Solar on Superstores

How Commercial Rooftops Can Boost Clean Energy Production in North Carolina

ENVIRONMENT NORTH CAROLINA
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Cover photo: Rooftop solar panels on IKEA in Charlotte, NC. (Credit: IKEA Charlotte.)

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Executive Summary

With more than 250 sunny days per year, North Carolina has the potential to replace much of its electricity from dirty fossil fuels with clean solar power. North Carolina has been a national solar leader, ranking fifth in the country for cumulative installed solar energy capacity as of September 2013. However, one of the biggest, largely untapped potential markets for solar power is large commercial buildings, such as "big box" retail stores, supercenters and shopping malls. Tapping into this solar resource to boost North Carolina's solar capacity can have substantial benefits for the state's environment, public health and economy.

North Carolina has millions of empty rooftops that can support solar panels, and much of the state's barren land is ideal for large-scale solar energy power plants. With the right policies in place, North Carolina could install solar energy capacity equivalent to 700,000 solar roofs by 2030.[1]

The roofs of large commercial buildings are perfect locations for solar panels—they are flat, largely vacant, and almost always fully exposed to the sun. They also produce energy that can offset the large electricity demand of these buildings while contributing to a cleaner electricity grid.

North Carolina has the potential to install more than 3,000 megawatts (MW) of rooftop solar photovoltaic (PV) capacity on large commercial buildings—enough to offset the annual energy use of these buildings by as much as 60 percent.

- North Carolina has many commercial buildings that are appropriate for solar energy systems: grocery stores, large supermarkets or supercenters, small and large strip malls, enclosed shopping malls and large freestanding "big box" retail stores, such as IKEA or Best Buy. Big box stores, in particular, are ideal because they are generally surrounded by several acres of parking space and therefore very little tree shading.

- North Carolina's large commercial buildings have approximately 160 million square feet of available and appropriate rooftop space for solar energy systems. That amount of rooftop space could support more than 3,000 MW of solar energy capacity—enough to generate as much electricity as one medium to large coal-fired power plant.

Rooftop solar panels can help offset the large electricity demand of big box stores, while contributing to a cleaner and more reliable electricity grid.

- Installation of 3,000 MW of rooftop solar power at big box stores would generate more than 4 million megawatt-hours (MWh) of electricity annually—offsetting the total annual electricity used by these buildings by as much as 60 percent. Replacing this much dirty electricity with solar power would help prevent 3 million metric tons of global warming pollution annually—equivalent to that produced by nearly 600,000 of today's passenger vehicles.

- By providing additional power when it is most needed—such as on hot summer days when air conditioner use increases—rooftop solar panels can reduce the strain that large commercial buildings place on the electricity grid, increasing reliability and reducing the need for expensive new power plants or transmission lines paid for by all consumers.

- Rooftop solar energy installations also reduce energy waste by producing electricity closer to the customers that will use it. This reduces energy losses during transmission and distribution from far-away power sources, making rooftop solar an important supplement to utility-scale solar production.

North Carolina's policies have played a major role in making the state a leader when it comes to solar. The following policies will help ensure we continue that leadership, and do even more to develop the state's rooftop solar market.

1. **Enable third-party sales of electricity.** The state should allow companies that install rooftop solar panels to sell electricity to their customers.

2. **Fairly compensate large solar energy producers in power purchasing agreements.** The rate that utilities pay for solar energy from large-scale producers is very low and does not account for many of the unique benefits of solar power for both the environment and the electricity grid. The state should increase the required rate of compensation to more accurately reflect the true value of solar power.

3. **Improve the state's net metering laws.** Net metering helps ensure that small commercial or residential customers are fairly compensated for the solar electricity that they produce. Investor-owned utilities should be required to reduce "standby fees" that deter consumers from installing solar panels, and co-op and municipal utilities should be required to offer net metering to their customers.

4. **Extend incentives for investing in solar technologies in North Carolina.** Current renewable energy tax credits for businesses and residents will expire by the end of 2015. In order to build a strong, self-sustaining market for renewable energy in North Carolina, the state should extend these tax credits and then phase them out in a planned and orderly fashion over a number of years.

5. **Reduce siting, permitting, and interconnection restrictions** that can greatly increase the total cost of installing solar energy systems.

6. **Defend and strengthen the state's renewable energy standard** to require utilities to get 20 percent of their electricity from renewable sources by 2020, and to increase requirements for solar energy production. The state should also require all of the solar power that counts towards North Carolina's renewable energy standard to be produced within the state.

Introduction

North Carolina's population has grown 17 percent within the last decade, bringing significant changes to both the state's economy and physical landscape.[2] Thousands of new businesses have sprung up or relocated to North Carolina's cities, resulting in an explosion of commercial development. Demand for cheap real estate drew many of these businesses to suburban and exurban areas, now transformed by hundreds of new strip malls, shopping centers and free-standing "big box" retail stores.

Stores in these large commercial developments consume vast amounts of energy for heating, cooling and lighting—contributing to increased pollution from the state's electricity grid. However, these stores also represent an unprecedented opportunity to generate clean, renewable solar power.

Satellite images of the state's large commercial buildings reveal hundreds of thousands of square feet of flat, largely empty, sun-drenched rooftop space. Installing large-scale solar energy systems on the rooftops of these buildings—or even ground-mounted systems in their huge parking lots for shaded parking—could help meet a significant portion of the energy demand of these stores while contributing to a cleaner electricity grid.

North Carolina is already an emerging national leader in solar energy. By tapping into its potential for rooftop solar power, the state can move even faster towards a clean energy economy.

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In this report, we estimate North Carolina's total potential for rooftop solar capacity on its large commercial buildings and offer policy recommendations to help North Carolina encourage more large-scale commercial solar energy installations. By tapping our potential for solar energy—both on big box stores and throughout the state—North Carolina can boost its solar energy industry and protect our environment.

Photo: Walmart Stores, Inc.

A Walmart location uses solar panels to generate power in Corona, CA.

North Carolina Has Great Potential for Rooftop Solar Energy

North Carolina is an emerging powerhouse for solar energy. Aided by excellent solar resources and several large-scale solar farms, North Carolina's installed solar capacity has climbed to 322 megawatts (MW) as of September 2013, placing it fifth in national rankings for cumulative installed solar energy capacity.[3] However, North Carolina's commercial and residential solar energy markets are much less developed than other leading states for installed solar capacity. Boosting and diversifying solar power in North Carolina, including by providing strong support for commercial rooftop solar power, will bring enormous environmental, public health and economic benefits to the state.

North Carolina can continue to move towards a clean energy future by tapping into one of its most abundant solar energy resources: empty rooftops. About three-quarters of North Carolina's currently installed solar energy capacity is in "utility-scale" ground-mounted PV installations larger than 1 MW.[4] Rooftop solar energy systems are smaller, but can be installed on millions of empty rooftops across the state, producing energy closer to where North Carolinians will use it and helping North Carolina ramp up its overall production of clean, renewable solar power.

