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Solar Photovoltaic Adoption in the Southeastern United States

Elise B. Fox

Thomas B. Edwards

Michael D. Drory

November 28, 2018

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Savannah River National Laboratory™

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EXECUTIVE SUMMARY

Solar market analysis typically focusses on states with large solar installations in the Western states, notably California, the Northeast, namely Massachusetts, and two states in the Southern US: Florida and North Carolina. Herein we examine the solar PV industry and trends in capacity, production and incentives within the Southeastern US. And provide an examination of how existing solar policy has influenced penetration on a state by state basis. In particular, why some states such as South Carolina have high residential solar capacity, while neighboring states, North Carolina and Georgia have high utility-scale penetration. Incentives developed in South Carolina through legislative action have increased solar PV residential installations dramatically since 2015, while utility scale installations continue to grow in North Carolina. North Carolina has the highest growth in non-residential (commercial and industrial) and utility-scale solar PV. It was found that for the residential sector, highest solar PV growth occurs when a) with the federal tax credit is augmented with a state-wide tax credit, b) enabling state laws, and c) net-metering and solar leasing programs.

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LIST OF ABBREVIATIONS

AC	Alternating current
ANOVA	Analysis of variance
DC	direct current
EOY	End of year
FTE	Full Time Equivalent
IOU	Investor Owned Utility
kW	Kilowatt
MW	Megawatt
PV	Photovoltaic
R^2	Coefficient of Determination
SE	Southeast Region of the United States
SRNL	Savannah River National Laboratory
SRNS	Savannah River Nuclear Solutions
SC	South Carolina
SuNLaMP	SunShot National Laboratory Multiyear Partnership
W	Watt

1.0 Introduction

The America Recovery and Reinvestment Act (ARRA), which was passed during the Great Recession in 2008, enabled energy efficiency and renewable energy programs to accelerate in the United States. These trends have continued with federal legislation by extending the renewable energy federal income tax credits [1], augmented by state-driven incentives [2], leasing arrangements [3], and lower global cost of solar photovoltaic (PV) hardware [4]. This article examines trends in electricity production by solar PV in the Southeastern United States (SE US) and how state policy adoption influences adoption rates of solar at the residential, commercial, and utility-scale. Electrical production is roughly forty percent of overall US energy consumption [5] and can be broken down into non-renewables production (coal, natural gas, nuclear, petroleum) and renewables production (hydroelectric, geothermal, wind, biomass, waste, and solar). Renewable sources of electricity generation accounted for less than ten percent of total electricity production in 2001, but grew to over seventeen percent by 2017, as seen in Figure 1.

