A Residential Customer Guide to Going Solar:

Duke Energy Carolinas Version

Prepared by the

NORTH CAROLINA Solar Center

for Duke Energy Carolinas Residential Customers

SunShot U.S. Department of Energy

SOLAR OUTREACH PARTNERSHIP

Throughout its history, North Carolina has been at the forefront of technological change and innovation. Innovative advances in fields such as biotechnology, nanotechnology, computing, textile engineering, crop sciences, and data science have improved the lives of millions of North Carolina citizens, and created hundreds of thousands of jobs.

Clean energy technologies have also made innovative advances, and are poised to help North Carolina residents save millions of dollars on their monthly utility bills. For example, the cost of installing solar photovoltaic (PV) panels on a home has fallen to the point that millions of Americans now have the opportunity to reduce their electric bills and more affordably generate their own energy. On top of these lower installation costs, there are several federal, state, and utility financial incentives available to North Carolina homeowners to make solar a more cost-effective energy option.

Installing solar also decreases costs for everyone because when a homeowner uses less energy from the grid, the utility can avoid investing in new power plants and other costly infrastructure. Delaying these investments delays or removes the need for rate increases. Solar also increases the efficiency of the grid, which reduces other fuel and operating costs that utilities pass on to their customers.

This guide is designed to help North Carolina residents looking to invest in solar and take a larger measure of control over their energy production and energy future. Even if you choose not to invest in solar at all, the staff of the North Carolina Solar Center hope the people of North Carolina will use this guide to help understand their options and become educated solar consumers.

Table of Contents

Glossary

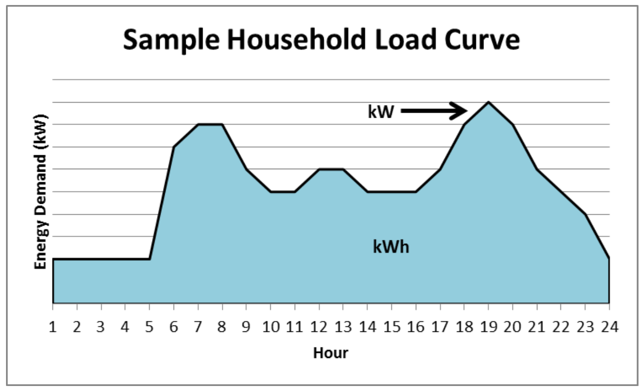
Avoided Cost- price the utility would have to pay to purchase another unit of energy based on their current generation portfolio; avoided cost is lower than the retail rate because it does not include delivery (transmission and distribution) or customer charges

Buy-All, Sell-All- arrangement in which a PV owner sells all of the electricity produced by their system to the utility and purchases all of the electricity they consume from the utility

Demand Charge- charge on a customer's utility bill for the maximum level of power (kW) used during the month; this reflects how much energy was being used at a single moment

Flat Rates- rates that do not fluctuate based on time of day or day of week; the same price is charged for all energy used

Kilowatt (kW)- unit of power; how much power is being consumed or produced at a single instant in time (see graph to right- kW are represented by the black line)



kW versus kWh

Kilowatt-hour (kWh)- unit of energy; amount of power used or generated over time (see graph to right- kWh are represented by the blue shaded area)

Net Metering- arrangement in which a homeowner with solar panels uses the energy produced by his or her system and sells any extra energy back to the grid at the retail rate for others to use

Off-Peak Energy- energy produced or consumed during periods of low demand (in the middle of the night and on weekends, for example)

On-Peak Energy- energy produced or consumed during the periods of highest demand (time when people are using the most energy, such as summer days when many people are using air conditioners)

Renewable Attributes- a quality of energy based on the fact that it was generated from renewable sources; the renewable attributes of energy can be financially separated from the physical energy and traded as RECs

Renewable Energy Certificate (REC)- accounting mechanism for the renewable attributes of energy generated from renewable sources; one REC represents one megawatt-hour of renewable energy

Renewable Energy and Energy Efficiency Portfolio Standard- North Carolina law requiring Duke Energy to obtain 12.5% of its electricity from renewable and energy efficiency sources by the year 2021

Retail Rate- the price at which a kWh of energy is selling for on a given tariff

Tariff- a utility's publicly posted schedule of rates; Duke Energy Carolinas has multiple tariffs for residential customers to choose from, such as the standard flat rate tariff and the time-of-use tariff

Time-of-Use Rates- rates that vary based on time of day and day of week; energy used during "on-peak" hours costs more than energy used during "off-peak" hours

Efficiency First

North Carolina residents both consume more energy and spend more money on energy than the national average, despite having lower rates.[1] Because of this, North Carolina residents in particular benefit financially from energy saving measures like increasing insulation, replacing inefficient appliances and lighting, and installing solar panels. While all of these measures reduce electricity consumption, efficiency improvements tend to provide a homeowner with the greatest bang for their buck. Improving efficiency before installing solar panels also allows a PV system to make a greater impact on the owner's electric bill. Because the home uses energy produced from the PV system more efficiently, the homeowner will require even less energy from the grid.