North Carolina has tremendous potential for rooftop solar power, particularly on the large, flat and mostly vacant rooftops of commercial buildings such as supermarkets, enclosed malls and "big box" retail stores. Most solar energy systems on big box stores or supermarkets can exceed 100 kilowatts (kW) in size, but some of these buildings can support systems that approach or exceed 1 MW.[5] **In North Carolina, large commercial buildings could support about 3,000 MW of distributed solar power—enough to offset the annual energy use of these buildings by as much as 60 percent.**[6]

With the right policies in place, North Carolina can start developing its potential for rooftop solar energy and speed the state's transition to a clean energy future.

North Carolina Has Good Solar Resources

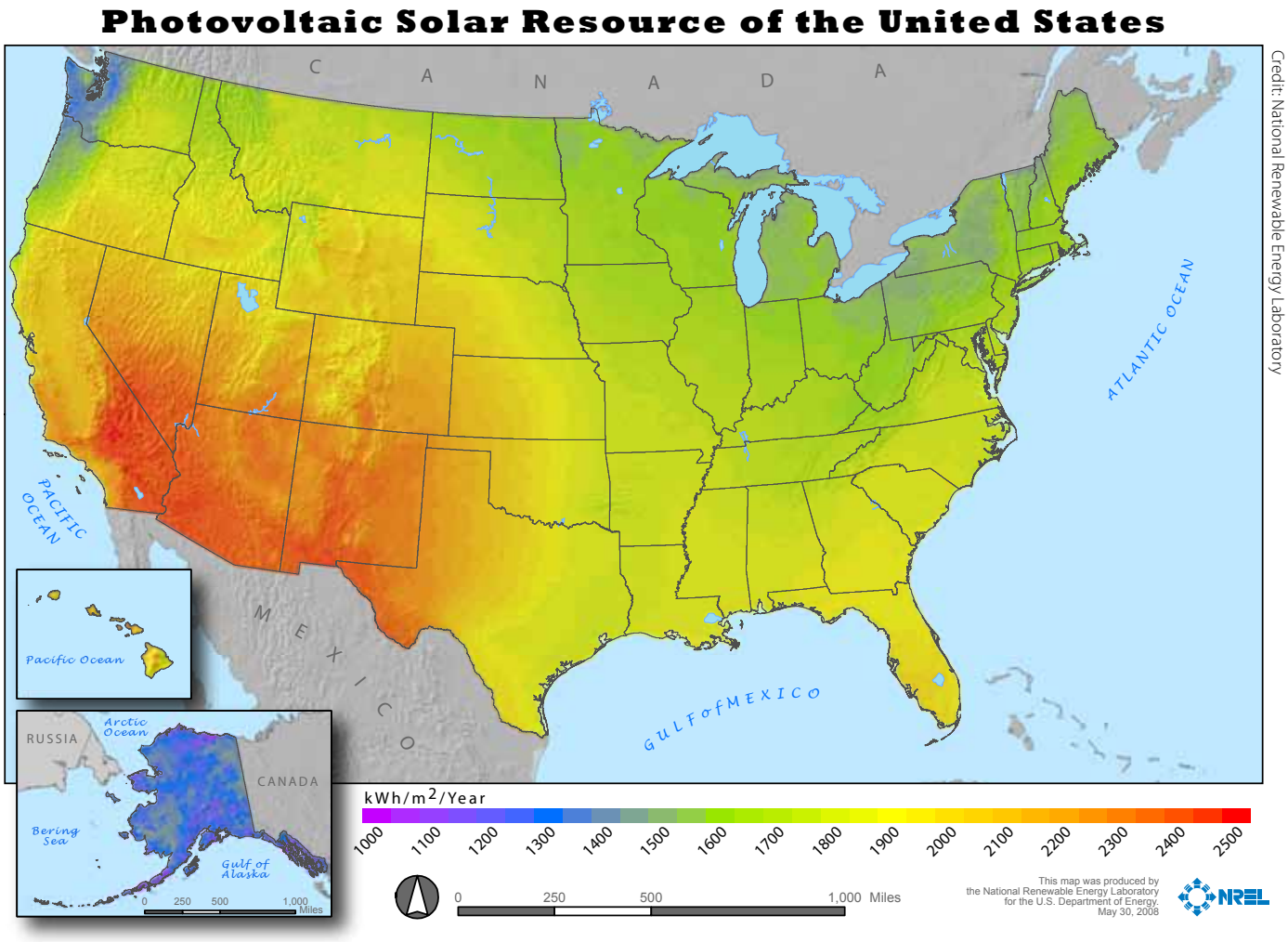
North Carolina is ideally positioned to take advantage of solar energy. Solar resource quality at a given location can be measured by the average output of a solar photovoltaic (PV) panel over the course of a year. The output—or amount of solar power generated—depends on the intensity of the sunlight reaching the panel, which varies from hour to hour with the weather and the passing of day and night, and from season to season with the angle of the sun and length of the day.

North Carolina has more than 250 sunny days per year, and the state's overall solar resources exceed those of New Jersey, the nation's third-largest market for solar power (in terms of total capacity) in 2012.[7] (See Figure 1.)

North Carolina Has Millions of Rooftops Suitable for Solar Development

North Carolina has millions of sun-drenched rooftops that are suitable for solar PV systems. Solar PV panels produce the most power when they are placed on a roof with optimal sun exposure. Appropriate locations face south and are not shaded by trees or other objects

Figure 1. North Carolina Has Good Solar Resources



Credit: National Renewable Energy Laboratory

Annual average solar resource data are for a solar collector oriented toward the south at a tilt = local latitude. The data for Hawaii and the 48 contiguous states are derived from a model developed at SUNY/Albany using geostationary weather satellite data for the period 1998-2005. The data for Alaska are derived from a 40-km satellite and surface cloud cover database for the period 1985-1991 (NREL, 2003). The data for Germany were acquired from the Joint Research Centre of the European Commission and is the yearly sum of global irradation on an optimally-inclined surface for the period 1981-1990.

for most of the day. According to the National Renewable Energy Laboratory (NREL), North Carolina has enough properly oriented and available rooftop space to install 23 gigawatts (GW) of rooftop solar capacity—enough to supply the equivalent of 21 percent of the state's 2012 electricity use.[8]

Commercial Buildings Are Ideal for Rooftop Solar Energy Systems

A large share of North Carolina's potential for rooftop solar energy lies on the rooftops of large commercial buildings, such as supercenters, enclosed malls, outdoor shopping centers and "big box" retail stores such as IKEA or Best Buy. The roofs of these buildings are generally flat, mostly vacant, and almost always fully exposed to the sun, making them ideal locations for solar panels. They are also quite large; grocery stores can take up to 65,000 square feet of space, while big box retail stores range from 100,000 to 250,000 square feet.[9] Enclosed malls can exceed 500,000 square feet.[10] Solar PV systems on these buildings can exceed 100 kW in size—compared to 3 kW to 8 kW for residential systems.[11] Solar panels could also provide shade in the parking lots of these stores, some of which span several acres, while taking up no additional land and reducing vehicle fuel consumption for air conditioning use.[12]

Commercial Rooftop Solar Power Has Untapped Benefits for North Carolina

Commercial rooftop solar power offers unique benefits for North Carolina, making it an important addition to the state's solar energy capacity.

