to meet the continuous level of demand, known as the baseload, are often 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 the most expensive peaker plants such as those that burn fuel oil and some natural gas turbines can ramp up and down quickly but typically operate only during the few hours of highest demand throughout the year.

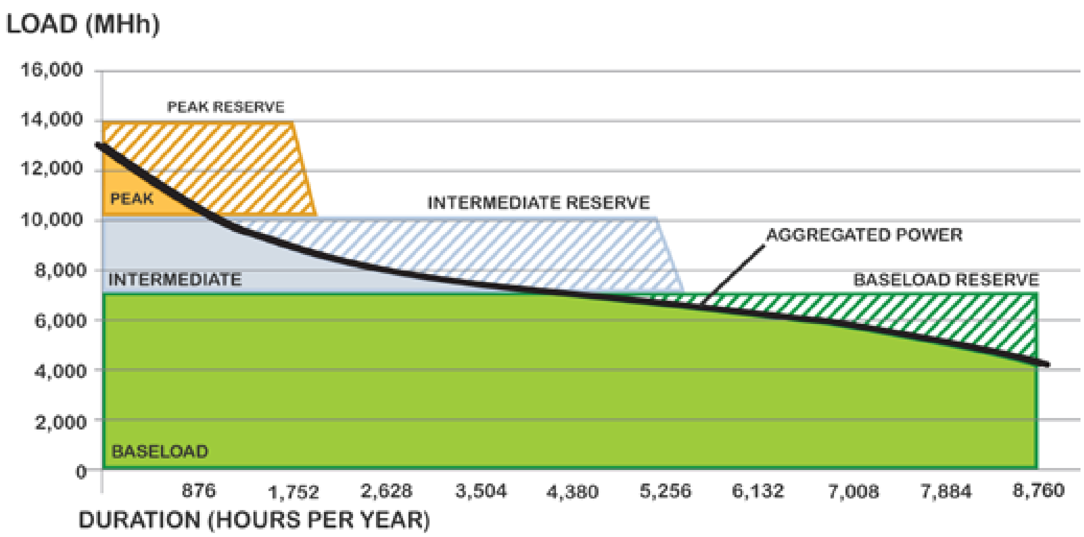

Figure 5. Aggregate electricity demand throughout a year. In North Carolina, utilities must meet customers' electricity demands, plus retain15% reserve generation capacity.

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

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.

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 Pricing (TOU): Price per kWh varies in seasonal and hourly blocks such as summer versus winter, and peak versus off-peak hours.

Critical Peak Pricing (CPP): Price per kWh spikes dramatically when qualifying critical events occur; the utility notifies customers in advance, giving them time to reduce their energy use before high rates begin.

Rates, however, are only one aspect of a customer's electricity bill. A customer's electricity bill also includes riders or charges approved by the Utilities Commission to reflect additional expenses incurred by the utility. These additional charges are included to compensate the utility for reliably meeting demand. For example, larger consumers often pay demand charges that reflect the costs of building and maintaining peaking plants that only operate a few hours per year, but are needed to meet the highest levels of demand. These charges are based on the peak demand of these customers during a billing period. Tariffs represent the full cost of electricity provided by the utility, and include the rate paid for electricity, classifications, rules and regulations, and any associated riders or fixed charges.

Common Electricity Riders

Cogeneration / Small Power Producer: Required by 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.

The City of Raleigh staff have taken steps to mitigate financial increases by proactively managing its rate schedules, changing rates where appropriate.

3. Renewable Energy Overview

A safe, reliable, and affordable supply of electricity allows 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 a renewable energy resource, describes the effects and considerations of incorporating these into municipal operations, and explains the technical and financial considerations associated with renewable resources.

3.1 Definition of Renewable Energy

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

- ☑ **Biomass** – 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 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)** – The direct conversion of sunlight into electricity through photovoltaic cells.
- ☑ **Solar Thermal** – Harnessing of sunlight to meet thermal requirements for residential, commercial, or industrial processes; or concentration of light from the sun to create heat energy used to generate electricity.
- ☐ **Wind** – Converts the force of moving air for useful purposes. This includes, but is not limited to, wind turbines for the creation of electricity and windmills for mechanical power.

☑ Indicates City of Raleigh has implemented this form of renewable energy

3.2 Technical Considerations of Renewable Energy

Recent technological advancements, production improvements, and increased investments continue to make 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 renewables provide to the electricity system.