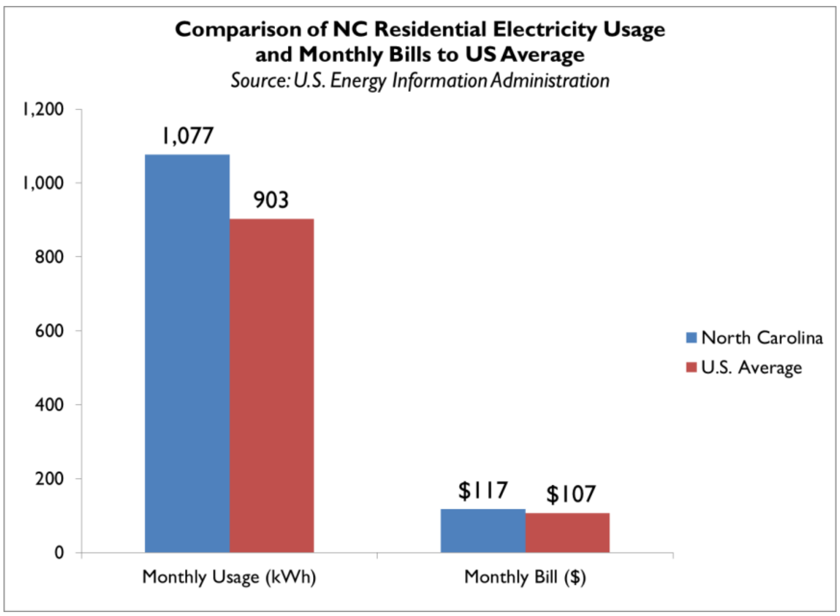


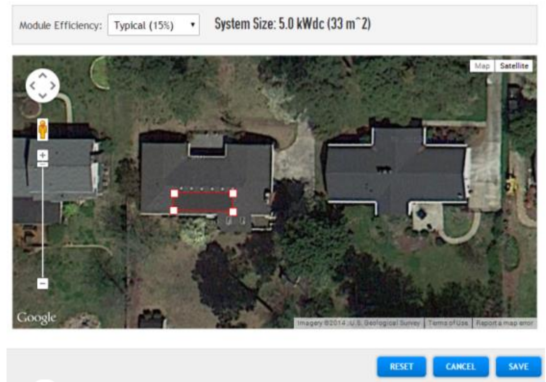
Figure 1: Comparison of NC Electricity & Monthly Bills to US Average

For this reason, as they are deciding whether or not to install solar PV, customers should consider having a full-spectrum home energy audit completed. An energy audit is a professional examination of how a customer's home uses energy and where efficiency improvements can be made. Duke Energy Carolinas offers free energy audits to its customers who own a single-family home, have lived there for at least 4 months, and have an electric water heater, electric heat, or central air. For more information on getting a free energy audit, visit http://www.duke-energy.com/north-carolina/savings/home-energy-house-call.asp. In addition, several solar companies in the Triangle that offer home energy retrofits also offer free home energy audits. To find such a company, please call the NC Sustainable Energy Association. Their contact information is on page 17 of this guide.

[1] U.S. EIA. Electric Sales, Revenue, and Average Price: Table T5.a. Available at http://www.eia.gov/electricity/sales_revenue_price/

How Much Energy Can Solar Generate At My House?

Fortunately, a homeowner does not need an ideally faced and sloped roof to produce lots of solar power. In fact, in North Carolina, panels installed on east or west facing roofs receive about 85% as much solar energy as an ideally oriented south-facing roof. The impact of less than ideal roof pitch is even lower. The U.S. Department of Energy's National Renewable Energy Laboratory (NREL) has a very useful online tool called PV Watts[2] that allows a homeowner to see their roof in a satellite photo and draw in the area for a solar system. PV Watts will then estimate how much energy the PV system will produce in a typical year and provide a monthly breakdown.



NREL's PVWatts® Calculator

The average household in North Carolina used an average of 1,077 kWh per month in 2012. Assuming a SE or SW facing roof with no shade, a 9.5 kW PV system is required to generate 100% of this average home's electricity use in a typical year. Thus, the 4.1 kW system used as an example in this guide would provide about 43% of the electricity needs for this home.[3]

What Do I Need to Know About Today's Solar Technology?

A residential solar PV system consists of three major components: (1) solar panels (modules), (2) an inverter, and (3) racking. Today there are many trusted brands of solar panels, with limited differences in quality, features, and performance between most typical-efficiency panels. All reputable panels will come with a 25-year power warranty that generally guarantees that the panels will still produce at least 80% of their initial nameplate rating 25 years from now. A great resource to learn more about current products and technologies is Home Power magazine[4], which offers many free articles on its website.

Traditionally, a group of solar panels are connected in a series (to form a "string" of panels) and then connected to a string inverter. These string inverters are still the lowest cost solution, but are more sensitive to partial panel shading than microinverters or inverters with DC optimizers. Solar PV systems are quite sensitive to shading, even partial shading, but both microinverters and DC optimizers limit the effect of shade to only the shaded panel, instead of the entire string of panels. This can result in 20% greater annual energy output in some situations.

---

2 http://pvwatts.nrel.gov/

3 kW values here are DC-rated

4 http://www.homepower.com/solar-electricity

How Does Solar PV Help Customers Save Money?

There are three primary ways a home can use the power generated by a photovoltaic (PV) system: 1) Using the electricity on-site and selling any excess back to Duke Energy via net metering, 2) Selling all the electricity and renewable attributes produced via NC GreenPower, and 3) Using the PV system to supply an energy storage system (such as a battery backup system).

Each option is accompanied by its own set of complexities and economic benefits. In some cases, choosing one option may disqualify a homeowner from some of the available financial incentives discussed later in this guide. Customers should discuss these options with their solar installer to make sure they pick the best option for their home.

Net Metering

At the moment when the sun's rays are striking a solar PV system, and a residential customer's home is wired to directly use the electricity generated by the system, the customer is able to avoid using that amount of energy from Duke Energy. During times when the sun is shining, the solar PV system is acting in a way that is very similar to any other appliance that helps customers save energy, like an ENERGY STAR certified HVAC system or clothes washer.

Just like with an energy efficient appliance or other similar measure, the self-supply characteristics of solar PV help customers save on their bill at the retail rate they pay for electricity from Duke Energy, since the amount of energy their system generates in kilowatt-hours (kWh) will reduce their demand for energy from the utility.

In the case of net metering, a rooftop solar PV system may sometimes generate more energy than the customer needs at that moment. This means that two things are happening:

- The PV system is still supplying the customer with the energy it needs; and
- The PV system is also ***exporting*** the excess energy back into the utility grid, which has the effect of supplying nearby customers with electricity

Net metering allows customers to power their homes with a solar PV system when the sun is shining, but still receive credit at the retail rate for generating more energy than they need, which will offset their bill during times when the sun is not shining. When extra electricity is produced by their systems, it is exported to the grid for others to use, "spinning the meter backwards" in the process. The solar PV customer's utility bill at the end of the month reflects the net amount of electricity used, or the difference between the total amount of energy the customer consumed and what the customer's PV system generated.