Rooftop solar PV panels capture the energy in sunlight and turn it into electricity, supplying power directly to the buildings on which they are installed. Buildings with rooftop solar PV systems are typically connected to the electric grid. The grid provides supplemental power during cloudy weather or at night, and during sunny weather it distributes the extra electricity produced by the panels for use elsewhere. Producing electricity closer to the customers that will use it also reduces electricity waste during transmission and distribution from far-away power sources, making rooftop solar an important supplement to utility-scale solar production.

On commercial buildings, rooftop solar energy systems can help offset high electricity use for lighting, refrigeration, heating and cooling, while contributing to a cleaner and more reliable electricity grid. For example, some Walmart stores use more than 28,000 kilowatt-hours (kWh) of electricity per day—equivalent to the energy use of 600 North Carolina homes.[13] In the South Atlantic region, of which North Carolina is a part, large grocery stores, malls, big box stores and other retailers are responsible for about 16 percent of all commercial energy use.[14]

Installing 3,000 MW of rooftop solar power on large commercial buildings would generate more than 4 million MWh of electricity annually—offsetting as much as 60 percent of the annual electricity used by these commercial buildings and contributing to a more stable electricity grid.[15] Replacing that much dirty electricity with clean, renewable solar power would also help the state avoid global warming pollution equivalent to that emitted by nearly 600,000 of today's passenger vehicles each year.[16]

Commercial Rooftops Can Generate Large Quantities of Solar Power

Large commercial buildings represent one of North Carolina's best opportunities to expand solar energy in the state. Between its grocery stores, big box retail chains, department stores, malls and shopping centers, North Carolina has about 160 million square feet of available rooftop space to support solar PV installations. (See Table 1.) **That amount of rooftop space could support more than 3,000 MW of solar energy capacity—enough to generate as much electricity as one medium to large coal-fired power plant.**[17] Installing 3,000 MW of solar energy capacity would increase the state's capacity more than nine-fold, and it would produce the equivalent of 3 percent of North Carolina's 2012 electricity use.[18]

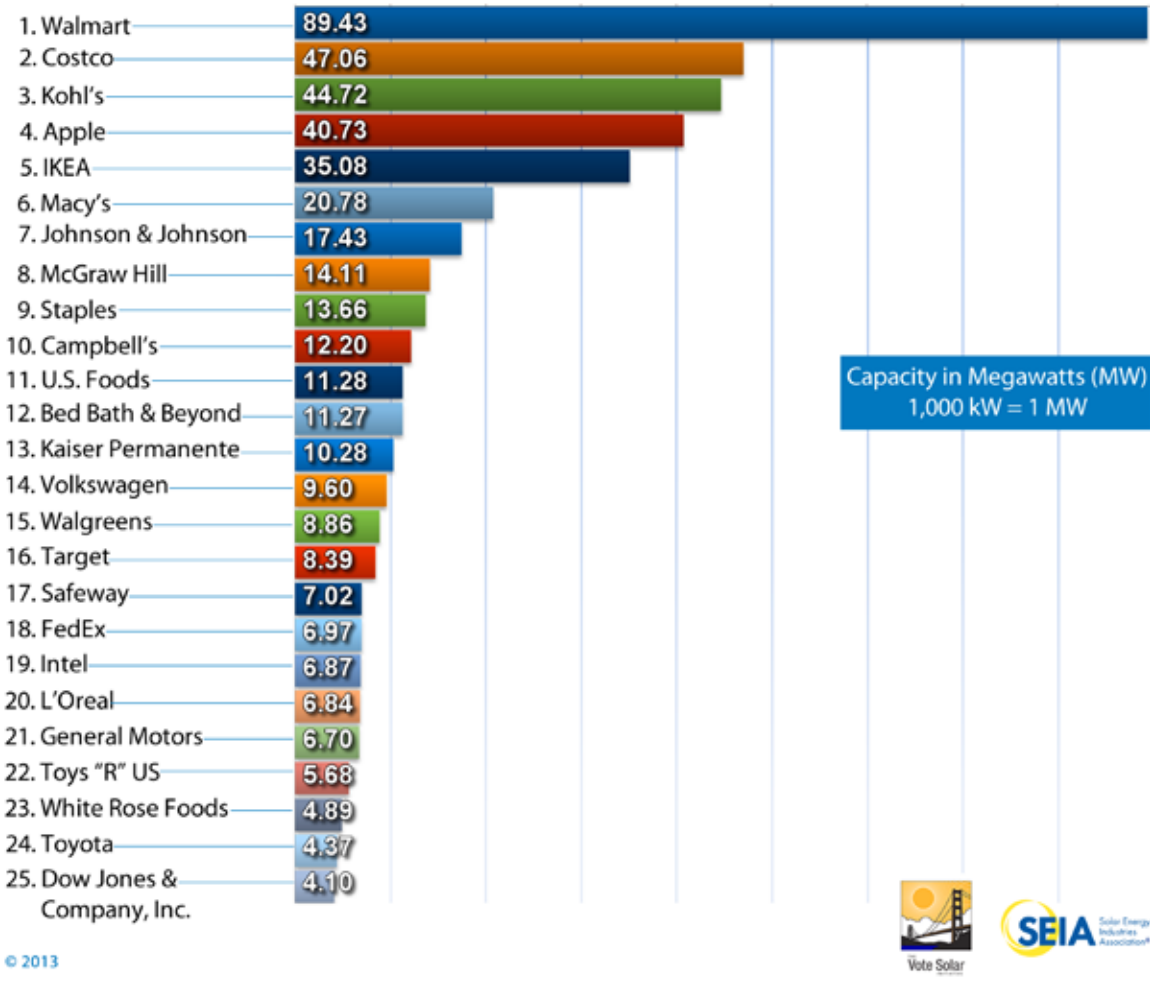
In other parts of the country, many of the nation's top retailers are already taking advantage of solar power. According to the Solar Energy Industries Association (SEIA), almost half of the top 25 commercial solar customers in 2013 were major retailers such as Kohl's, Costco or Staples.[20] (See Figure 2.)

