POWER PURCHASE AND RATE STRUCTURE OPTIONS FOR COMMERICAL CUSTOMER PHOTOVOLTAIC SYSTEMS

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ABSTRACT

Commercial customers who make the decision to install photovoltaic (PV) systems can benefit from the electricity produced in a number of ways. Customers have the option to offset their energy usage by net metering with their utility company or to sell the generated power and renewable energy credits to the utility company or a third-party organization. Which option a customer chooses for their system's generated power will depend on system size, rate structure of their monthly billing demand, and energy usage. Although the PV system can reduce monthly energy usage, the demand charges remain the same.

This study will investigate the economics of different combinations of billing demand, customer energy usage, system size, and options for using or selling the electricity produced. A range of PV system sizes and their generated output as well as several different billing demands, will be used to model net-metering and power purchasing options for each customer. This information has the potential to help customers make decisions regarding options for generated power based on their billing demand and PV system size.

1. INTRODUCTION

A PV system is intended to reduce a customer's monthly energy cost and provide additional electricity as needed; however, the effect it has on a customer's utility bill depends on which economic option they choose for the system's generated power. The customer can choose to net meter or sell their generated power through a purchase power negotiation (PP-N).

Net Metering allows the commercial customer to use the solar energy produced from their system to serve their needs first. This option would have the customer add a net metering rider and standby charge to their current rate schedule.

The PP-N option allows the customer to continue on their current rate structure without adding a rider or standby charge. The customer sells the system's generated energy to the utility company at a Variable Rate or a Fixed Long Term Rate.

Both options will reduce a customer's effective cost per energy and annual utility bill, but which option will lower both more than the other is debatable. It is not very well understood if a customer's billing demand (kW) has an effect on which option they should chose. Also, it is not understood if PV system size should effect the decision. Therefore, it is important to estimate and analyze these two options to understand how they will affect a customer's utility bill.

Overall, customers are not given detailed information about what option benefits them most based on their utility profile and PV system size. This study will investigate different combinations of billing demand, system size, and options for using or selling the electricity produced. This information has the potential to help customers make decisions regarding options for electricity produced based on their billing demand and PV system size.

2. REVIEW OF LITERATURE

The Solar Market Insight identifies trends in the U.S. solar market and uses this information to predict solar installations by state for the next five years. The report analyzes the differences in incentives, customer types, and project development timelines The Solar Market Insight predicts a 25% to 30% growth in PV projects and a drop in system cost from 2012-2016. NC alone is predicted to install 137 photovoltaic projects in the next three years. Most of these systems will be monitored and put on either a purchase power negotiation rate or net metering rider for the energy generated (Kimbis, Baca, Lent, Rumery, Kann, Mehta, Shiao, Krulewitz, & Campbell, 2012).

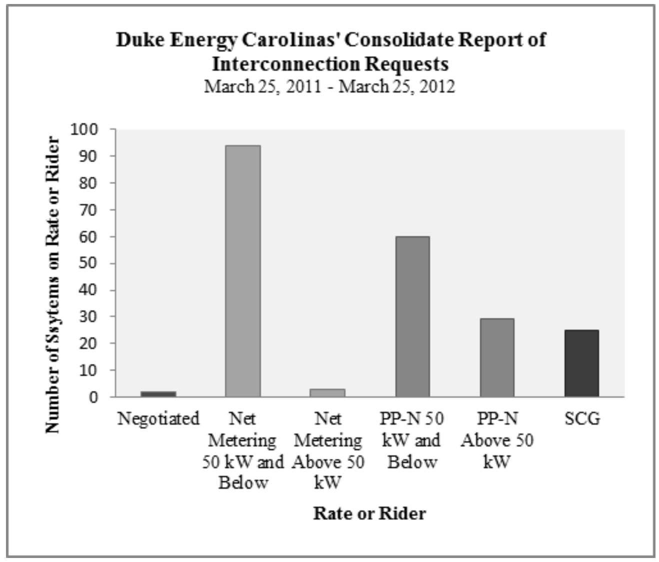
Currently, NC's average PV installed price for non-residential is $4.67/W compared to the national average of $4.51/W. However, this can be misleading because non-residential projects are typically < 1 MW and smaller systems tend to have a higher unit cost (Kimbis et al., 2012). The option the customer chooses for their system's generated power impacts how much the customer pays for energy.