If the system produces more electricity than it uses in a given month, the "net excess generation" is carried forward into the following month like rollover minutes for a cellular phone plan. Net excess generation credits can be carried forward from month-to-month until June 1st of each year, when all credit is cleared with no compensation to the customer.

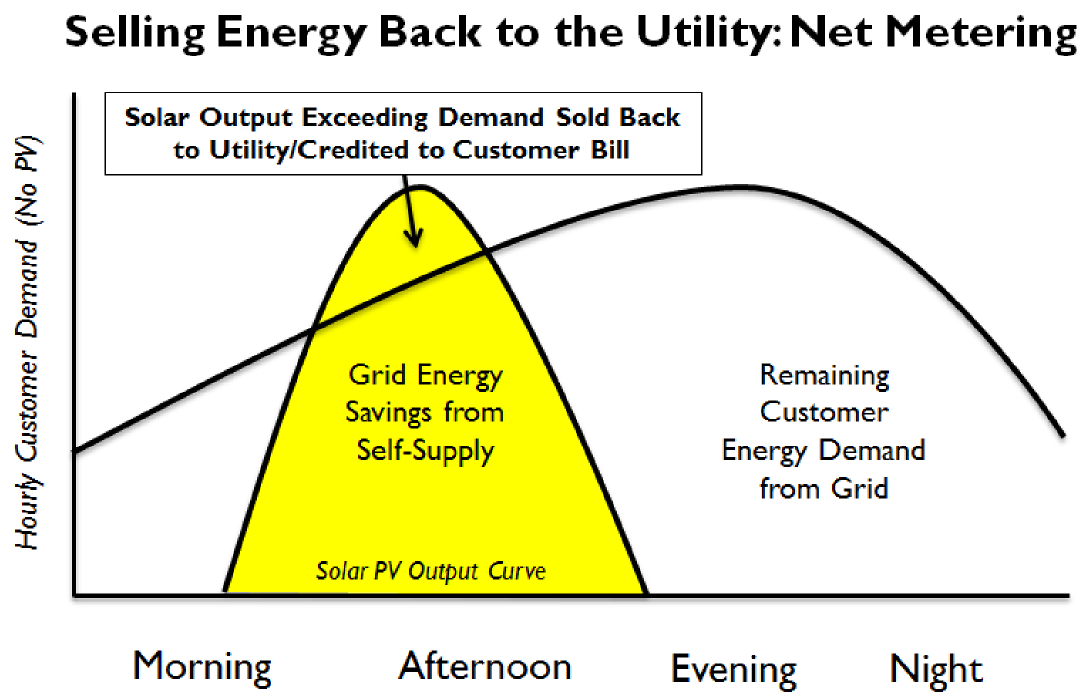


Figure 2: Visual Representation of Net Metering

Duke Energy offers two main residential rate schedules for customers who want to participate in net metering- the **standard flat rate schedule** and a **time-of-use rate schedule.** There is also a third option, a new **pilot time-of-use schedule**, currently available on a limited basis. North Carolina's net metering rules allow PV owners to participate in net metering under any of these rate schedules. Under the standard schedule, customers pay a single rate for all electricity consumed.[5] Under both time-of-use schedules, the rate varies by time of day and day of the week. Electricity consumed during hours classified as "on-peak" costs more than electricity consumed during "off-peak" hours. Additionally, customers on the time-of-use schedule pay a demand charge, which reflects their peak usage that month. Duke Energy's pilot time-of-use schedule is similar to the standard time-of-use schedule, but features a lower demand charge and higher energy charges. Participation in this pilot schedule is currently limited to 250 customers. See Table 6 in the Appendix for more details on Duke Energy's rates.

[5] While all electricity consumed per month is charge the same rate under the standard flat rate schedule, this rate changes seasonally, with a higher rate being charged during the months of July through October.

NC GreenPower

Unlike net metering, NC GreenPower requires a "buy-all, sell-all" agreement between a customer and the utility, meaning that the customer agrees to sell all electricity generated by their PV system to the utility at a set rate and to continue to buy all of the electricity they will consume from the utility.

NC GreenPower participants sell their power under the Non-Hydroelectric Qualifying Facilities Purchased Power (PP-N) tariff, which offers an avoided cost rate for power sold to Duke Energy. "Avoided cost" refers to the price that Duke Energy would have to pay to get the energy it is purchasing from that customer from another source. Participants have two options, A and B, under this tariff, which provide the homeowner with approximately the same amount of earnings. The primary difference is that Option B payments fluctuate more by season, whereas Option A payments are more consistent throughout the year. Option B also pays a higher rate for on-peak generation than Option A, but fewer hours are categorized as on-peak under Option B.

On top of this rate, NC GreenPower participants get paid a premium for the power they produce, due to its "renewable attributes". This premium is $0.06 per kWh and is only paid for 5 years. NC GreenPower may not be used in combination with net metering. It is important to note that money earned under the NC GreenPower option is classified as income, and therefore subject to income tax.