So far, North Carolina has developed very little of its rooftop solar energy resources, particularly in the commercial sector. However, previous research from Environment North Carolina Research & Policy Center shows that with the right policies in place, North Carolina could develop at least 7,000 MW

Table 1. North Carolina Commercial Establishments by Business Category[19]

Commercial Building Category	Number of Establishments	Building Size Range (Square Feet)
Supermarkets and Grocery Stores	1,860	20,000-65,000
Department Stores (includes some "big box" retailers)	253	65,000-200,000
Warehouse Clubs and Supercenters	142	100,000-250,000

Figure 2. The Largest Commercial Solar Customers in 2013 Were Major National Retailers[21]



Credit: Solar Energy Industries Association

of solar energy capacity by 2030—equivalent to 700,000 small-scale rooftop solar energy systems.[22]

More rooftop solar power would not only reduce North Carolina's dependence on dirty fossil fuels and help clear the air, but also help boost the state's economy by giving rise to more solar energy businesses, like large-scale solar developers such as Strata Solar in Chapel Hill and FLS Energy in Asheville, and small-scale commercial and residential solar developers such as Southern Energy Management based in Morrisville.[23]

Installing Solar Energy Systems Is Cost-Effective

North Carolina is ideally positioned to start developing its commercial solar market, particularly given the declining cost of solar power. In 2012, the installed cost of solar photovoltaic panels declined by 27 percent in the U.S. compared to the year before, according to Greentech Media and SEIA's annual *U.S. Solar Market Insight Report*.[24] These declining prices are partially a result of increasing economies of scale in solar panel production and falling prices for solar modules.[25] Nationwide, the price of solar PV modules dropped precipitously in 2012, falling 41 percent from an average sales price of $1.15/Watt (W) in the fourth quarter of 2011 to $0.68/W at the end of 2012.[26] In North Carolina, average installed prices for residential and commercial photovoltaic systems fell by 16 percent in 2012.[27] No other type of major power generation technology is achieving cost reductions at such a rapid pace.[28]

As the market for solar PV grows in North Carolina, the industry is likely to develop economies of scale in manufacturing and installation, which will bring down costs even further.

Solar Power Contributes to a Cleaner and More Reliable Electricity Grid

Solar panels generate the greatest amount of electricity at the times when it is most needed—particularly on hot, sunny summer days, when air conditioner use increases and energy demand spikes. Even though energy demand may only peak two or three days per year, millions of dollars of generation and transmission infrastructure must be in place to ensure the supply of power meets demand in order to avoid blackouts or brownouts. During periods of peak consumption, electricity providers must bring peaking power plants, which are expensive to operate, on line to ensure reliability of service.

Rooftop solar power's characteristics reduce the need to run these peaking power plants or to build more power plants or transmission lines. Because rooftop solar panels generate electricity near where they are used, they reduce the need to invest in new high-voltage transmission lines and reduce the electricity losses that result from long-distance transmission of power from large, centralized power plants.[29]

In addition, solar panels provide energy for decades at a fixed cost, because sunlight is free. Fossil fuels often experience wild price swings. Solar PV can act as an effective hedge against these price fluctuations, helping to maintain stable electricity prices.[30]

Finally, rooftop solar energy requires no additional land beyond that already occupied by buildings, parking lots or other developed areas, and consumes practically no water.

Walmart: The nation's largest corporate producer of solar power

Photo: Walmart Stores, Inc.

Thin-film solar panels produce energy on a Walmart location in Marina, CA.

With 89 MW of solar energy capacity installed on its stores at the end of 2013, Walmart is now the nation's largest corporate producer of solar electricity.[31] (See Figure 2 on page 11.) Worldwide, Walmart has 150 solar PV installations that deliver a total of 71,000 MWh of electricity annually to its stores and distribution centers; that's enough electricity to power over 4,000 typical North Carolina homes for a year.[32] According to the company, as of July 2012 renewable energy sources such as solar energy supplied about 4 percent of the annual energy used in Walmart locations.[33]

According to Marty Gilbert, Walmart's energy director, the company decides which store locations receive solar panels based on how they will improve the bottom line of each store. "The only projects that we were doing are the ones that economically make sense at the store level," said Gilbert in an interview with *Bloomberg Businessweek*.[34]

Some of the company's solar energy projects are in places with high utility rates, such as California, where at least 75 percent of all Walmart-owned locations will have solar panels by the end of 2013.[35] Other projects are spread across locations in Ohio, Hawaii, Puerto Rico and Connecticut, where utility rates or other factors have made solar power an attractive investment.[36] As of September 2013, there are no installations at Walmart locations in North Carolina.

Walmart plans to continue building its rooftop solar resources. The company is planning to install solar energy systems on 1,000 of its store locations by 2020.[37]

Solar Energy Works for North Carolina's Environment, Public Health and Economy

Solar power protects North Carolina's public health and the environment by offsetting the state's reliance on fossil fuels, and creates new jobs to strengthen the state's economy. Commercial rooftop solar power is an untapped opportunity for North Carolina to continue its current progress as a solar energy leader and move towards a clean energy future.

Solar Energy Protects Our Environment

Increased deployment of commercial-scale solar energy systems can reduce North Carolina's dependence on fossil fuels and lessen its contribution to global warming. Solar energy helps reduce fossil fuel combustion for electricity generation, reducing emissions of carbon dioxide, the leading pollutant driving global warming.[38] In addition, reducing fossil fuel consumption helps protect the Appalachian Mountains from the harmful impacts of coal mining, as well as the state's rivers and lakes from water withdrawals by power plants.

Global Warming

North Carolina's environment and economy are vulnerable to the impacts of global warming. Climate models predict global average surface temperatures could increase by 2.5°F by 2025 and up to 11°F by 2100.[39] Climate scientists warn that higher temperatures will impact many aspects of North Carolina's environment and economy. For example:

- Hotter summers will cause North Carolina's spruce and fir forests to retreat northward, while warmer winters that allow certain pest species to survive for more of the year will increase the vulnerability of these forests to insect outbreaks.[40] Loss of spruce and fir forests will shrink the habitat available for many birds and mammals living in these forests.
- Global warming is likely to exacerbate existing threats to North Carolina's rich diversity of aquatic species, including increased pollution, alteration of physical habitat and hydrological patterns, and increased penetration of invasive species. These problems already affect 83 of the state's fish species, 43 mussel species, 21 crayfish species and 10 snail species, all of which have been identified as priorities for conservation.[41]
- By 2080, sea-level rise is expected to erode 14 of the 17 recreational swimming beaches in southern North Carolina. For the southern beaches in the state, the lost recreation value is projected to be $93 million a year by 2030 and $223 million a year by 2080.[42]

In North Carolina's regional electricity grid, energy sources used to meet daily peak electricity needs emit more than 1,680 pounds of carbon dioxide pollution for every megawatt-hour of electricity generated. In comparison, solar panels emit zero carbon dioxide pollutants.[43]

Installing 3,000 MW of solar energy capacity on the state's large commercial buildings would generate enough electricity to prevent 3 million metric tons of global warming pollution—equivalent to that emitted by nearly 600,000 of today's passenger vehicles.[44]

Land Use and Water Pollution

Solar power also reduces the need for coal mining, which has destroyed large tracts of land in the Appalachian Mountains. Mountaintop removal methods have scarred some parts of the Appalachian Mountains with mines, some as big as the island of Manhattan, and afflicted nearby communities with polluted air and poisoned water. Mines using mountaintop removal supply coal to 13 North Carolina power plants.[45] When North Carolina and other states are using enough solar power to displace significant amounts of coal power, the pressure to mine for coal will be reduced.