Creating a more reliable energy source for the City of Raleigh is one of several benefits 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

Due to economies of scale and the nature of the electric utility industry (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, such as 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

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 distributed generation, but several renewable energy resources—such as solar, wind, biomass, geothermal, and small hydro—can fill this role as well.

Distributed energy generation may benefit the City in terms of resiliency. An example of beneficial DER would be mobile generating stations that can be used to address immediate health and safety needs 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, creating the need for more advanced grid infrastructure. A more advanced electricity grid is often referred to as the smart grid, which represents a collection of different technologies that are helping to automate and modernize the electricity grid (Figure7).

Figure 7. The smart grid is comprised of advanced technologies that enhance communication and automation in the electricity system.

Source: "Smart Grid: Smart Grid 101" Economy, Energy, Environment, Tech, Wyly Wade. January 2014

Smart grid technologies include power meters, voltage sensors, fault detectors, and other power electronic equipment characterized by an ability for two-way communication between the device and power supplier. This flow of information allows the utility to automate control and make adjustments to the network of devices that make up the grid and provides 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, identify and react to system disturbances, and initiate mitigation efforts to correct problems. 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 regarding implementing energy efficiency measures, generating renewable energy, evaluating utility programs and rate schedule options, and opportunities to adjust energy consumption behavior. Furthermore, smart grid technologies are also being equipped with cyber security to help protect the grid against data breaches and other forms of attack.

Balancing the Grid

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. Energy storage technology allows electrical energy to be stored so it can be available to meet demand when 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, integrate distributed generation resources with advanced smart grid technologies and energy storage to enhance the reliability of the facilities 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.

Renewable 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 and relies 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 use renewable energy to respond to 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. Progress has begun in the City in the areas of renewable energy systems, energy efficiency measures, and demand management programs. Diversifying the City's energy resources can enhance system resilience should one resource become scarce or unavailable, by giving the ability to substitute an alternative energy resource.

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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 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 and wastewater can be used to 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

Raleigh is already home to the development, production, and distribution of many renewable energy technologies. In addition to making the City more reliable and resilient, renewable energy encourages economic growth in the Raleigh area. The Unified Development Ordinance adopted by the City of Raleigh already defines "Sustainable Energy Systems" and favorably addresses solar systems within City regulations, streamlining the process for citizens installing renewable energy on their properties.

Incorporating renewable energy into City operations highlights the City's 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] Increasing renewable energy in City operations can have direct, positive economic impacts on job creation related to installation, development, and maintenance of these systems. Money spent on locally manufactured materials and construction labor stays in North Carolina, spurring the state and local economy. Between 2007 and 2014, clean energy development investments in North Carolina increased nearly 20-fold, from $48 million per year to more than $900 million annually.[14] Creating new partnerships with businesses in the region to demonstrate new technologies signals the City's commitment to innovation and growth of the local economy, and establishes an environment consistent with today's leading employers, such as Duke Energy Progress and North Carolina State University.[15]

See Appendix C for information about the renewable energy projects that the City of Raleigh has already completed.

3.3. Financial Considerations of Renewable Energy

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

There are a variety of factors that must be considered when attempting to finance and own renewable energy projects in North Carolina. Renewable energy systems can provide savings to the City by offsetting electricity purchases and peak demand charges, and act as a hedge against volatility in the prices of traditional generation fuels. 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).

Prominent financial considerations to take into account when developing renewable energy projects are provided below.

Evaluating the 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 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 generating 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). The total cost to install renewable energy systems has fallen steadily since their first deployment more than 40 years ago. Figure 9 shows the costs of solar PV panels over time.