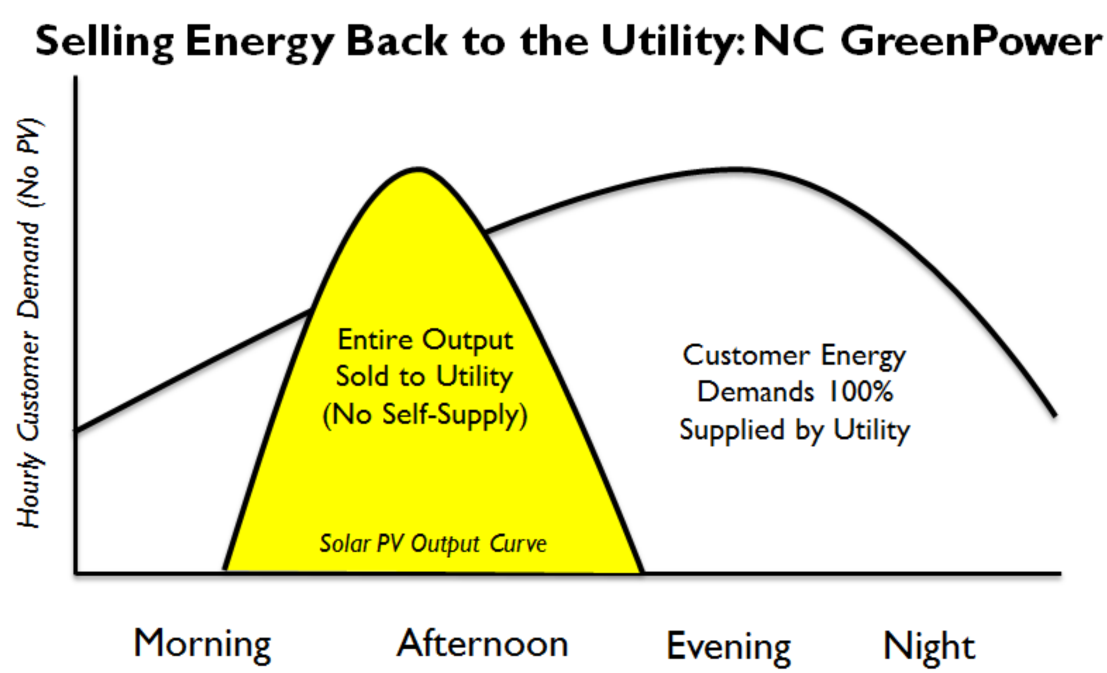


Figure 3: Visual Representation of NC GreenPower

Battery Backup

Connecting a PV system to batteries may make sense for customers in remote locations that are not connected to the grid, or for customers whose utility does not offer net metering or NC GreenPower. However, batteries can add significant cost to a system and require a level of maintenance that would be unattractive to most homeowners.

In most cases, net metering or NC GreenPower would be more advantageous ways to benefit from a PV system.

Putting it All Together

Tables 5 and 6 in the appendix compare the different basic rate and billing options available. Homeowners may only select one of the two options presented in Table 5: NC GreenPower or net metering. The chart details payments and bill credits included in each option, the ability to roll over energy credits from month to month if a customer's solar PV system causes them to "zero out" their bill, the time limits on incentives, and interconnection fees. REC (Renewable Energy Certificate) ownership is also noted. RECs are the accounting mechanism used to ensure utilities meet the state Renewable Energy and Energy Efficiency Portfolio Standard (REPS) requirements and allow for trading to occur to meet these requirements. Finally, rate schedule options are listed for each of the incentive choices. This is particularly important for those homeowners wishing to participate in net metering.

How Much Does Solar PV Really Cost?

One of the most significant misconceptions about solar is that it is prohibitively expensive and is not a good investment for all but a few homeowners. In fact, the cost of PV has decreased by over 50% in the last 2-3 years. As Figure 4 shows, the average cost (after incentives) of a system to serve an average home in Duke Energy Carolinas territory ranges from ***just $5,775 to $9,406!***[6]

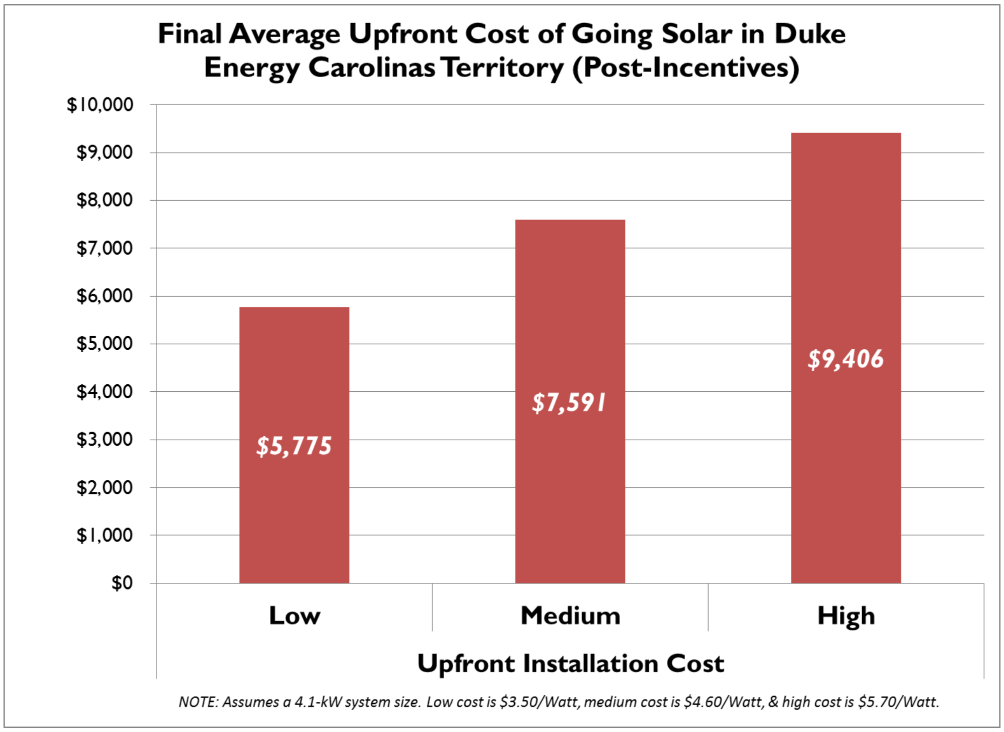


Figure 4: Average PV System Cost Post-Incentives

Financing Options

There are a number of different financing options available if customers do not have the cash upfront to pay for a solar PV system. Many local banks and credit unions provide low-interest loans to people going solar. Another option to finance the costs of a PV system is to borrow against the equity of one's home, taking out what is known as a home equity loan. While these options reduce or eliminate the upfront costs of going solar, it is important to note that taking out a loan will increase the total cost of owning the system, due to interest. However, with these options, solar is accessible to more people, and with all of the upfront incentives available, the dollar amounts of these loans are less than, for example, the typical car loan.