Duke Energy and the Carolinas

Duke Energy is a Fortune 250 Company and is headquartered in Charlotte, NC. Duke Energy became the largest electric power company in the United States in 2012 after their merger with Progress Energy (U.S. Department of Energy, 2012). With over 7.1 million electric customers, Duke Energy has a generating capacity of 49,600 MW. They serve North Carolina, South Carolina, Indiana, Ohio, Kentucky, and Florida. Their energy generation is primarily coal-fired and gas-fired. Currently, Duke Energy has 11 solar farms with an installed capacity of 50 MW (Duke Energy Fast Facts, 2012).

All utilities operating in NC are required to file annual reports with the NCUC indicating the number of net metering applicants. Duke Energy Carolinas filed a report of interconnection requests for the period of March 25, 2011 to March 25, 2012 with the N.C. Utilities Commission. The report included photovoltaic, landfill gas, and wind turbine systems. The report listed 213 photovoltaic system applications that were either requesting interconnection, were accepted and put on a rate or rider, or under the application process. As seen in Table 1, systems over 50 kW typically choose a PP-N schedule to sell their electricity to the utility company. Out of the thirty four PV systems over 50 kW, only four were not on a PP-N rate structure (Franklin, 2012).

<u>TABLE 1: DUKE ENERGY CAROLINAS' CONSOLIDATED REPORT OF THE NUMBER OF PV SYSTEM PROJECTS ON RATE AND RIDER OPTIONS.</u>



Duke Energy and Net Metering

Riders are a method that the utility company uses to credit a customer who has a renewable energy system, as seen in Fig. 1. Riders include additional charges to the customer's current rate structure, but the idea is that a customer's overall utility bill will be lower because they are purchasing less energy from the utility company. In most cases the renewable energy system generates more than the customer's needs then, the bi-directional meter turns backwards and the customer is compensated by the utility company for their excess energy produced, but not with net metering in NC (Duke Energy Carolinas Configuration Options for North Carolina, 2012). The electricity produced by the PV system serves customer's loads first and the excess electricity is delivered to the grid and is netted against the customer's monthly usage and the customer buys additional electricity from the grid as needed (Duke Energy Carolinas Configuration Options for North Carolina, 2012).

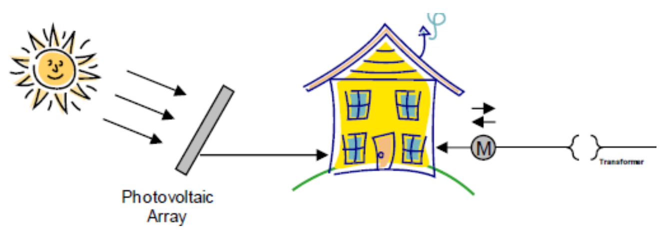


Fig. 1: Rider Net Meter Application- bi-directional meter.

In 2005, the North Carolina Utilities Commission issued an order to adopt net metering in North Carolina (NC). Utilities, such as Duke Energy, were required to implement Net Metering in 2006 (Mount, 2005). In September, 2012 Freeing the Grid gave NC a score of D for their net metering policy (Generating a Project Revenue Stream, 2012). Freeing the Grid is a report that provides an analysis of what constitutes an appropriate "net metering rule and Interconnection standard" and gauges U.S. electric utility's perspectives on net metering. Freeing the Grid was first created by the Solar Electric Power Association and Interstate Renewable Energy Council (IREC). It is important to evaluate Net Metering procedures because net metering enhances the security and reliability of the electric grid. Also, it encourages solar and other renewable technologies. Cost effective policies for interconnect agreements and net metering help drive a sustainable solar market. The four factors that make up a cost effective solar policy are incentives, net metering, interconnection, and utility rates & revenue policies (Wiedman, Culley, Chapman, Jackson, Varnado, & Rose, 2012). NC cannot have an effective solar policy without satisfying these factors. Non-profit legislative groups, such as the North Carolina Sustainable Energy Association (NCSEA), suggest that NC needs net metering and interconnect rules that won't discourage customers from installing solar PV systems. Poor net metering policy could be a barrier to those who want to invest in NC's future (Fleming & Robinson, 2008).

First, the customer must go through an interconnection agreement application to plug into the grid. The net metering rider is the billing arrangement between the customer and the utility company (Best Practices in State Net Metering Polices and Interconnection Procedures: North Carolina, 2012). Customers surrender their solar renewable energy credits and cannot sell them to a third party, for example participate in benefits offered by NC GreenPower, unless they are under a TOU schedule (Best Practices in State Net Metering Polices and Interconnection Procedures: North Carolina, 2012).