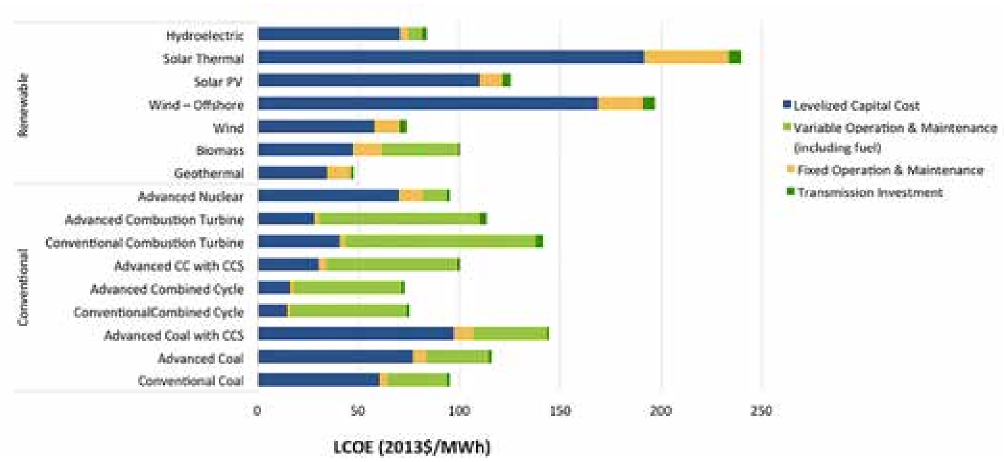
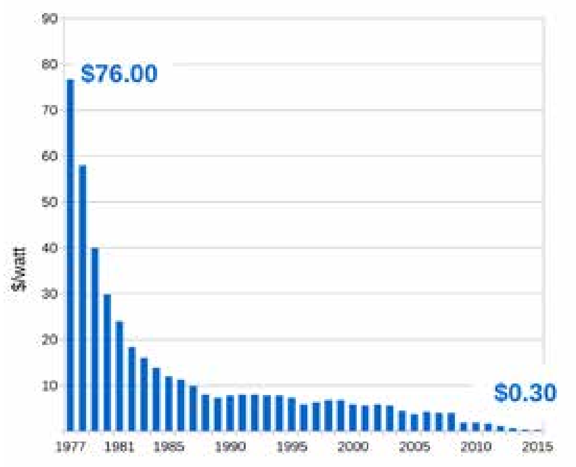


Figure 8. Estimated LCOE of U.S. plants entering service in 2020.

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

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. 2015



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 potential of renewables. When a renewable energy system is installed the cost of electricity produced remains stable 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.

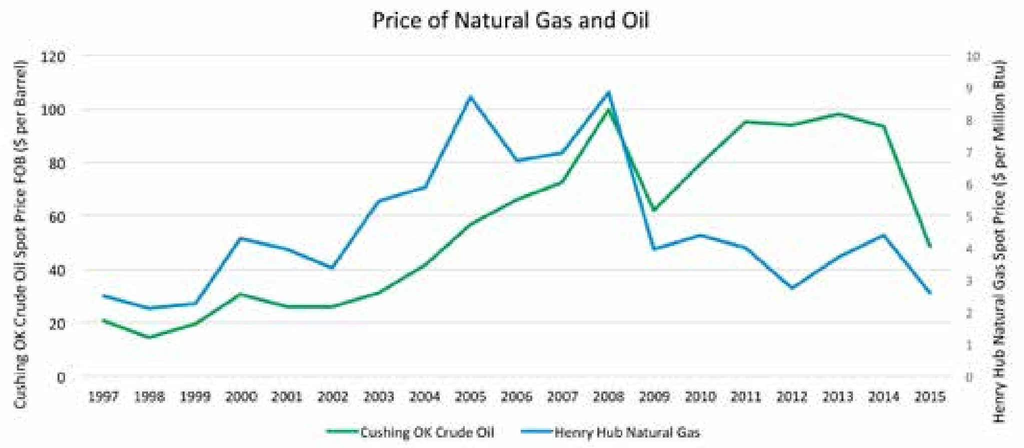


Figure 10. Price of Natural Gas and Oil

Source: U.S. Energy Information Administration Spot Prices. 2015

Distributed generation resources can also offset utility demand charges and peak pricing costs at the City's largest 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 billing cycle. Renewable energy resources such as solar, generate the most energy during mid-afternoon hours, coincident with many facilities' peak energy use. Figure 11 shows the energy production curve for solar PV systems. By offsetting some energy use during these time of high demand, renewables can decrease a customer's demand charges. Time of Use (TOU) rates, where the price paid for electricity fluctuates depending on the hour of the day, reflect the higher costs for the utility to produce electricity during the periods of highest demand, such as hot summer afternoons, when they must deploy more expensive peak generation. Peak production by renewable energy systems often coincide with these times of high prices and can offset utility electricity purchases when they are most expensive, effectively lowering the rate paid for electricity from the grid.