[6] This figure is based upon a system size of 4.1 kW and a cost of $3.50 to $5.70 per watt. Cost figures were obtained from conversations with local solar installers and LBNL's *Tracking the Sun VI* report. (Lawrence Berkeley National Laboratory. *Tracking the Sun VI: An Historical Summary of the Installed Price of Photovoltaics in the United States from 1998 to 2012*. Accessible at: http://emp.lbl.gov/sites/all/files/lbnl-6350e.pdf.)

What Kind of Federal and State Incentives are Available?

There are several key federal and state incentives that help to reduce or "buy down" the upfront cost of a residential rooftop PV system. These incentives are described in detail below.

Federal and State Incentives

The main upfront incentives for individuals trying to go solar are federal and state tax credits. The Federal Residential Renewable Energy Tax Credit provides a taxpayer with a credit for 30% of his or her solar installation costs. There is no cap on the amount of this tax credit, and it is available for solar installations placed in service by December 31, 2016. The North Carolina State Renewable Energy Tax Credit provides a taxpayer with a credit for 35% of his or her solar installation costs. This credit is available for solar installations placed in service by December 31, 2015 and may be carried over for 5 tax years.[7]

Together, these two tax credits alone bring down a homeowner's cost of installing solar significantly. Due to tax implications explained below, the effective cost reduction is about 60%.

Federal and State Solar PV Tax Credits Available to NC Residents					
Tax Credit Type	**Credit Amount**	**Total Credit Maximum**	**Annual Credit Limitation**	**Credit Rollover**	**Expiration Date**
Federal Tax Credit	30% Installation costs	None	Total federal tax liability for that year	Until credit expiration-rollover is uncertain after this date	12/31/2016
State Tax Credit	35% Installation costs	$10,500	50% state tax liability for that year	Up to 5 years	12/31/2015
Source: Database of State Incentives for Renewables and Efficiency (DSIRE)					

Table 1: Federal/State Solar PV Tax Credit Information

A sample breakdown of the tax credits available to North Carolina residents is shown in Figure 5 below. The calculations are based upon a 4.1 kW-sized system. To reflect variation in the cost of PV systems, low, medium, and high cost scenarios are presented in figures 4 and 5. The low cost scenario represents a system cost of $3.50 per watt, which was obtained through conversations with local solar installers. The high cost scenario ($5.70 per watt) is based upon Lawrence Berkeley National Laboratory's 2012 average North Carolina residential solar installation cost from their *Tracking the Sun VI* report. This is used as the high scenario because

[7] Database of State Incentives for Renewables and Efficiency (DSIRE), http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=NC20F&re=0&ee=0

prices have already declined since 2012, and local installers indicate that this figure now represents a higher end cost. The medium cost scenario splits the difference between the low and high cases, equaling $4.60 per watt.