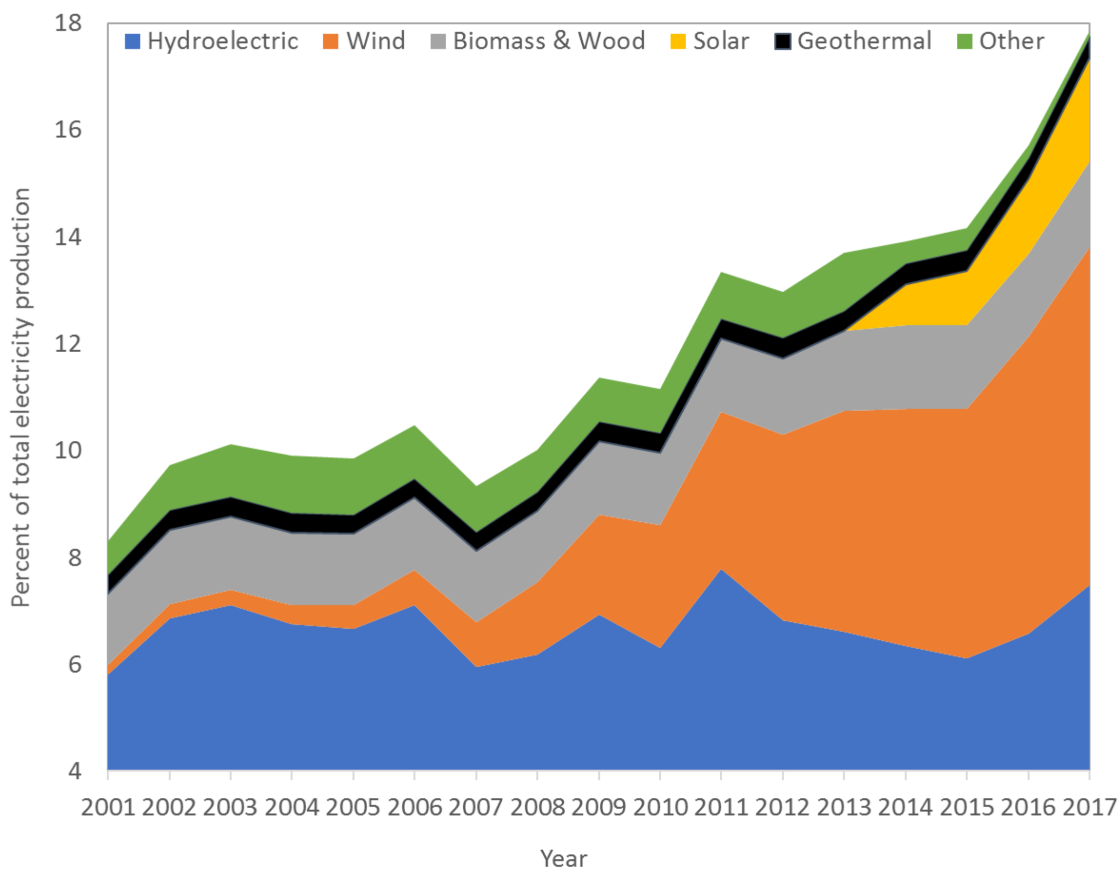

Figure 1. Trends in renewable electricity production from 2001 to 2017. [6]

During that period, hydroelectric generation was essentially flat and a majority of the renewable growth can be attributed to large scale wind farms that came on line in the Midwest and Texas. [7] US electricity total demand has been nearly flat since 2007, reversing the upward trends over sixty years of increasing electricity demand. [8] A large drop in demand occurred in the Great Recession, followed by implementation of energy efficiency measures and investment in renewables, which coupled with dramatic price reductions in solar photovoltaic modules, helped increase the penetration of both wind and solar. Since 2007 electrical production from coal has fallen from 48% in 2007 to 30% in 2017. [6] The drop in coal generation was strongly influenced by falling natural gas prices and the resulting retirement or refurbishment of coal generating plants to natural gas fueled plants. Falling natural gas prices also helped diminish the use of petroleum based fuels for electrical power generation from 3% in 2001 to 0.3% as a fuel source in the lower forty-eight US states in 2017. [9]

2.0 Experimental Procedure

Data analyzed within was obtained from several resources including surveys completed by solar installers in the state of South Carolina from 2015-2017. [10-13] Any additional data was compiled through the use of US Energy Information Agency (EIA) Forms 860-M [14] and 861-M [15], as noted. Solar module pricing was obtained from EIA Electric Power Monthly report. [16] Data for solar installations in Georgia was obtained from Southface [17] and international solar PV data was obtained from the International Energy Agency (IEA) [18]. Census data is obtained from the US Census Bureau. [19]

3.0 Results and Discussion

3.1 US Solar Capacity Trends since 2005

Growth in solar PV capacity in the entire United States tracks well with the reduction of module pricing to less than one US dollar per watt. Pricing and financial incentives by the US and many state governments, along with Investor-Owned Utilities (IOUs), helped fuel increases in the use of solar PV for electricity production by all market sectors. Solar PV capacity in the US has increased steadily since 2012 with a rapid pace in 2016 continuing into 2017. The growth in solar PV coincides with decreased in module pricing for US consumers since 2008, see Figure 2. Between 2008 and 2013, solar module pricing in US dollars per watt ($/W) decreased by two-thirds from about $3.49/W to $0.75/W. This price reduction is remarkable and coincides with global events. The "Great Recession" of late 2007 through late 2009 dropped global GDP, followed by economic stimulus from the US government with investments in energy efficiency and alternative energy through the US "America Recovery and Reinvestment Act - ARRA". ARRA funded nearly $5B in 2009 for energy efficiency projects through the US Department of Energy's Weatherization Assistance Program (DOE-WAP) along with amending the US tax code for $2.5B in tax credits for renewable energy, including solar PV projects, via the so-called "48-C" program. [20] Concurrently, large growth in European solar PV installation occurred from 2010 through 2013 as indicated in Figure 3.