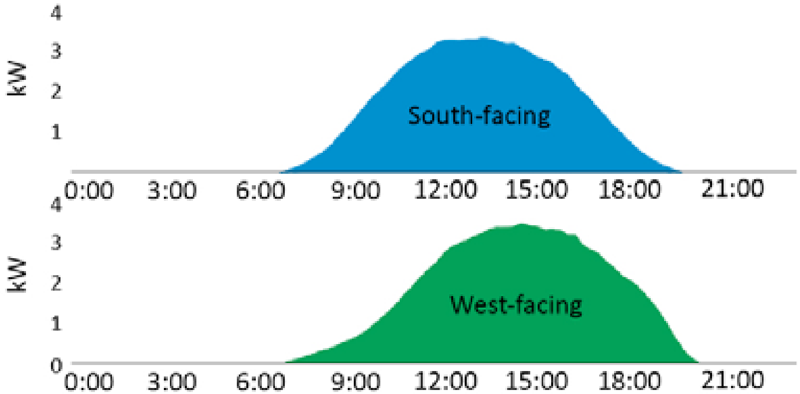


Figure 11. Average daily generation profile of rooftop PV systems

Source: Pecan Street Research Institute. 2013

Net-metering

North Carolina's current net-metering rules (NCUC Docket No. E-100, Sub 83) allow unused electricity generated by customer-owned systems to be sold back to the grid in exchange for a credit on their utility bill (Figure 12). In this way, 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. Currently, 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 on June 1st each year. Net-metering is offered to customers on all rate schedules, but provisions may differ for customers on TOU rates. Additionally, net-metering is limited to projects rated at 1MW or less.

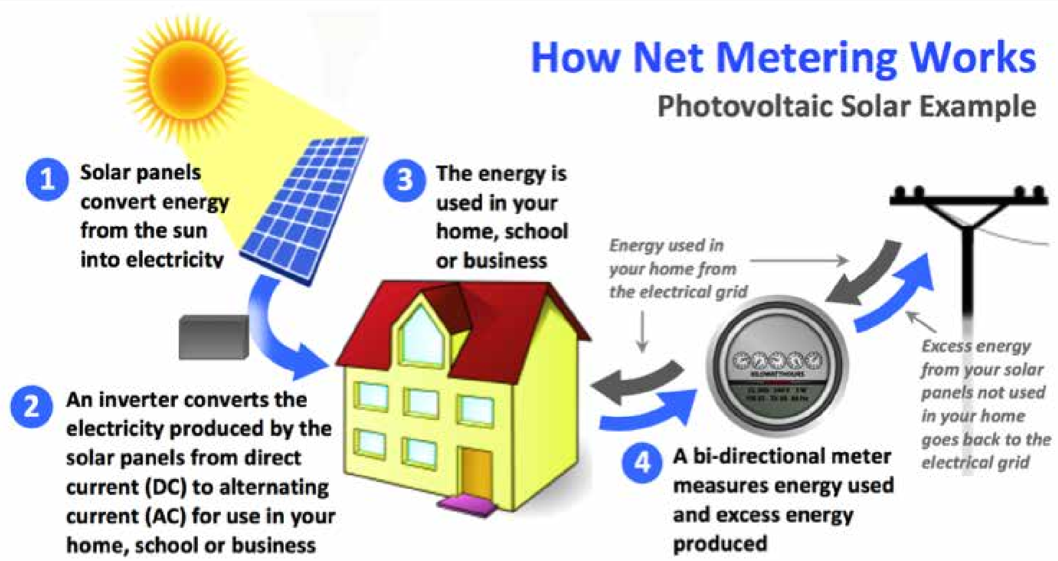


Figure 12. Flow of electricity for a residential rooftop solar PV system with net-metering

Source: Our Power Campaign: Net Metering Tool Kit. July 2015

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

Ownership Structures

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 electricity, to the City leasing property to another entity to generate and sell directly to the utility.

City Owned

City-owned renewable energy systems can and do participate in net-metering, where the City receives bill credits for the excess energy produced by the system. City-owned renewable energy systems may also be used in conjunction with other technologies to create island-able microgrids that could provide power to support City services during times it is unavailable from the utility.