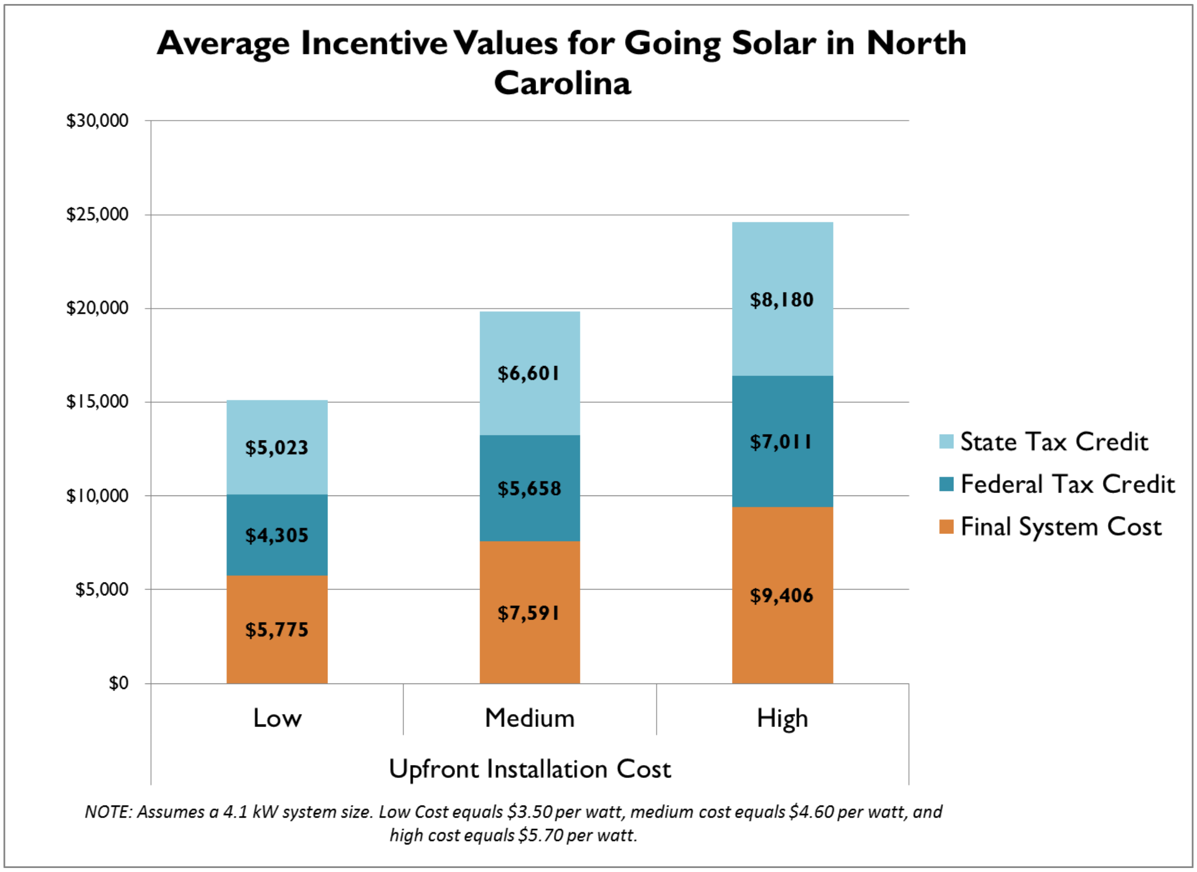


Figure 5: Expected Incentive Breakdown for North Carolina Customers

The 30% federal tax credit and the 35% state tax credit offset a large portion of the system costs once the year's tax refund is received. However, because the state tax that a consumer pays is a federal tax deduction, the state tax credit received eliminates a portion of this federal tax deduction, increasing one's federal taxable income by the amount of the state tax credit. This has the net effect of increasing one's federal income tax bill by their marginal tax rate times the value of the state tax credit received. For example, for someone in the 15% tax bracket, their federal income tax bill increases by 15% of the state tax credit.

Altogether, this leaves the customer with an average total cost of just $7,591, <u>a discount of 60%!</u> These numbers will certainly vary based upon system size, system cost, payment terms, and a variety of other factors, but they show just how big of a difference these incentives make. While the customer in this example is still left with a cost ranging from $5,775 to $9,406 after tax credits are received, this remaining cost may be recouped over time through net metering or NC GreenPower.

How Do All of These Options Compare?

This section compares these options using the energy usage patterns of a typical household in Durham and Charlotte. While actual savings will vary widely depending upon how much electricity customers use and when they use it, these estimates provide a good example of bill savings for a typical household with an average-sized residential PV system in the portions of North Carolina served by Duke Energy.

*** * * * DISCLAIMER: The figures presented below are estimates based on average PV output and energy usage data. Individual customer savings may vary significantly from those in the example below. * * * ***

Estimated Savings for a Typical Customer

There are both advantages and disadvantages to the different performance-based payment options and rate schedules available. People who use a lot of electricity at once or use most of their electricity during on-peak hours (see Table 6 in the appendix) will see higher electricity bills on a time-of-use rate schedule than with flat rates. People who stagger the use of appliances that consume a lot of energy, use natural gas for heating or water heating, or use most of their electricity at night or on the weekend can see lower electricity bills with time-of-use rates. Therefore, savings are highly dependent upon individual energy usage patterns.

Average Monthly Bill Savings Over PV System Life Under Rate/Billing Options				
Rate/Billing Option	**City**	**Average Flat Rate Bill Without PV**	**Average Bill With PV**	**Average Monthly Savings**
Net Metering (Flat Rate)	Durham	$151.36	$96.73	$54.63
	Charlotte	$152.17	$95.96	$56.21
Net Metering (Time-of-Use Rate)	Durham	$151.36	$129.56	$21.80
	Charlotte	$152.17	$130.69	$21.48
Net Metering (Time-of-Use Pilot Rate)	Durham	$151.36	$100.27	$51.09
	Charlotte	$152.17	$98.98	$53.19
*NC GreenPower Option A**	Durham	$151.36	$130.38	$20.98
	Charlotte	$152.17	$129.92	$22.25
*NC GreenPower Option B**	Durham	$151.36	$129.42	$21.94
	Charlotte	$152.17	$129.18	$22.99
*NC GreenPower does not technically reduce a customer's monthly electric bill, as it is a buy-all/sell-all agreement. Because NC GreenPower is a 5 year agreement, no NC GreenPower income is included after year 5. In this example, the payment received for selling all energy and RECs (5 yrs) is shown as savings to illustrate the value received through participation in the program. NC GreenPower income is also subject to federal and state income tax, thus reducing these initial "savings"; **Monthly bills for the full 25 years of PV use were averaged.				

Table 2: Typical Monthly Bills Before and After Going Solar

The savings shown in Tables 2 and 3 were calculated using typical energy usage data and PV output data for a 4.1 kW-sized system in Duke Energy Carolinas territory. PV output data was obtained from NREL's PV Watts tool for the cities of Durham and Charlotte, and energy usage data was taken from NREL's dataset entitled "Commercial and Residential Hourly Load Profiles for all TMY3 Locations in the United States".

Table 2 shows estimated bill savings for each of the different performance-based payment choices paired with its available rate options. Savings for each option are based upon what the customer would otherwise be paying under the standard flat rate schedule with no PV system in place. The figures in Table 2 are averages of monthly savings calculated over the entire life of the PV system (25 years). As the savings are averaged over 25 years and assume a 2% annual increase in electricity costs, the bill amounts may appear higher than a typical customer's bill today. Savings will vary from month to month and over the years, but these estimates provide a useful comparison between the available options.

Table 3 displays estimated total savings for a PV system in Durham and Charlotte under each of the different billing options. In this example, net metering under flat rates and the new time-of-use pilot rate schedule are the most favorable options. As the results show, the rate option a customer chooses can have a significant impact on whether solar PV is a good investment for them.

Net Savings Over PV System Useful Life				
Rate/Billing Option	**City**	**Net Savings After 25 Years**		
		Low System Cost	Medium System Cost	High System Cost
Net Metering (Flat Rate)	Durham	$10,614	$8,798	$6,983
	Charlotte	$11,088	$9,272	$7,457
Net Metering (Time-of-Use Rate)	Durham	$767	-$1,049	-$2,864
	Charlotte	$668	-$1,148	-$2,963
Net Metering (Time-of-Use Pilot Rate)	Durham	$9,553	$7,737	$5,922
	Charlotte	$10,182	$8,366	$6,551
NC GreenPower Option A	Durham	$520	-$1,296	-$3,111
	Charlotte	$900	-$916	-$2,731
NC GreenPower Option B	Durham	$806	-$1,010	-$2,825
	Charlotte	$1,122	-$694	-$2,509
**NOTE: Negative savings reflect upfront costs not recouped over the PV system's life.*				

Table 3: Net Savings Over 25-Year Useful Life

NC GreenPower has the advantage of paying customers a premium for their RECs for the first five years, which can also help pay back the costs of the system quickly and reduce interest payments. However, it does not provide as much savings over the life of the system as the other options, since the NC GreenPower credit is limited to 5 years, and the amount each system is paid is renewed only at the discretion of the program. As previously mentioned, both Options A and B provide approximately the same level of savings and differ in the distribution of these savings. Option A provides more consistent payments, while Option B's payments have more seasonal variation.