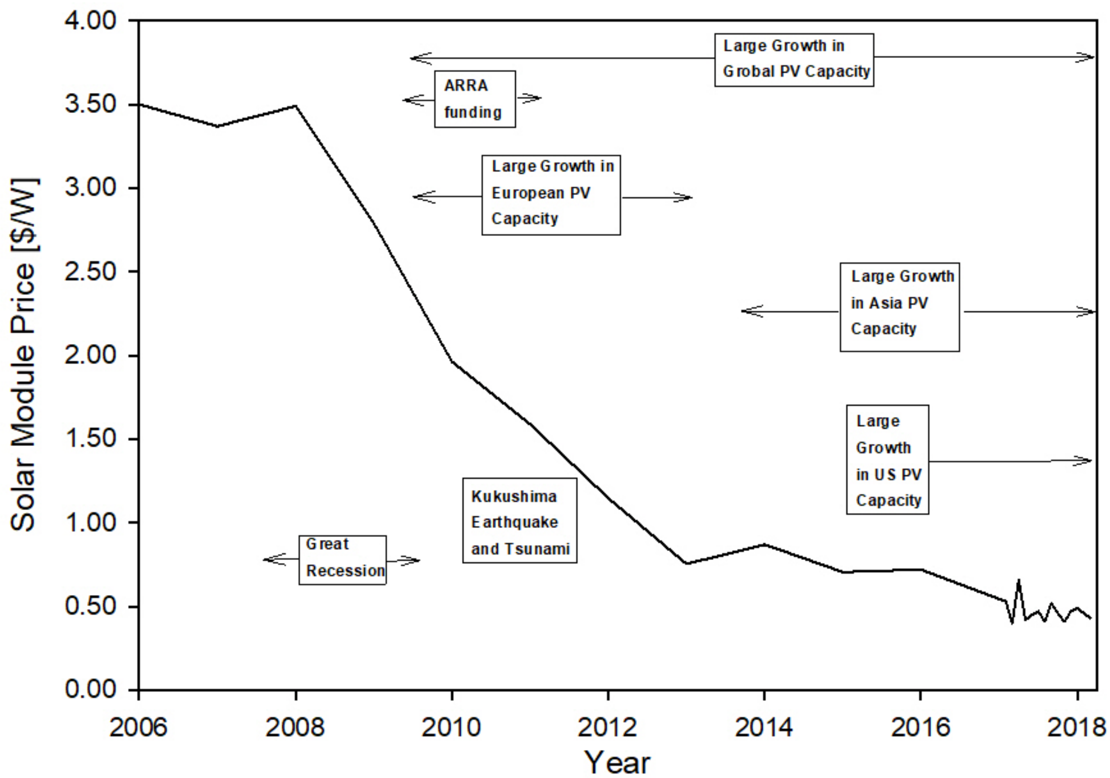

Figure 2. Solar module pricing since 2006 with timing of major events and trends

The 2011 Fukushima earthquake and tsunami shifted interest in Japan to solar PV for doubling of capacity between 2011 and 2015, [21] Nearly constant module pricing from 2013 to early 2017 implies stable global supply of PV modules after a tremendous increase in manufacturing capacity to meet demand. The sudden drop in module pricing to $0.53/W in early 2017 may be indicative of near-term over-supply or other efforts in reducing inventory and maintaining market share.