Net metering is often a better option for residential customers or customers who generate less than 6 kW because there are no additional metering charges.
If a customer decides to use a net metering rider they are only charged the basic facility charge of their current rate schedule's facility charge. The facility charge is a once a month charge that is added to the utility bill. On top of a basic facilities charge, customers are charged a standby charge of $1.184 per kW of the PV system. The net metering rider is for systems larger than 100 kW, which is more common in commercial customers (Rider NM (NC) Net Metering, 2012; Rider SCG (NC) Small Customer Generator Rider, 2012).

PP-N Purchased Power

Commercial customers choose the rate structure that best fit their demand (power) usage and their operating schedule, but rates and riders have the potential to negatively affect their utility bill.

The Time of Use (TOU) rate structure charges a customer based on on-peak and off-peak consumption. However, these hours do not line-up with on-peak and off-peak solar generation. The TOU structure defines on-peak hours in the summer months, June 1st- September 30th, from 1:00 p.m. to 9:00 p.m. and in the winter months, October 1st – May 31st, from 6:00 a.m. to 1:00 p.m. Off-peak hours are defined as all other weekday hours, Saturday and Sunday hours, and holidays: New Year's Day, Memorial Day, Good Friday, Independence Day, Labor Day, Thanksgiving Day, Day after Thanksgiving, and Christmas Day (Schedule OPT-G (NC) Optional Power Service: Time of Use General Service, 2012). Since the TOU structure's on-peak and off-peak consumption does not line-up with on-peak and off-peak solar generation, it's difficult for customers to off-set their on-peak usage with solar generation. This is of concern because the on-peak consumption hours are more $/kWh. Also, customers cannot use battery storage to use during on-peak consumption hours (Best Practices in State Net Metering Polices and Interconnection Procedures: North Carolina, 2012).

Customers also have the option to sell the PV systems produced energy to the utility company at a Variable Rate or a Fixed Long Term Rate under the PP-N purchased power option. The Variable Rate is a five year contract between the utility company and the customer. Under this rate the payment of credits changes from time to time until the contract period ends. A customer on the Fixed Long Term Rate has the option to sign a fixed $/kWh contract of 5 years, 10 years, or 15 years, see Figure 4 (Schedule PP-N (NC) Non- Hydroelectric Qualifying Facilities Purchase power, 2012).

Option B

Administrative Charge	$ 8.17 per month
Facilities Charge (if applicable – See Interconnection Facilities Charge)	$ 8.03 per month

Interconnected to Distribution System:

		Fixed Long-Term Rate (a)		
I. Capacity Credit	Variable Rate	5 Years	10 Years (b)	15 Years (b)
a. All On-Peak Energy per Summer Month per kWh:	9.70 ¢	10.01 ¢	10.51 ¢	10.97 ¢
b. All On-Peak Energy per Non-Summer Month per kWh:	1.50 ¢	1.55 ¢	1.63 ¢	1.70 ¢
II. Energy Credit				
a. All On-Peak Energy per Month per kWh:	5.37 ¢	5.54 ¢	6.36 ¢	6.78 ¢
b. All Off-Peak Energy per Month per kWh:	4.29 ¢	4.40 ¢	4.94 ¢	5.20 ¢

Fig. 2: Rate at which energy can be sold ($/kWh) on a Purchase Power Negotiation (PP-N) for customers who want to connect to the distribution system.

Impact of Rate Structures on Utility Bills

There are two parts to a utility bill: energy & demand charges. A PV system has more impact on the energy charges and can reduce how much a customer pays per kWh. However, the customer's billing demand is a major part of their utility bill because it controls the rate ($/kWh) of how the energy is being charged. The tier and rate at which the energy is charged is based off of the customer's billing demand per month.

RATE:		
I.	Basic Facilities Charge per month	$23.34
II.	Demand Charge	
	For the first 30 KW of Billing Demand per month, per kW	No Charge
	For all over 30 KW of Billing Demand per month, per kW	$3.6301
II.	Energy Charge	
	For the First 125 kWh per kW Billing Demand per Month:	
	For the first 3,000 kWh per month, per kWh	11.2282 ¢
	For the next 87,000 kWh per month, per kWh	6.9892 ¢
	For all over 90,000 kWh per month, per kWh	6.9315 ¢
	For the Next 275 kWh per kW Billing Demand per Month:	
	For the first 6,000 kWh per month, per kWh	6.5743 ¢
	For the next 134,000 kWh per month, per kWh	5.8277 ¢
	For all over 140,000 kWh per month, per kWh	5.7360 ¢
	For all Over 400 kWh per kW Billing Demand per Month:	
	For all kWh per month, per kWh	5.4983 ¢

Fig. 3: Duke Energy Schedule Large General Service, LGS (NC)

PV Watts Viewer
The National Renewable Energy Laboratory (NREL) has developed a tool, PV Watts, which can estimate solar energy production based on PV system size and location. PV Watts gives the user this information monthly and hourly if available.