Inflation-Adjusted Return on Investment (ROI)				
Rate/Billing Option	City	Low System Cost	Medium System Cost	High System Cost
Net Metering (Flat Rate)	Durham	72%	31%	5%
	Charlotte	77%	34%	8%
Net Metering (Time-of-Use Pilot Rate)	Durham	61%	22%	-1%
	Charlotte	67%	27%	3%
NOTE: An annual inflation rate of 2.03% was used for this calculation. This rate of inflation is the annual average inflation rate for 2004-2014, as measured by the U.S. Bureau of Labor Statistics. The cost of financing a system with low- or no-money down may increase overall cost of ownership, and reduce system ROI.				

Table 4: Inflation-Adjusted Return on Investment

For each of the net metering options, a homeowner's energy usage patterns will play a large role in determining how much he or she saves. The flat rate pays a PV owner the same rate for all energy sold to the grid, no matter the time of day. The advantages of this option are that it lets the customer earn a higher rate for energy produced during off-peak hours than he or she would get on either time-of-use schedule, avoid paying a demand charge, and avoid paying a higher rate for on-peak energy use. This is an attractive option if a homeowner consumes a lot of energy at once or uses a lot of energy during on-peak hours.

Net metering under the regular time-of-use schedule pays a lower rate for the extra electricity sold to the grid during both on- and off-peak hours. However, if a homeowner is very conservative with how much energy he or she uses at once, this option could result in overall savings. These savings would be largely due to energy consumption behavior, rather than PV output, though.

The final net metering option, the pilot time-of-use option, has the advantage of paying a significantly higher price for electricity generated during on-peak hours. However, if a customer consumes a lot of energy during on-peak hours, he or she will also have to pay this same higher price for on-peak energy taken from the grid. An advantage of this rate schedule over the other time-of-use schedule is that the demand charge is much smaller. Therefore, a homeowner gets the time-of-use advantage of a higher rate for on-peak PV generation without the burden of a high demand charge. When deciding which option to go with, customers should think about their typical usage patterns and consider the estimates provided by a qualified and knowledgeable solar company to select the option that is best for them.

What Can I Do to Get Started?

The North Carolina Sustainable Energy Association (NCSEA) and the North Carolina Clean Energy Business Alliance (NCCEBA) represent most of the solar companies operating in North Carolina. Customers interested in installing solar on their home should feel free to contact Kathleen Fleming of the North Carolina Sustainable Energy Association (NCSEA) at (919) 832-7601 ext. 107 or kathleen@energync.org to learn more about your options and to be put in touch with local installers.

Fortunately for homeowners, solar installers handle most of the paperwork themselves. Installers are responsible for performing site assessments, obtaining building and electrical permits, handling interconnection applications, and, of course, doing the installation.

DISCLAIMER: Many of the options available to customers have changing terms and conditions, and some are subject to first-come, first-served availability. Customers interested in pursuing the NC GreenPower option should visit NC GreenPower's home page[8].

Looking Forward

Solar energy has much to offer North Carolina homeowners. With the financial incentives available today, solar is more affordable than ever. This guide should help North Carolinians realize these benefits of solar energy by informing citizens of the options available and what each of these options means for them.

With properly informed citizens, solar can be a step toward saving money for local people, achieving energy independence, and continuing to show that North Carolina is a state at the forefront of modern technology.

This material is based upon work supported by the U.S. Department of Energy under Award Number DE-EE0003525.

[8] http://www.ncgreenpower.org/

APPENDIX

Table 5: Net Metering and NC GreenPower Options Available to Duke Energy Carolinas Customers

	Eligibility	Monthly Production Credit	Monthly Credit Rollover	Time Limits	REC Ownership	Interconnection Fees
NC Green-Power	NC residents with grid-tied PV systems	GreenPower credit of $0.06 per kWh generated, plus avoided cost rate for all kWh generated (PP-N tariff)	N/A	GreenPower credit is paid for 5 years only	NC Green-Power owns RECs	$100 application fee
Net Metering	Duke Energy Carolinas customers with grid-tied PV systems	kWh credit on utility bill for excess energy generated	Yes, until June 1st of each year	None currently	Utility owns RECs if on RT rate schedule, customer owns RECs if on RT rate schedule	$100 application fee

Sources: NCGreenPower: Become a Generator (http://www.ncgreenpower.org/become-a-generator/) and FAQ (http://www.ncgreenpower.org/faq/); Duke Energy Carolinas Rider NM (http://www.duke-energy.com/pdfs/NCRiderNM.pdf); Duke Energy Carolinas: How to Connect to Duke Energy's Grid (https://www.duke-energy.com/generate-your-own-power/nc-connect-to-the-grid.asp)

Table 6: Retail Rate Schedule Choices for Duke Energy Carolinas Customers

	Key Features	Basic Customer Charge	Monthly Demand Charge	Monthly Energy Charge	Total Cost of Applicable Per kWh Riders	REPs Rider	On-Peak Details
Standard Residential Rate Schedule (RS)	Flat rate for all electricity used	$12.19 per month	None	9.6701 cents per kWh	0.204 cents per kWh	-$0.04 per month	N/A
Residential Time of Use Rate Schedule (RT)	Rate varies based upon time of day and day of the week; includes a demand charge	$13.83 per month	$8.03 per kW (June-Sept.); $4.01 per kW (Oct.-May) for highest demand level reached during on-peak hours	On-peak: 7.1594 cents per kWh Off-peak: 5.8801 cents per kWh	0.2096 cents per kWh	-$0.04 per month	In general: 1pm-7pm Mon-Fri (June 1-Sept. 30); 7am-12 noon Mon-Fri (Oct. 1-May 31)
Residential Time of Use Pilot Rate Schedule (RST)	Rate varies based upon time of day and day of week; includes a modest demand charge	$13.83 per month	$1.53 per kW for highest demand level reached	On-peak: 15.2417 cents per kWh (June 1-Sept. 30); 13.7877 cents per kWh (Oct. 1-May 31) Off-peak: 7.2643 cents per kWh	0.204 cents per kWh	-$0.04 per month	In general: 12 noon-6pm Mon-Fri (June 1-Sept. 30); 7am- 1pm Mon-Fri (Oct.1- May 31)