Solar power has the additional benefit of conserving water. Traditional power plants depend heavily on a constant supply of water to produce steam and cool the plants.[46] North Carolina's electric utilities are responsible for over 80 percent of the water withdrawals in the state.[47] In contrast, solar photovoltaic systems generate electricity using very little water. Replacing traditional electric production with solar power will relieve some of the stress on the state's water supplies.

Solar Energy Protects Public Health

Replacing electricity from dirty fossil fuels with clean solar power also protects the health of North Carolina residents. Fossil-fueled power plants emit ozone-forming compounds that can damage lung tissue and airbourne mercury that can build up in the food chain and pose human health threats. Using large commercial buildings to increase North Carolina's solar energy production can reduce the state's reliance on dirty energy and help avert these public health hazards.

Soot and Smog

Reducing fossil fuel combustion decreases emissions of health-threatening air pollutants, such as soot and smog. North Carolina's power plants harm public health by emitting a variety of pollutants, including pollution that contributes to ground-level ozone, a key element of smog. When inhaled, ozone quickly reacts with airway tissues and produces inflammation similar to sunburn on the inside of the lungs. This inflammation makes lung tissues less elastic, more sensitive to allergens, and less able to ward off infections.[48] Minor exposure to ozone can cause coughing, wheezing and throat irritation. Constant exposure to ozone over time can permanently damage lung tissues, decrease the ability to breathe normally, and exacerbate or potentially even cause chronic diseases like asthma.[49]

The American Lung Association's 2013 *State of the Air* report awarded air quality grades of "C" or lower to 16 of the 33 North Carolina counties for which it collects data based on those counties' high levels of ground-level ozone.[50] However, with 3,000 MW of solar energy capacity on commercial buildings, North Carolina could replace 3 percent of its 2012 fossil fuel-generated electricity use, which would help the state avoid more than 5 million pounds of smog-forming nitrogen oxide pollution from power plants annually.[51]

Mercury

Coal-burning power plants produce more than half of all emissions of airborne mercury in the U.S., a potent neurotoxicant that is converted by microorganisms into a form that accumulates up the food chain.[52] North Carolina has 24 coal-burning power plants, and fish consumption advisories have been issued for more than 50 types of fish and shellfish from rivers, lakes and coastal areas due to the threat posed by mercury contamination, especially to children, nursing mothers and pregnant women.[53]

By reducing the need for electricity from fossil fuel-fired power plants, solar power reduces the threat posed by mercury contamination.

Solar Energy Creates Jobs and Strengthens the Economy

North Carolina's solar energy industry is thriving, and it has more room to grow. Increasing the market for commercial-scale rooftop solar power in North Carolina would create jobs in manufacturing of solar panels and other parts of solar energy systems, as well as sales and installation, and would boost the state's economy.

North Carolina is already home to 121 businesses that develop, manufacture, sell or install solar panels; these businesses employ 1,400 people, according to SEIA, and they have a significant impact on local economies.[59] For example, Durham-based Semprius Energy will hire 250 new employees over the next several years to run its recently opened manufacturing facility in Henderson.[60] Schletter, Inc., which supplies 25 percent of all solar panel mounting systems produced and delivered in the U.S., announced plans in 2012 to set up its national headquarters in Shelby and hire 300 people by 2016 to run a production and distribution center in Cleveland County.[61] The company plans to pay its Cleveland County employees $41,000 per year plus benefits on average—about $8,000 higher than the current average annual wage in the county.[62]

In addition to their direct impact on local economies in the form of wages paid to employees or property taxes paid to local governments, solar energy businesses contribute indirectly to economic growth as well. In Beaufort County, Duke Energy's largest solar energy project to date is expected to bring about $21 million into the local economy by creating local construction jobs and increasing spending at local retailers, motels and restaurants.[63]

IKEA Charlotte Installs a 1.1 MW Rooftop Solar Energy System

IKEA, the Swedish home furnishings retailer, is putting its rooftop space to work generating clean, renewable solar power. Thirty-nine of IKEA's 44 U.S. locations now have rooftop solar energy installations, with IKEA Charlotte going online in June 2013.[54] The 1.1 MW array at IKEA Charlotte brings total solar capacity at IKEA stores nationwide to 35 MW—making IKEA the fifth-largest corporate user of solar electricity in the U.S.[55] (See Figure 2 on page 11.) According to IKEA's website, the company plans to continue to ramp up its use of solar energy and other renewable energy to produce more energy than it uses by 2020.[56]

In Charlotte, IKEA was able to use 120,000 square feet of sun-drenched rooftop space for the solar energy installation.[57] The Charlotte solar array is expected to produce 1,300 MWh of electricity annually—or enough electricity to power 140 homes, according to the company.[58]

Photo: IKEA Charlotte

Solar panels generate clean power on an IKEA location in Charlotte.

North Carolina Can Launch a Market for Commercial Solar Power

North Carolina can start taking advantage of its potential for commercial rooftop solar now. The cost of installing solar PV panels has declined significantly in recent years, making investments in solar energy more attractive. However, up-front installation costs can still deter many business owners, and there are other barriers as well, such as siting and permitting restrictions, interconnection regulations, and taxes and fees. In addition, businesses often lease commercial space, resulting in a problem of "split incentives" between tenants interested in installing solar panels and property owners responsible for capital improvements. These barriers can make solar energy investments less attractive to potential customers.

States with strong solar energy markets have worked to eliminate financial barriers and simplify the installation process. For example, the 12 leading states for solar power (including North Carolina) account for only 28 percent of the U.S. population but more than 85 percent of the nation's total solar electricity generating capacity.[64] Many of these states have taken similar policy approaches that have helped lead to strong solar market growth, including the development of a robust commercial solar energy market. For example, according to a recent report by Environment America Research & Policy Center:[65]

- All but one of the top 12 states have ***renewable electricity standards*** (RES) that set minimum requirements for the share of a utility's electricity that must come from renewable sources, and nine of them have ***solar carve-outs*** that set specific targets for solar or other forms of clean, distributed electricity.
- Eleven of these states also have strong ***net metering policies***, which help support residential markets for rooftop solar power. In nearly all of these states, consumers are compensated at the full retail rate for the excess electricity they supply to the grid. Net metering ensures that consumers receive reliable and fair compensation for the electricity they provide to the grid.
- Ten of the 12 have strong statewide ***interconnection policies***. Good interconnection policies reduce the time and hassle required for individuals and companies to connect solar energy systems to the grid.
- The vast majority of the states allow for ***creative financing options*** such as third-party power purchase agreements that can significantly lower the up-front cost of installing solar energy systems.

North Carolina Can Improve Its Energy Policies to Boost Its Commercial Solar Market

North Carolina has several policies that have helped promote utility-scale solar power in the state, including a generous solar investment tax credit and other incentives for manufacturers of solar technologies.[66] It is this commitment to utility-scale solar energy that has earned North Carolina its place as the fifth-best state for cumulative installed solar energy capacity.[67] However, North Carolina's potential is far from realized. While the state ranks fifth nationwide for overall installed capacity, the state ranks only 11th on a per capita basis.[68] Much smaller states, with less attractive

solar resources, are outpacing North Carolina when it comes to solar energy, in large part because their policies are stronger, and they have done more to develop commercial and residential markets.