Tax Credit

Federal tax credits (26 U.S.C § 48) help offset the costs of capital expenditures made installing solar, fuel cells, small wind, and other renewable energy projects—up to 30% of the capital cost depending on the type of system. Because the City is not a taxable entity, Raleigh has and should continue to use novel financing structures to pass the incentives to federal tax-equity investors, in order to redeem the benefit of these tax credits.

North Carolina 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 invested in specified renewable energy technologies. Those credits equaled up to 35% of the eligible property and covered many of the same technologies as the federal credit. The North Carolina REITC expired December 31, 2015.

Third-Party Property Leasing

Raleigh has also benefited from lease contracts that allow third parties to own and operate renewable energy systems on City property. In these instances the City and a developer have entered into a lease agreement for city owned property where the developer can design and install a renewable energy system. The power produced by the system is sold to the electric utility via a Power Purchase Agreement (PPA) and all revenue from the sale of the electricity goes to the third-party owner and operator of the system. The City receives lease payments from the third-party owner for use of the space, but does not utilize the electricity produced by the system and therefore foregoes the benefits provided by onsite generation.

Third-Party Energy Sales

Third-party sales are not currently allowed in North Carolina, but legislation enabling them has been proposed. There are two primary models for third-party energy sales, where customers contract with third-party developers to finance, install, maintain and operate renewable generating projects: third-party energy sales, and third-party financing. In both cases, the developer owns the system, while the host enters into a PPA to purchase the electricity directly from the developer. Both forms of third-party energy sales allow the customer to enjoy the benefit of receiving power from on-site generation and low, stable electricity prices over the period of the contract. Third-party PPAs consist of a developer constructing a renewable energy system on a customer's property at no cost to the customer (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 has the option of extending the contract or even purchasing the system.

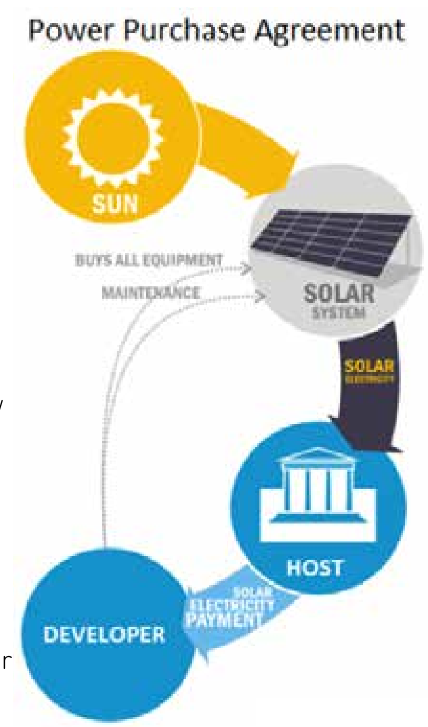


Figure 13. A power purchase agreement is a contract between a developer & a host customer for electricity

Source: K12Solar. Power Purchase Agreements (PPA) 101. June 2015.

Third-Party Financing

Third-party financing is a model where a developer designs and installs a renewable energy system on the customer's property and the customer leases the system's equipment from the developer for a period of time. 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 redeeming tax credits that would otherwise apply to renewable energy capital expenditures.

Over the last 10 years the City of Raleigh has demonstrated leadership and commitment to renewable energy through its use of alternative financing models. Some examples include: E.M. Johnson Water Treatment Plant, Raleigh Convention Center, and the Neuse River Resource Recovery Facility. See Appendix C for further details on these projects.

4. City of Raleigh Renewable Energy Assessment Findings

New renewable energy systems may benefit the City of Raleigh by reducing its energy expenses, decreasing its dependence on fossil fuels, and significantly lowering its carbon emissions.

The NC Sustainable Energy Association (NCSEA) partnered with the City of Raleigh 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 recommendations for deployment of renewable energy resources.

4.1. 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 to gain insight into their respective roles, previous and upcoming renewable energy projects, available sources of data, and desired outcomes. Staff 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 suggestions for changes the City could make to encourage renewable energy development, and how they would measure the success of this Renewable Energy Overview. Second, NCSEA staff performed research on best practices by municipal governments for managing their energy resources. NCSEA used the information provided during the interviews, as well as independently collected data, to determine the findings.

Interviews helped NCSEA identify strengths, weaknesses, opportunities, and challenges related to renewable energy implementation in City operations. City staff that were interviewed are listed in Appendix A.