Sources: Duke Energy Carolinas RS Tariff (http://www.duke-energy.com/pdfs/NCScheduleRS.pdf); Duke Energy Carolinas RT Tariff (http://www.duke-energy.com/pdfs/NCScheduleRT.pdf); Duke Energy Carolinas RST Tariff (http://www.duke-energy.com/pdfs/NCScheduleRST.pdf); Fuel Cost Adjustment Rider (http://www.duke-energy.com/pdfs/NCFuelCostAdjRdr.pdf); Energy Efficiency Rider (http://www.duke-energy.com/pdfs/NCRiderEE.pdf); Existing DSM Program Costs Adjustment Rider (http://www.duke-energy.com/pdfs/NCRiderEDPR.pdf); Coal Inventory Rider (http://www.duke-energy.com/pdfs/NCRiderCoalInv.pdf); Merger Capacity Mitigation Rider (http://www.duke-energy.com/pdfs/NCMergerCapacityMitigation.pdf); BPM Prospective Rider (http://www.duke-energy.com/pdfs/NCRiderBPM-NFPTPProspective.pdf); BPM True-Up Rider (http://www.duke-energy.com/pdfs/NCRiderBPMPPTTrueup.pdf); Cost of Removal Rider (http://www.duke-energy.com/pdfs/NCRiderCostofRemoval.pdf); Renewable Energy Portfolio Standard Rider (http://www.duke-energy.com/pdfs/ncreps.pdf)

Model Assumptions and Data Sources:

Assumptions

- Savings are based upon the assumption that the customer was previously on the RS rate schedule. Savings are thus in relation to what the customer would be paying under the RS tariff with no PV system, all else equal.
- Energy use (kWh) and monthly peak demand (kW) include monthly variation, but no annual variation. Future household energy use may decrease due to greater efficiency, or may increase due to new loads. As it is therefore uncertain in which direction energy use will move, constant usage and demand are assumed.
- A 4.1 kW DC PV system is assumed. This was determined to be the average residential PV system size by dividing the total residential PV net metered capacity in Duke Carolinas territory by the total number of residential net metered PV customers. Data used is from Form EIA-826 (http://www.eia.gov/electricity/data/eia826/)
- A 0.5% annual PV output degradation rate is assumed and incorporated as a 0.04167% monthly degradation rate in the model. This is the median degradation rate and is taken from NREL's report, "Photovoltaic Degradation Rates- An Annual Review" (http://www.nrel.gov/docs/fy12osti/51664.pdf)
- A 2% annual power cost escalator is assumed for energy rates, riders, basic customer charges, demand charges, and PP-N monthly seller charge. No cost escalation is assumed for rates under the Non-Hydroelectric Qualifying Facilities Purchased Power tariff, as these are representative of avoided cost. No escalation is assumed for the REPs rider.
- It is assumed that the cost of the PV system was paid with cash upfront (no financing) or with a 0% interest loan.
- A 31% energy export rate is assumed.
- No discount rate is assumed in the model.
- The assumed PV system life is 25 years.

Data

- Rates: Electric rate data comes from Duke Energy Carolinas North Carolina tariffs (see http://www.duke-energy.com/rates/north-carolina.asp). Tariffs used in this analysis are RS, RT, RST, PP-N, and NM. Riders used in this analysis are the Fuel Cost Adjustment Rider, EE, Existing DSM Program Costs Adjustment Rider, REPS, Coal Inventory Rider, Merger Capacity Mitigation Rider, BPM Prospective Rider, BPM True-Up Rider, and Cost of Removal Rider.
- Energy usage data comes from NREL's dataset, "Commercial and Residential Hourly Load Profiles for all TMY3 Locations in the United States" (http://en.openei.org/datasets/node/961). Figures represent estimated average household hourly load.
- Peak monthly energy demand data is derived from the NREL dataset, "Commercial and Residential Hourly Load Profiles for all TMY3 Locations in the United States" (http://en.openei.org/datasets/node/961) and NREL's PVWatts data (http://pvwatts.nrel.gov/). Hourly PV output is subtracted from hourly energy demand to determine the effect of a PV system on peak demand. The maximum hourly demand, after PV output has been subtracted, each month is then multiplied by 3 to reflect the difference between average demand of a group and individual household demand, which is likely to be more peaky and variable. As we are looking to identify the very highest 30-minute demand for an individual household, we used this technique. This methodology is based upon the section on demand for electric power in the book *Distributed Power Generation: Planning and Evaluation*, edited by H. Lee Willis (p. 51). (Available at http://books.google.com/books?id=3T3hV3057oEC&pg=PA51&lpg=PA51&ots=zneeXVUNtx&focus=viewport&dq=residential+peak+load+diversity+factor&output=html_text)
- Solar PV hourly and monthly output data comes from NREL's PVWatts model (http://pvwatts.nrel.gov/). Output data is adjusted for daylight savings time. Hourly data is categorized as on- and off-peak according to the 2014 calendar year.
- Low PV system cost ($3.50/watt) is based upon conversations with local solar installers. High PV system cost ($5.70/watt) is based upon state-specific average residential PV installation cost data included in Lawrence Berkeley National Laboratory's *Tracking the Sun VI* report: : http://emp.lbl.gov/sites/all/files/lbnl-6350e.pdf. This is 2012 data, and used as the high scenario because costs have declined since this report. Medium PV system cost ($4.60/watt) is halfway between low and high cost scenarios.