The hourly data that PV Watts provides is best used to estimate a PP-N rate because the customer gets paid for their energy based on Duke Energy's "on-peak" and "off-peak" hours. For Option B Rates under the PP-N, the "on-peak" and "off-peak" hours follow the same convention as the TOU schedule (Schedule PP-N (NC) Non-Hydroelectric Qualifying Facilities Purchase power, 2012). This information can help the customer better estimate what they will receive $/kWh based on "on-peak" and "off-peak" rates.

3. RESEARCH METHODOLOGY

This study investigated different combinations of billing demand, system size, and options for using or selling the electricity produced from a PV system. A range of PV system sizes and their generated output as well as several different billing demands, was used to model net-metering and power purchasing options for each commercial customer. Additionally, for this research study, PV Watts was used to estimate net metering and PP-N options for each PV system size.

General Overview of the Research Design
The focus of this research was Duke Energy Corporation and the Charlotte, North Carolina area and the options they offer to customers who generator electricity from PV systems. Three customers with different billing demands on the Large General Service (Schedule LGS (NC) Large General Service, 2012) rate schedule were used to estimate how different PV system sizes and options benefit the customer.

Net metering has an obvious effect on the utility bill's energy charges, but in order to see the effect of a PP-N rate a customer would have combine the profit from their system with their utility bill to see their overall benefits.

PV system sizes from 25 kW to 300 kW and the option to net metering versus PP-N was modeled for the three customers, as seen in Fig. 4.

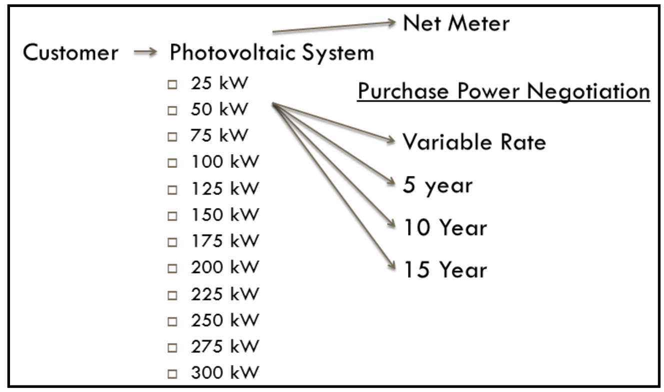


Fig. 4: Research methodology for PV system size and options for customer.

Data Collection Procedures
The 2011 utility bill for each customer was collected and then estimated for the current utility rate to get an accurate representation of their utility bills in 2012.

The information gathered from the monthly utility bills included:
Billing Month
Billing kWh (Energy)
Billing kW or kW (Demand)

This information was stored in a Microsoft Excel spreadsheet that calculated current Duke Energy rate schedule prices for LGS. The estimated 2012 monthly utility bill price was used as the utility bill for that customer. This was the utility bill to estimate Net Metering and PP-N options for each customer.

Photovoltaic System
The following sized (kW) photovoltaic systems will be used to estimate the customer's benefit from net metering and PP-N options.

These system sizes include:
- 25 kW
- 50 kW
- 75 kW
- 100 kW
- 125 kW
- 150 kW

175 kW
200 kW
225 kW
250 kW
275 kW
300 kW

Each system's solar performance (AC kWh) was estimated using PV Watts. PV Watts used Charlotte, NC and the above system sizes to estimate monthly AC energy (kWh) expected from the solar radiation (kWh/m2/day) of that location.

Net Metering Option:
The system size and solar performance was used to calculate the estimated annual utility bill with a net metering rider for each commercial customer. The net metering fee and standby charge was applied to the system size and utility bill.

Purchase Power Negotiation (PP-N):
The PP-N Option B was estimated at the Variable Rate, 5 year, 10 year, and 15 year rate ($/kWh) for each PV system size. PV Watts hourly data was used to estimate the systems hourly output. The customer's annual utility bill under a PP-N rate was estimated by using crediting the profit from the systems generated energy against the energy charges on the customer's utility bill. After the money earned from the system on a PP-N was subtracted from the customer's utility bill, the utility bill was divided by the customer's kWh usage to get $/kWh and annual utility bill.