The City of Raleigh is already a recognized leader in sustainability practices. Previous efforts and initiatives, including the completion of several renewable energy projects, have led to numerous awards for their success. Recognition of these past successes sets the stage for further renewable energy development. This assessment is the first 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, the North Carolina energy policy landscape, and 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.

4.2. Findings

Energy Consumption and Performance Information

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, and data management, 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. A technology solution may need to be developed to integrate reporting tools the City already uses, such as Periscope and Electronic Data Interface (EDI), with Duke Energy and other data sources. Baseline measurements are a key component in the development of objectives for renewable energy implementation and this disaggregated data makes it difficult to measure the impact of existing policies and assess opportunities for the future.

Energy Planning Process

NCSEA also discovered that the City's energy planning process is not integrated throughout all departments. This makes informed renewable energy integration difficult. Staff mentioned 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 opportunistic, with the genesis for most ventures being an available funding opportunity. There are a number of different departments and staff members with roles in energy consumption and performance information, see Appendix B for a description of the energy role within the City.

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. There is a list of existing renewable energy projects provided in Appendix C.

Communication

Finally, several interviewees noted 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 both citizens and City employees have the potential to continue to reduce costs, decrease environmental impacts, and enhance the performance of municipal operations.

5. City of Raleigh Renewable Energy Recommendations

The following recommendations will help the City maximize the operational efficiency of resources through data, planning, communication, and partnerships.

Energy Performance Measurements

Energy use is a critical consideration for nearly all City operations. A proactive and organized approach will systematically incorporate renewable energy in a financially responsible manner. Accurate, meaningful, and thorough measurement of all City energy consumption and generation is essential to understanding the existing energy situation and identifying areas for improvement. Data is the basis for the establishment of specific goals that improve energy performance in the City of Raleigh. After obtaining this energy data, the City can develop an actionable renewable energy plan, including 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 being a leader in renewable energy, better integration is needed around energy use and procurement: Communication might be maintained throughout project planning and management, involving the appropriate parties in identifying opportunities, designing projects, and optimizing operations. Open interaction during the planning process will ensure appropriate staff are active participants and the core needs of mission critical standards are included 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 of 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 its internal energy management program and promoting their successes externally.

Financing Strategies

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

Communication and Education

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

Partnerships

Raleigh may also benefit from the fostering of 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 may allow the City to implement new technologies at little or no cost, while fostering 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 energy projects. Additional partnership opportunities may encourage citizens' use of renewable energy, allowing them to benefit from lessons learned through municipal implementation. By educating the public about the benefits and lessons learned from projects already undertaken by the City, 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 a more 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 make the benefits discussed above available to all consumers. The City can continue to engage with these organizations and support their efforts at the North Carolina General Assembly and the NCUC.

The City of Raleigh is restructuring the Public Works department and energy related activities as of July 1, 2016.

Conclusion

This assessment shows that energy is both a substantial expense and a vital component of the City's day-to-day operations; therefore, the City's energy resources are worthy of careful consideration. This report outlines the intricacies associated with energy planning and highlights the opportunity renewable energy systems present to lower the City's costs and increase its resiliency.

While the City of Raleigh has shown leadership in sustainability and made significant improvements in the efficiency of buildings and operations, this assessment found that it lacks 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 to considering its energy needs. While renewable energy systems can be capital intensive, a total cost of ownership approach that includes analysis of price hedging, state and federal tax laws, and Utility Commission regulations will most accurately represent the value of any investments. Furthermore, 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 be further involved in North Carolina's energy landscape by supporting the development of 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
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	Utility market segment that includes businesses, such as stores and offices
Critical Peak Pricing (CPP)	Utility pricing where rates spike 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 that reflect the cost of additional investments utilities make to meet their customers' load are based on the peak demand customers incur 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. Law that provides 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
Smart Grid	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	Devices, such as batteries and capacitors, that store electrical energy that is available to meet demand whenever needed
Federal Energy Regulatory Commission (FERC)	The independent, federal (U.S.) agency that regulates interstate transmission of electricity, natural gas, and oil
Geothermal Energy	The use of thermal energy (heat) stored in the Earth to generate electricity
Ground Source Heat Pump (GSHP)	Technology used as a central heating and cooling system to transfer heat to or from the ground
Hedge/Hedging	Investment strategy that reduces or offsets risk changed by diversifying one's portfolio
Hydropower	Conversion of the force of falling or flowing water, such as in hydropower marine waves, for useful purposes such as generating electricity or creating mechanical force
Independent System Operators (ISOs)	Independent, federally regulated grid operations organizations established to coordinate regional electricity transmission in a non-discriminatory manner and ensure the safety and reliability of the electric system
Industrial/Institutional	Utility market segment that includes manufacturers and other large users of electricity
Interconnection Standards	Power, quality, and safety requirements that generating facilities must meet before connecting to the grid