For example, New Jersey's RES requires nearly twice as much renewable energy as that of North Carolina, and the state recently increased its solar "carve-out" to ensure that a significant share of that clean energy comes from the sun.[69] A stronger RES—with a stronger solar carve-out—would inspire confidence among consumers and solar businesses and encourage more long-term investments in solar energy installations of all sizes.

In addition, while North Carolina requires investor-owned utilities to reimburse net metering customers at the retail rate for the excess electricity they provide to the grid, there are several limitations, restrictions and fees that weaken the policy and reduce incentives for homeowners and business owners to go solar. For example, residential and commercial customers that use net metering are usually credited for the extra electricity they supply to the grid on their next month's utility bill; however, they must surrender all accrued credits to the utility—without compensation—at the beginning of each summer billing cycle.[70] Additionally, businesses with systems over 100 kW in size (and homeowners with systems larger than 20 kW) must pay monthly "standby fees" to the utility for having to hold backup generation in reserve in case the solar PV systems ever goes down.[71] These fees are assessed based on the size of the PV system, rather than on the amount of electricity the utility might actually need to provide if the system goes down. For small generators for whom utilities would only need to provide a small amount of back-up power, standby charges can diminish most, if not all, of the economic incentive that net metering is intended to provide.[72] These and other restrictions earned North Carolina's net metering policies a "D" grade in *Freeing the Grid 2012,* the Interstate Renewable Energy Council and the Vote Solar Initiative's annual scorecard grading states on their net metering and interconnection policies.[73] North Carolina can improve its net metering policies by limiting these standby fees, and by requiring co-op and municipal utilities to offer net metering to their customers, in addition to investor-owned utilities.

Another key policy to support rooftop solar energy growth that is present in other top states but missing in North Carolina is allowance of third-party sales of electricity. In third-party sales agreements, solar developers lease rooftop space from home or business owners for the installation of solar panels. The solar developer retains ownership of the panels, and customers then sign a "power purchasing agreement" (PPA) to pay a monthly fee for the electricity the panels produce, often at lower rates than those charged by electric utilities. Third-party sales shift the up-front cost of installing solar panels and the cost of ongoing maintenance to the solar developer, making the benefits of solar energy more affordable to customers and protecting customers against electricity price increases. In North Carolina, however, only electric utilities such as Duke Energy are allowed to sell power to customers—if a solar company wants to establish a PPA program, state law requires it to be regulated as a utility, effectively prohibiting this type of financing in North Carolina by non-utilities.

Third-party sales could help make solar energy investments particularly attractive to business owners. Because the solar energy company retains ownership of the panels, it shoulders the risk of the investment, greatly reducing the financial burden on the business owner. Lower up-front costs may also allow business owners to consider installing larger systems to displace more of their annual consumption than they otherwise would have if they had to pay for the installation themselves. The solar company also typically handles permitting and interconnection paperwork in addition to ongoing maintenance on the panels—further simplifying participation for solar energy customers.

Policy Recommendations

North Carolina's policies have played a major role in making the state a leader when it comes to solar. The following policies will help ensure we continue that leadership, and do even more to develop the state's rooftop solar market.

1. **Enable third-party sales of electricity.** Financing rooftop solar energy systems through third-party electricity sales significantly lowers the up-front cost of installing solar PV systems for commercial consumers. The state should allow companies that install solar panels to sell electricity to their customers without subjecting them to the same regulations as large public utilities, such as Duke Energy.

2. **Fairly compensate large solar energy producers in power purchasing agreements.** North Carolina currently requires utilities to purchase power from large commercial or utility-scale solar producers in their service territories, but only at a very low rate mostly made up of the utilities' "avoided cost" for not generating and delivering the electricity. Because the avoided cost rate does not account for many important benefits of solar power—such as its unique ability to reduce costs at periods of peak demand or to reduce harmful air pollution—the state should increase the required rate of compensation for solar developers to more accurately reflect the true value of solar power.

3. **Improve the state's net metering laws.** Net metering helps ensure that small commercial or residential customers are fairly compensated for the solar electricity that they produce. Investor-owned utilities should be required to reduce "standby fees" to encourage large commercial customers to install solar panels, and co-op and municipal utilities should be required to offer net metering to their customers.

4. **Extend incentives for investing in solar technologies in North Carolina.** Current renewable energy tax credits for businesses and residents will expire by the end of 2015. In order to build a strong, self-sustaining market for renewable energy in North Carolina, the state should extend these tax credits and then phase them out in a planned and orderly fashion over a number of years.

5. **Reduce siting, permitting, and interconnection restrictions** that can greatly increase the total cost of installing solar energy systems. As much as 23 percent of the total installed cost of solar energy systems is related to permitting, inspection, interconnection and other non-hardware costs.[74] The state should work with local governments to streamline these processes and reduce red tape.

6. **Defend and strengthen the state's renewable energy standard** to require utilities to get 20 percent of their electricity from renewable sources by 2020, and to increase requirements for solar energy production. The state should also require all of the solar power that counts towards North Carolina's renewable energy standard to be produced within the state.

Methodology

Solar PV Technical Potential: Large Commercial Buildings

To estimate the technical potential for solar PV systems on large commercial buildings in North Carolina, we used the U.S. Energy Information Administration's *Commercial Building Energy Consumption Survey (CBECS)* to determine the square footage of large commercial buildings in the South Atlantic census region.[75] We defined large commercial buildings using *CBECS* microdata and the following selection criteria:

- **Small grocery stores and strip malls**—These buildings are between 25,001 and 100,000 square feet with the following principal building activities: grocery, other food sales and strip shopping malls.
- **"Big box" retail stores and large supermarkets or superstores**—These buildings are between 100,001 and 500,000 square feet with the following principal building activities: grocery, food sales, strip shopping mall, retail store and other retail.
- **Enclosed shopping malls and large strip malls**—These buildings are from 500,001 to 1,000,000+ square feet with the following principal building activities: enclosed mall and strip shopping mall.

Then, using Microsoft Access, we used *CBECS* microdata to divide the total floor space in each building by the number of floors in each building.[76] This gave us an estimate of rooftop space available on each building and of total rooftop space on large commercial buildings in the South Atlantic census region.

We then apportioned the total rooftop space on big box stores in the South Atlantic to North Carolina according to the percentage of the South Atlantic census region population living in North Carolina in 2003—about 16 percent.[77]

This yielded 245 million square feet of rooftop area on large commercial buildings in North Carolina. We assumed that 65 percent of this rooftop area is suitable for rooftop solar energy systems, per a 2008 study by Navigant Consulting for the National Renewable Energy Laboratory, *Rooftop Photovoltaics Market Penetration Scenarios*.[78] In calculating this number, Navigant took into account factors such as tree and other shading on residential and larger buildings, roof tilt and orientation, and the room needed on roofs between solar panels and taken up by other objects such as chimneys and fan systems.