Forecasting growth of solar in the United States by the US-DOE Energy Information Agency to 2050 indicates near doubling to 31% of the total percentage of renewables as a source of electricity generation compared with a present-day level of 16% in 2017 [22]. By 2050, 35% of US electricity production is expected from natural gas turbines with coal providing 21% and nuclear power, 12%. The same study indicates nearly all the growth electric power generation is in natural gas and renewables, specifically, solar PV. Solar generated electricity is projected to increases from 100 TWh in 2017 to nearly 800 Terawatt (TWh) in 2050; or a corresponding change from 14% to 47% share of the US total renewables. This equates to about 400 GW of added solar capacity over the next thirty years. The dramatic increase in the solar segment as percentage of renewables is due to stable, but non-increasing hydroelectric power capacity and relatively flat growth in bio-mass and wind electricity generation sources. Surprisingly, the greatest growth in solar PV capacity is expected in the Eastern Interconnection portion of the US electrical grid, surpassing solar energy production in the Western Interconnection before 2040 [22]; This highlights the importance of understanding trends and effects of solar incentives in the areas of the US. Despite these upward trends, fluctuations in short-term growth of solar are expected. At the time of writing, the US is imposing tariffs on imported solar modules providing uncertainty in present and near-term future of solar PV growth. This may of greatest impact to areas of the US seeing emerging solar PV penetration for the next several years, such as the Southeast US. [23]

3.2 Electricity Markets and Demographics of the Southeast US

The Southeastern US is not typically known for aggressive renewable energy legislation. Except for North Carolina and Georgia, there is relative low utility scale deployment within the Southeast (SE). To better understand how policy within the SE US affects deployment, the adoption rates of the residential, commercial and industrial, and utility scale sectors of solar are studied in eight states of the SE region: Alabama (AL), Florida (FL), Georgia (GA), Kentucky (KY), Mississippi (MS), North Carolina (NC), South Carolina (SC), and Tennessee (TN). Population, median income and poverty rate for the eight southern states of focus here are listed in Table 1 utilizing data obtained from the US Census Bureau. [19] This allow us to examine state-based incentives for solar PV decoupled from key demographics. Also included are data on the number of housing unity, owner occupied housing rate, and total employer establishments used to calculate adoption rates.

All states within the SE US have a lower median income and have a higher poverty rate than the US average. Interestingly, the owner-occupied housing rate is higher in the SE US then the rest of the US, likely due to high ownership rates of mobile homes. [19] Florida is the most populous state in the SE, followed by GA and NC. The three largest states also have the highest median income within the SE US. AL, SC, and KY have roughly the same population, median household income, and owner-occupied house rates.

Table 1. Demographics of Southeast States as compared to the US average.

Southeast US state	Population[1]	Median Household Income[1]	Poverty Rate[1]	Housing Units	Owner-Occupied Housing Rate	Total Employer Establishments
AL	4,874,747	$44,758	17.1%	2,230,185	68.5%	98,540
FL	20,984,400	$48,900	14.7%	9,301,642	64.8%	532,830
GA	10,429,379	$51,037	16%	4,218,776	62.8%	224,593
KY	4,454,189	$44,811	18.5%	1,965,556	66.8%	91,845
MS	2,984,100	$40,528	20.8%	1,307,441	67.9%	58,662
NC	10,273,419	$48,256	15.4%	4,540,498	64.8%	223,209
SC	5,024,369	$46,898	15.3%	2,236,153	68.4%	103,973
TN	6,715,984	$46,574	15.8%	2,522,204	66.3%	133,344
SE States	65,740,587	$47,784	15.9%	28,322,455	65.5%	1,466,996
US	323,719,178	$55,322	12.7%	135,697,926	63.6%	7,663,938

1. US Census Bureau, https://www.census.gov/quickfacts/fact/table/SC/PST045216 (accessed March, 2018).

In order to better understand the regional energy market in the SE US, the percent of total energy generation (TWh) by each fuel source for the 2017 calendar year is compared in Figure 3. A twelve-month period was selected to account for effects of winter and summer peak electricity demand. Total non-renewable electrical generation in the Southeast US was higher than the national average of 76%, varying from 84% to 92%. Five of the eight Southeast states have diversified electricity production by base load generators. A generator is classified as dominate in Table 2 if it accounts for greater than 50% of the total TWh generated within a state. In MS and FL, natural gas is the dominate fuel source at 75% and 64%, respectively. Kentucky generated over 79% of all electricity from coal fired plants in 2017, and is the only state in the Southeast US region without nuclear power generation. Nuclear is the dominant fuel source in SC at 52%. Four other states in the SE (AL, GA, NC, and TN) have nuclear generation at rates higher than the US average of 18%. During 2017 there was a fourth-month shutdown of the Grand Gulf 1,440 MW station in Mississippi, which effected the generation totals for the 12-month period. Conversely, additional capacity was added with the Watt Bar – 2 reactor in Tennessee which added 1,270 MW generation capacity. This reactor only partially increased the overall percentage of nuclear power in Tennessee over the twelve-month period examined since Watts Bar – 2 was off-line for four months in mid-2017.