Intermediate Load	The load between the baseload and peak load that is 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 generator 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 for all public utilities in the state
Peak Load	The highest demand of electricity within a period that is usually met with the most expensive generation plants, that can ramp up and down quickly, such as fuel oil and natural gas turbines
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)	Federal U.S. law that requires utilities to purchase power from qualifying facilities (QF) and requires 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 (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, which may be fixed or variable based on both quantity and time
Real-Time Pricing (RTP)	Utility pricing model 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 an energy source that experiences fewer and shorter periods of unavailability
Renewable Energy and Energy Efficiency Portfolio Standard (REPS)	North Carolina law passed in 2007 that requires investor-owned utilities to generate 12.5% and municipal utilities and electric cooperatives to generate 10% of their electricity sales with eligible renewable energy resources or energy efficient measures by 2021
Residential	Utility market segment that includes houses and apartments

Resilience	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	A modification 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; or 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	Represent the full cost of electricity provided by the utility, including rate schedules, classifications, rules and regulations, and any riders
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

The City of Raleigh is restructuring the Public Works department and energy related activities as of July 1, 2016.

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

Note: This list is current as of 2015.

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 it will continue to be used for research and outreach.

Raleigh Convention Center: Rooftop

Size: 500 kW
Date Installed: August 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
Date Installed: August 2011
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: November 2010
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: 2012
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.
The City is evaluating adding additional solar to this facility by expanding the current net metering to further offset the Administrative building consumption.

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, developed, and owns the project 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 Owned 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

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

Date Installed: 1983
Notes: 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

Date Installed: 2011
Notes: Solar thermal hot water heating systems supplement natural gas units at some of the City's Fire Stations. The installed solar collectors on top of the stations' roofs provide hot water for station needs.

Solar LED Lights

Campbell University Parking Lot

Date Installed: 2009
Ownership Structure: City Owned
Parties Involved: City of Raleigh, Campbell University School of Law

Raleigh City Plaza

Date Installed: 2009
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 capacity
Date Installed: December 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 and soybeans grown at the Neuse River Wastewater Treatment Plant, as well as produce biodiesel from used cooking oil from other sources. The BCNC was defunded in 2013, but the grant remained with the Department of Agriculture. The potential 3,000 gallons of biofuels produced annually are used in the City of Raleigh Fleet Operations and at the Wastewater 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
Date Installed: 2011
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

Appendix D: Original Project Contacts

The North Carolina Sustainable Energy Association and the Office of Sustainability would like to thank the following city staff for their participation in this project:
Tansy Hayward (Assistant City Manager-Services); Richard Kelly, Kevin Adams, Bill Black, Danny Bowden (Construction Management- Public Works); Roger Krupa (Convention Center); Dick Bailey (Parks, Recreation and Cultural Resources); Billy Jackson, Suzanne Walker, Willistine Hedgepeth (Facilities and Operations); Allyson Wharton (Finance); Carolyn Bachl, Dan McLawhorn (City Attorney's Office); Kenny Waldroup, Aaron Brower, TJ Lynch, Michele Mallette (Public Utilities); Fred Battle, Andrew Martin (Solid Waste Services); Robert Hinson, Julian Prosser, Paula Thomas, Cindy Holmes, Megan Anderson (Office of Sustainability); and Mike Kennon (Transportation – Public Works).

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Robin Aldina, Elizabeth DeMarco, William Supple, Ellis Baehr, Pierce Few, Samantha Radford and Ivan Urlaub.

For additional information about Renewables at the City of Raleigh, please contact the City of Raleigh's Office of Sustainability at Sustainable.Raleigh@raleighnc.gov.

Inquiries may also be directed to NCSEA at info@energync.org.

NC SUSTAINABLE
ENERGY ASSOCIATION

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NORTH CAROLINA