This yielded 160 million square feet of rooftop area available and appropriate for rooftop solar PV systems. At 18.5 percent conversion efficiency, installing solar PV systems on all available and appropriate rooftop space on large commercial buildings would yield 3,101 MW of solar energy capacity.[79]

Energy Output

We calculated the energy output of solar PV panels in North Carolina using a population-weighted state average annual electricity generation estimate of 1,299 kWh per kW, per the National Renewable Energy Laboratory's *PVWatts* tool.[80]

Estimating North Carolina's Future Electricity Needs

Calculations for the equivalent percent of North Carolina's future energy needs that solar output would represent were based on the following.

We derived an estimated value for 2030 electricity consumption in North Carolina using the actual and forecasted annual growth rates for electricity demand for 2010-2025 in the service territories of North Carolina's three largest investor-owned utilities: Progress Energy, Duke Energy and Dominion Power Company.[81] The 2012 integrated resource plans (IRP) of these utilities included projected energy sales in their service territories through 2025. We applied the annual rate of growth in energy sales among these three utilities to actual statewide electricity consumption in 2010, per Energy Information Administration *State Electricity Profiles*, to estimate statewide electricity consumption each year through 2025.[82] From 2025 to 2030, we assumed consumption would increase at an average annual rate of 1.6 percent.

To be conservative, this calculation assumes that there are no improvements in the energy efficiency of residential and commercial buildings (beyond those assumed in the utilities' IRPs) in North Carolina before 2030.

Energy Consumed by Large Commercial Buildings

To estimate how much electricity is consumed by large commercial buildings in the state, we used *CBECS* microdata; the selection criteria listed above (see "Solar PV Technical Potential: Large Commercial Buildings"); and Microsoft Access to estimate electricity consumption by large commercial buildings in the South Atlantic census region in 2003—the last year of available data from *CBECS*. We scaled this number down to North Carolina according to the percentage of the population of the South Atlantic census region living in North Carolina.[83]

Reducing Global Warming Pollution

We estimated global warming pollution from electricity generation as follows.

We assumed that energy generated by solar PV would primarily replace non-baseload electricity generation. In the SERC Virginia/Carolina (SRVC) eGRID subregion, non-baseload electricity sources produce an average of 1,678 pounds of carbon dioxide per MWh.[84]

For natural gas, we assumed that every million British thermal units (BTU) of avoided natural gas use would prevent 53 kilograms of carbon dioxide pollution, per emission coefficients from the U.S. Department of Energy.[85]

Notes

1. For the purposes of this report, we assume rooftop solar PV systems to be a mix of residential and commercial systems averaging 10 kW (DC) in size.

2. Population estimates for 2002 and 2012 per U.S. Census Bureau, *State Population Estimates: April 1, 2000 to July 1, 2002*, released 20 December 2002, and U.S. Census Bureau, *State and County Quickfacts: North Carolina,* downloaded from quickfacts.census.gov, 24 July 2013.

3. As of September 2013, the Solar Energy Industries Association reported 322 MW of installed solar energy capacity that ranks North Carolina fifth in the country for cumulative solar capacity, per Solar Energy Industries Association, *North Carolina Solar*, downloaded from www.seia.org/state-solar-policy/north-carolina, 18 September 2013.

4. 322 MW as of November 2013: Ibid. SEIA also reported in September 2013 that the state has 254 MW of operational utility-scale solar installations larger than 1 MW per Solar Energy Industries Association, *Major Solar Projects in the United States Operating, Under Construction, or Under Development* (fact sheet), 1 November 2013.

5. IKEA, for example, has several rooftop solar PV arrays on its stores and distribution centers that exceed 1 MW in size, per IKEA, *IKEA Powers-Up Solar Panels Atop Charlotte, NC Store* (press release), 4 June 2013; IKEA, *IKEA Completes Maryland's Largest Rooftop Solar Array Atop Distribution Center in Perryville, MD* (press release), 18 April 2013; and David Shaffer, "Ikea's Rooftop Solar Array Will Be the Largest in Minnesota," *Star Tribune,* 12 January 2012.

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7. 250 sunny days: State Climate Office of North Carolina, *Other Climatic Factors,* downloaded from www.nc-climate.ncsu.edu/climate/ncclimate.html, 24 July 2013; State rankings: Solar Energy Industries Association, *2012 Top 10 Solar States*, downloaded from www.seia.org/research-resources/2012-top-10-solar-states, 19 September 2013.

8. Anthony Lopez, et al., National Renewable Energy Laboratory, *U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis*, July 2012; North Carolina's 2012 electricity use: See "Estimating North Carolina's Future Electricity Needs" in the methodology.

9. U.S. Department of the Treasury, Community Development Financial Institutions Fund, "Understanding the Grocery Industry" in *Financing Healthy Food Options: Implementation Handbook,* 30 September 2011, and Institute for Self Reliance, *How Big Are Big Box Stores?,* downloaded from www.ilsr.org/how-big-are-bigbox-stores, 17 July 2013.

10. Elaine Misonzhnik, "Return of the Mall," *Real Estate Investor*, 5 May 2011.

11. Size based on data from the California Solar Initiative: California Energy Commission & California Public Utilities Commission, *California Solar Initiative Working Data Set*, 7 September 2011, available at www.californiasolarstatistics.ca.gov/current_data_files; Systems take approximately 100 square feet of roof area per kW, per Solaris Blackstone, *Frequently Asked Questions*, downloaded from www.solarisblackstone.com, 20 January 2012.

12. Will Macht, Urban Land Institute, *Greening the Big Blue Box*, 26 October 2012.

13. Walmart daily electricity consumption: Aly Courtemanch and Lani Bensheimer, "Environmental Impacts of the Proposed Wal-Mart Supercenter in Potsdam," *Conservation Biology*, 29 April 2005; North Carolina homes use about 17,000 kWh per year, calculated by dividing state residential electricity consumption in 2010 (62,160,000 MWh per U.S. Energy Information Administration, *State Electricity Profiles 2010,* 27 January 2012) by number of households in the state (per *State and County Quickfacts: North Carolina*, note 2).

14. Large commercial buildings in the South Atlantic region (as we have defined them in the methodology), consume about 42 billion kWh of electricity annually, per U.S. Energy Information Administration, *2003 Commercial Buildings Energy Consumption Survey*, June 2006. All commercial buildings in the South Atlantic region consume 254 billion kWh of electricity annually, according to *CBECS*.

15. See methodology.

16. See methodology; Passenger vehicles emit about 5.2 metric tons of carbon dioxide annually, per U.S. Environmental Protection Agency, *Emission Facts: Greenhouse Gas Emissions from a Typical Passenger Vehicle*, February 2005.