4. RESULTS

The overall utility bill for each customer decreased with increase system size. The annual utility bill on net metering, PP-N Variable rate, PP-N 5 year, PP-N 10 year, and PP-N 15 year is estimate for each system size. The PP-N rate had a larger effect on the utility bill than net metering in all cases, as see in table 3, 4, and 5. PP-N rate appeared to be the best options for commercial customer PV systems based on decreasing annual utility bills.

Table 2: The annual utility bill for various system sizes and rate structure options for customer with average billing demand of 126 kW.

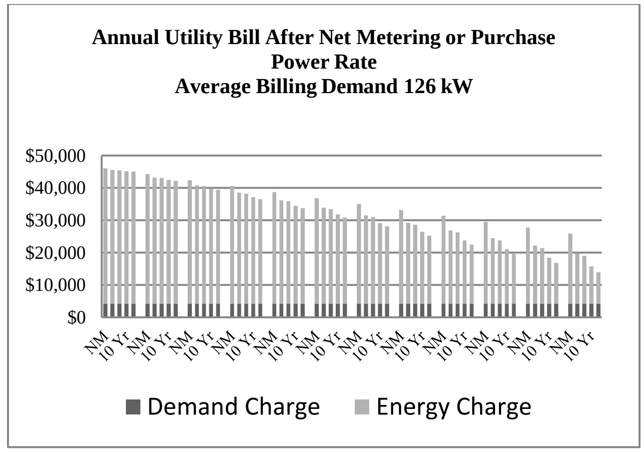


Table 3: The annual utility bill for various system sizes and rate structure options for customer with average billing demand of 320 kW.

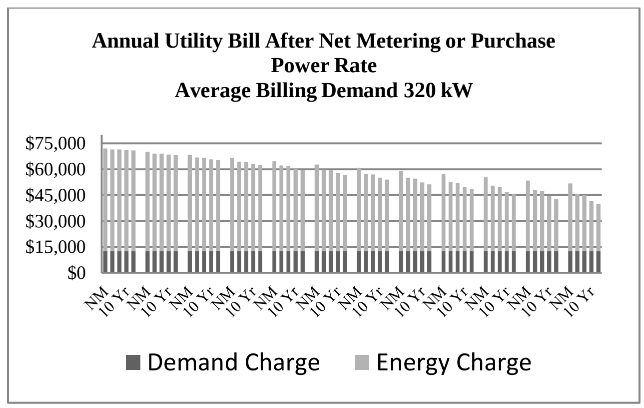
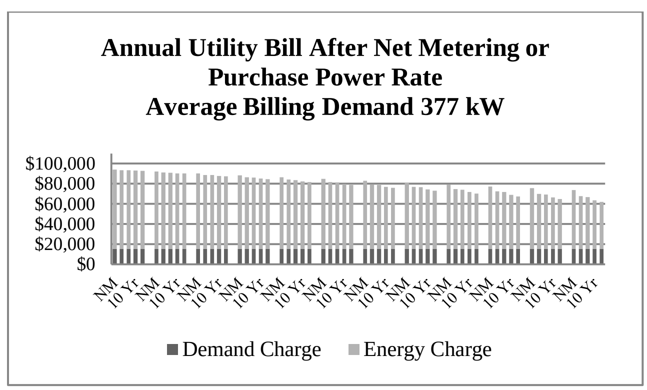


Table 4: The annual utility bill for various system sizes and rate structure options for customer with average billing demand of 377 kW.



In addition to the annual utility bill being lower under a PP-N rate, the $/kWh for each customer was also lower under the PP-N rate. The PP-N rate, as seen in Tables 5, 6, and 7, decreased how much the customer pays per kWh to the utility. The customer's average billing demand and PV system size have an impact on the range the customer pays per kWh, but a PP-N rate was always lower than net metering. Overall, a customer on Large General Service rate schedule pays less $/kWh on a PP-N rate.

Table 5: The $/kWh for various system sizes and rate structure options for customer with average billing demand of 126 kW.