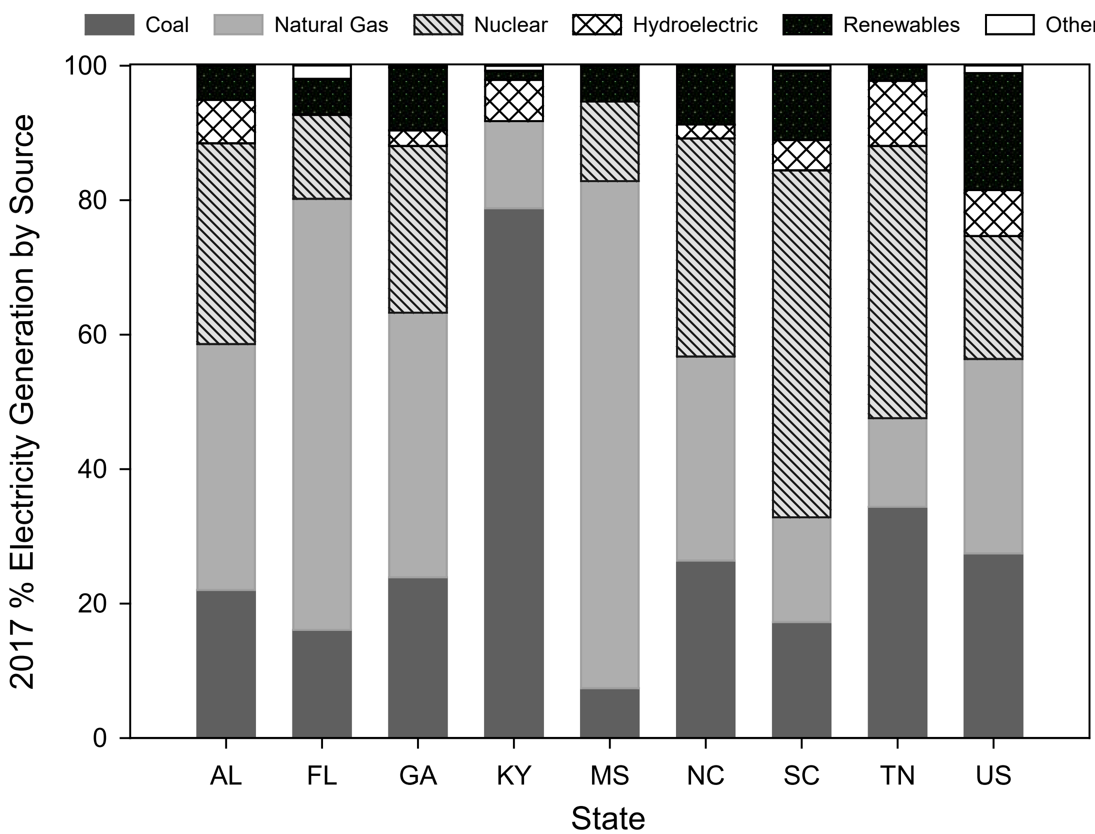

Figure 3. 2017 Electricity generation by source for Southeastern states.

Several states in the SE region have contributions to electricity generation other than base load generators (nuclear, coal, natural gas, and hydroelectric), and non-hydroelectric renewables (biomass, solar PV, and wind), indicated in Figure 3 as “others’”. This includes generation capacity of non-renewable sources: petroleum, landfill gas, and municipal solid waste. Some of these sources, such as municipal solid waste, can have large capacity plants generating 50MW or greater, however the overall total generation remains small accounting for one percent or less of the state total, with the exception of FL at 2% of total generation.