17. See methodology; calculation assumes a coal-fired power plant to be 500 MW in size with a capacity factor of 63.9 percent per U.S. Energy Information Administration, *Electric Power Annual 2009*, April 2011. Capacity factor for solar panels is assumed to be about 15 percent, based on a population-weighted average solar radiation in North Carolina of 1,299 KWh_{AC} per kW_{DC} per year, per National Renewable Energy Laboratory, *PVWatts Grid Data Calculator (Version2)*, downloaded from www.nrel.gov, 10 June 2013; Population estimates for Greensboro, Jacksonville, Fayetteville, Charlotte, Greenville, Raleigh, Winston-Salem and Rocky Mount obtained from U.S. Census Bureau, *State and County Quickfacts*, revised 10 January 2013.

18. More than nine-fold: North Carolina's cumulative installed solar PV capacity as of November 2013 was 322 MW, per note 3; 3 percent of North Carolina's 2012 electricity use: See note on population-weighted average solar radiation in North Carolina, Ibid. For North Carolina's 2012 electricity use, see "Estimating North Carolina's Future Electricity Needs" in the methodology.

19. Number of commercial establishments and business categories: U.S. Census Bureau, *2007 Economic Census: Retail Trade: Subject Series - Misc Subjects: Floor Space by Selected Kind of Business for the United States and States: 2007*, downloaded from factfinder2.census.gov, 17 July 2013; Building size ranges: U.S. Department of the Treasury, "Community Development Financial Institutions Fund, 'Understanding the Grocery Industry,'" *Financing Healthy Food Options: Implementation Handbook,* 30 September 2011; See Institute for Self Reliance, note 9; and Chain Store Guide, *A Look Into The Top 10 Department Store Companies*, downloaded from www.narms.com/pdf/NARMS1285687711.pdf, 26 September 2013. Note: The North America Industry Classification System (NAICS) definition for "department store" used by the 2007 Economic Census includes "big box" stores selling general housewares such as Target or Walmart; however some "big box" stores that sell specific categories of products, such as electronics, home improvement materials, or office supplies, fall under their own "specialty store" categories and therefore may not be listed in Table 1. (See U.S. Census Bureau, *2002 Economic Census—Appendix B, NAICS Codes, Titles, and Descriptions*, downloaded from www.census.gov/prod/ec02/ec0244i11ab.pdf, 24 July 2013).

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26. See note 24.

27. See note 3.

28. See comparison between the forecast cost of electricity from different technologies in: Joel Klein, California Energy Commission, *Comparative Costs of California Central Station Electricity Generation Technologies*, August 2009.

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30. T. Hoff, et al., Clean Power Research LLC, *The Value of Distributed Photovoltaics to Austin Energy and the City of Austin*, 2006.

31. See note 20.

32. 71,000 MWh: Walmart, *Renewable Energy*, downloaded from corporate.walmart.com/global-responsibility/environment-sustainability/renewable-energy, 24 July 2013; A typical North Carolina home uses about 17,000 kWh of electricity annually, calculated assuming annual statewide residential electricity consumption of 62,160,000 MWh, per *State Electricity Profiles 2010*, note 13, and an estimate of 3,664,119 North Carolina households, per *State and County Quickfacts: North Carolina*, note 2.

33. Ehren Goossens, "Wal-Mart Beats Apple, Ikea in U.S. Solar Installations," *Bloomberg Businessweek*, 30 July 2012.

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51. Calculation assumes 2012 state electricity consumption of 132,679,228 MWh (down from 136,414,947 MWh in 2010, per *State Electricity Profiles 2010*, note 13). See "Estimating North Carolina's Future Electricity Needs" in methodology. SERC Virginia/Carolina eGRID subregion non-baseload NOx annual emission rate is 1.3 lbs/MWh, per note 43.

52. U.S. Environmental Protection Agency, *Mercury: Basic Information*, accessed at www.epa.gov/hg/about.htm, 14 June 2013.

53. North Carolina has 24 coal-burning power plants, per note 43; Fish consumption advisories: See U.S. Environmental Protection Agency, *National Listing of Fish Advisories—NLFA Technical Advisories Search,* downloaded from fishadvisoryonline.epa.gov/Advisories.aspx, 24 July 2013; U.S. Environmental Protection Agency, *Fish Consumption Advisories—General Information*, downloaded from water.epa.gov/scitech/swguidance/fishshellfish/fishadvisories/general.cfm, 14 June 2013.

54. Alison Angel, "Ikea Charlotte Plugs in Solar System," *Charlotte Business Journal*, 6 June 2013.

55. Eric Justian, "IKEA Surges to Second-Largest Private Producer of Solar Energy in U.S.," *TriplePundit.com*, 20 June 2013; See note 20.

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58. See *IKEA Powers-Up*, note 5.

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60. North Carolina Solar Center, *Semprius to Power $2.3M Pentagon Solar Project* (press release), 20 November 2012.

61. North Carolina Solar Center, *Solar Company to Create More than 300 Jobs in NC* (press release), 14 August 2012.

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63. North Carolina Solar Center, *Solar Energy Providing Jobs in Eastern N.C.* (press release), 16 November 2013.

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65. Ibid.

66. See Database of State Incentives for Renewable Energy, *North Carolina: Renewable Energy and Energy Efficiency Portfolio Standard,* 12 December 2012; North Carolina Solar Center, *North Carolina Policy*, downloaded from ncsc.ncsu.edu/index.php/policy-markets/nc-policy, 24 July 2013.

67. As of September 2013, the Solar Energy Industries Association reported 322 MW of installed solar energy capacity, per note 3.

68. See note 64.

69. Database of State Incentives for Renewable Energy, *New Jersey Incentives/Policies for Renewable Energy—Renewable Portfolio Standard*, 28 March 2013, and see *North Carolina,* note 66.

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79. Based on converting annual solar output to BTU by multiplying by 3,412 BTU per kWh, then calculating how much surface area would be required to capture that much sunlight in a year given a population-weighted average solar radiation in North Carolina of 1,299 KWh_{AC} per kW_{DC} per year (See note on population-weighted average solar radiation in North Carolina, note 17) at 18.5 percent conversion efficiency and adding an additional 25 percent to account for space required by ancillary equipment, per note 78.

80. See note on population-weighted average solar radiation in North Carolina, note 17.

81. Note: Duke Energy and Progress Energy merged in 2012, and the new company is called Duke Energy. However, the companies filed separate integrated resource plans (IRPs) in 2012, which we used to obtain values for actual and forecasted electricity sales between 2010 and 2025. See Duke Energy, *The Duke Energy Carolinas Integrated Resource Plan (Annual Report)*, 1 September 2012; Progress Energy Carolinas, *Progress Energy Carolinas Integrated Resource Plan*, November 2012; Dominion North Carolina Power*, Dominion North Carolina Power's and Dominion Virginia Power's Report of Its Integrated Resource Plan*, 31 August 2012. For actual energy sales between 2010 and 2012 for Progress Energy and Duke Energy, we referred to Duke Energy, 2012 *Annual Report and Form 10-K*, 2013.

82. See *State Electricity Profiles 2010*, note 13.

83. See note 77.

84. See note 43.

85. U.S. Department of Energy, Energy Information Administration, *Voluntary Reporting of Greenhouse Gases Program Fuel Emission Coefficients*, 31 January 2011.