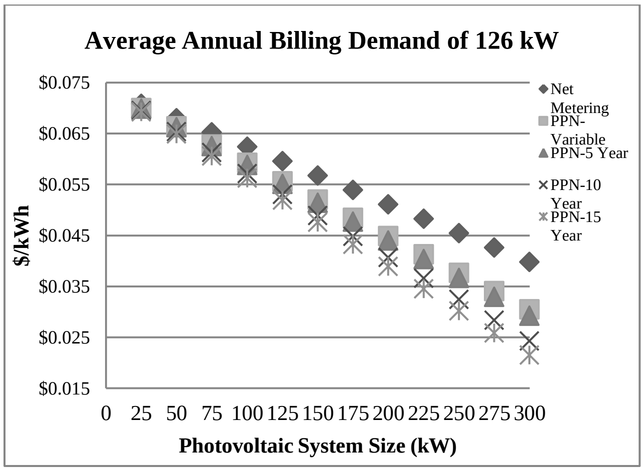


Table 6: The $/kWh for various system sizes and rate structure options for customer with average billing demand of 320 kW.

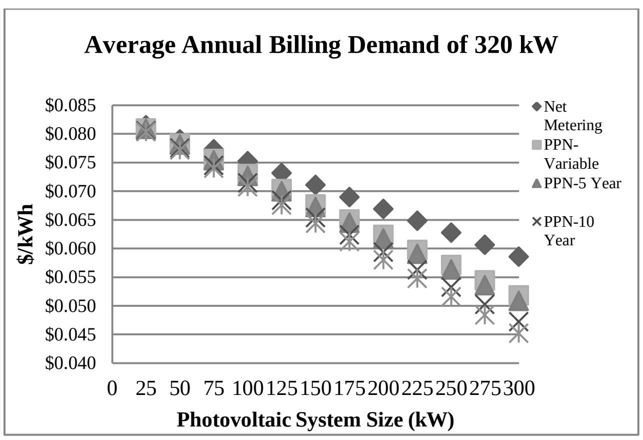
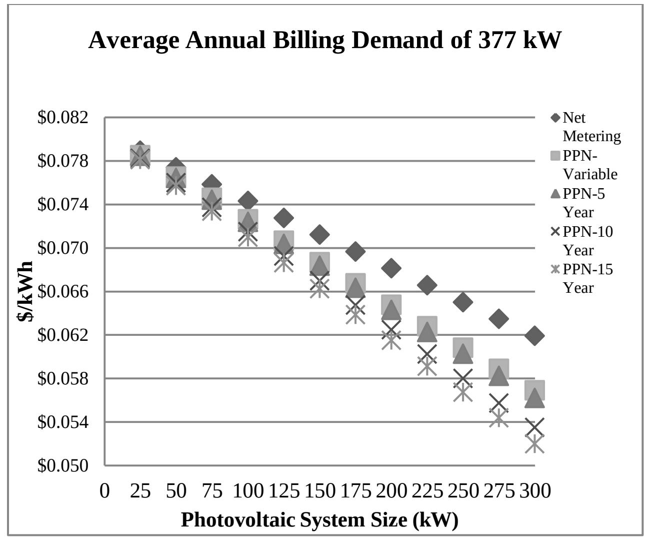


Table 7: The $/kWh for various system sizes and rate structure options for customer with average billing demand of 377 kW.



5. SUMMARY AND CONCLUSIONS

The first limitation was not knowing the annual fluctuation in the energy prices ($/kWh) for customer rate schedules and PP-N rates. Therefore, this study can only estimate year one for the options described in the methodology. Also, under the PP-N the Variable rate is said to fluctuate over time, but those fluctuations are unknown and cannot be predicted. Therefore, this study looks at the Variable in year one.

There are additional options for customers to benefit from their system's generated energy such as NC Green Power. However, NC Green Power does not disclose how much they pay for solar renewable energy credits for systems larger than 10 kW. Information about past projects is not public knowledge because they go through a bidding process.

Despite these limitations, this information has the potential to help customers make decisions regarding options for generated power based on their billing demand and PV system size. Currently, the best option for commercial customer's is to sell their generate power on a PP-N rate. A PP-N rate will lower their annual utility bill and $/kWh. Unless the net metering rider improves and reduces charges (ex: stand-by) to be more palatable to customers, the PP-N rate will always be a more attractive option for commercial customer PV systems.

Some suggestions to improve net metering options are to remove system size limitations to allow customers to meet all on-site energy needs. The current system size limit is 1MW and any system over 1 MW has to be put on a PP-N rate or another negotiated rate. Another way for utilities to improve net metering is to adopt safe harbor language to protect customer-sited generators from extra and/or unanticipated fees. Right now customers are charged standby fees for the system size and extra facility charges per month. Also, limitations on REC ownership should be removed for customers who choose to Net Meter. Until then, PP-N rates benefit a customer more on both $/kWh and their annual utility bill.

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