Seven percent of the total US electricity production is by hydroelectric power. In contrast, 10% of total generation in Tennessee is by hydroelectric, while little or no hydroelectric sources are within Mississippi or Florida. AL and KY have over 6% hydroelectric generation, while SC has 4.5% hydroelectric generation. SC and GA have the highest percent non-hydroelectric renewable generation in the region, at 10% and 9%, respectively. NC is ranked a close in third place with 8.6%. A majority of the non-hydroelectric renewable generation in the SE is primarily from biomass. Wind energy generation in the Southeast is small or negligible except for the on-shore 208 megawatt (MW) Desert Wind Farm in Elizabeth City, North Carolina, and nearly 30 MW wind power in Anderson county, Tennessee.

Electricity generation for the SE states was further analyzed to determine net imports and exports from each state, as seen in Figure 4. Almost third of electricity generated in AL flows out of the state as excess supply, while TN imports roughly a third of electricity production from elsewhere. This is likely due to generation assets held by the Tennessee Valley Authority (TVA), which has a large presence in both states. MS and SC are net energy exporters, whereas the other states within the SE US are considered importers. TVA also has operations in KY, MS, and NC. FL, GA, and SC do not have a TVA presence. A large portion of SC energy exports are designated for NC due to state agreements. Understanding how electricity is generated in each state and by what fuel source is important because existing generating assets play an important role in determine how future generation needs will be met through integrated resource planning.

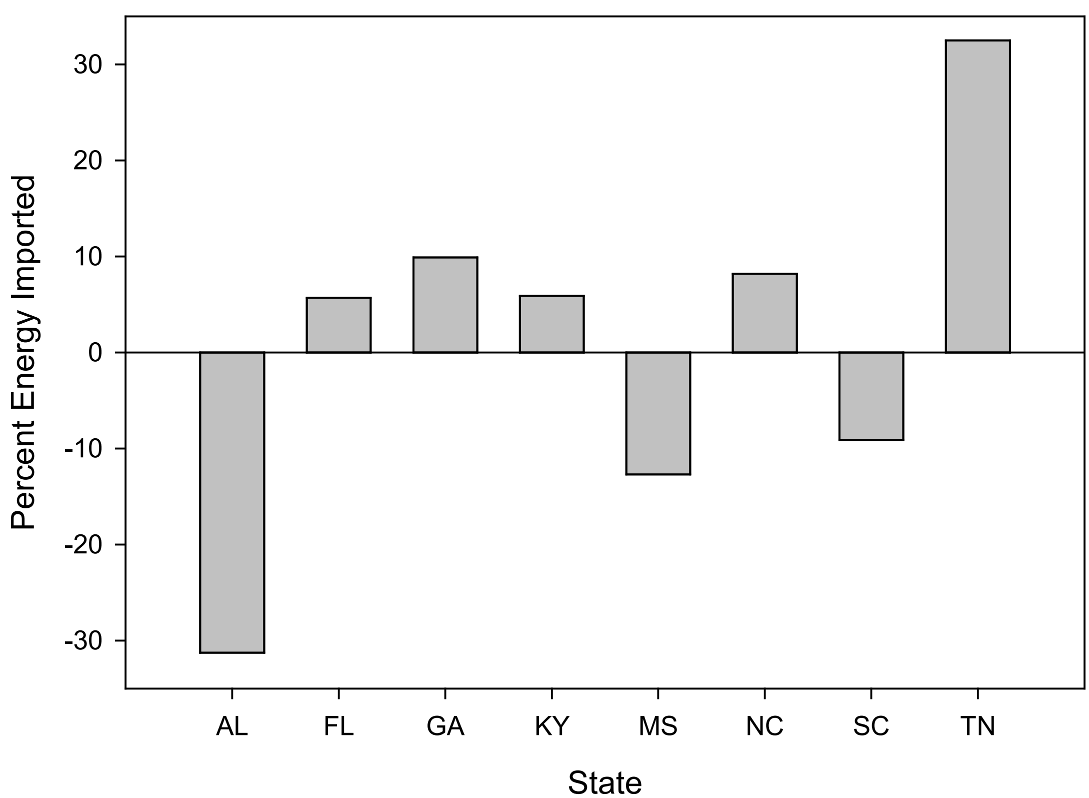

Figure 4. Electricity in-flow for Southeast states

3.3 Growth of Solar Capacity in the Southern US

In order to understand how state policy effects solar installations throughout the southeastern US, a list of incentives and utility make up was compiled in Table 2. Homeowners and businesses in all eight states are eligible for the 30% Federal Investment Tax Credit (ITC) that will begin phasing out at the end of 2019. The ITC will reduce from 30% to 26% at the end of 2020 and 22% at the end of 2021. After December 31, 2021 commercial systems will be eligible for a 10% ITC, but there will no longer be a Federal ITC for residential systems. [24] South Carolina is the only SEUS state with a state tax credit. This tax credit is available for up to 25% of the cost of the system. It is limited to $3500 per year or 50% of an owner's tax liability. [25] This credit can be taken over ten years. North Carolina is the only state with a Renewable Portfolio Standard (RPS). [26] The RPS required that 12.5% of the state's IOUs energy needs must come from renewable energy or energy efficiency measures. The cooperatives and municipal utilities are required to meet 10%.

Table 2. Southeastern US State Solar Incentives and Utility Composition

Incentives & Solar PV Trends	Southeastern US State							
	Alabama	**Florida**	**Georgia**	**Kentucky**	**Mississippi**	**North Carolina**	**South Carolina**	**Tennessee**
Federal Tax Credit	✓	✓	✓	✓	✓	✓	✓	✓
State Tax Credit							✓	
Renewable Portfolio Standard						✓		
Dominant Fuel Source[(a)]		Natural Gas		Coal	Natural Gas		Nuclear	
Large TVA Coverage	✓				✓			✓
IOU incentives						✓	✓	
IOU's	1	5	1	4	2	3	4	0
TVA	Yes	No	Yes	Yes	Yes	Yes	No	Yes
Municipal	36	34	52	47	40	72	21	59
Cooperatives	23	17	41	26	26	26	22	23
State Owned	No	No	No	No	No	No	Yes	No

(a) Greater than 50% of total kWh produced by fuel source

Understanding the utility make up of each state, their service territories, their existing dominating fuel source, also helps better understand renewable adoption rates. In this case, a dominant fuel source is defined as having greater than 50% of the instate kWh production produced by one type of generating facility. FL and MS produce more than 50% of their kWh from natural gas facilities. MS has large off-shore gas production facilities, while FL receives its natural gas through pipeline distributions. KY is heavily dominated by coal production. This is due it in-state mining. Alternatively, SC which does not have in-state resources for natural gas or coal produces over 50% of their kWh from nuclear power. The Tennessee Valley Authority (TVA), a federally owned operation, maintains service territory in every SEUS state except FL and SC. In TN and other states, the TVA sells the power to local cooperatives and municipal utilities, which adopt broader policies developed by the TVA. SC is unique in that it has a state-owned utility, best known as Santee Cooper, which produces power for SC's cooperatives and some direct customers. Cooperatives and Municipal utilities have a large presence in all SEUS states due to the Rural Electrification Act, which established the TVA, Santee Cooper, and the cooperative system to help bring power to rural areas the IOUs would not serve during that time.

Utility scale solar installation trends for the SEUS states 2014 to the end of 2017 can be found in Figure 5 and the total installation capacity as of March 2018 can be found in Table 3. NC has the largest installed utility scale capacity at over 3GW, which is more three times that of the next largest SE state for this category, GA with 1GW. Utility scale installations continue to grow in NC, but have stagnated in GA. FL has relatively low utility scale capacity of less than 500MW based on population. Other states in the SE region (AL, KY, SC, and TN) each have less than 100MW of installed utility-scale solar PV capacity with nearly all installations occurring after 2015. Finer examination of trends since 2015 indicate rapid gains in overall utility scale installations between 2015 and 2016, while the growth is relatively flat in the first ten months of 2017. A single 10MW project was reported for Kentucky in 2016 with 8.5 MW added by a second project in 2017. In contrast, Mississippi increased in utility solar capacity from 3MW to over 100MW capacity in 2017. In terms of percentage of total utility scale generation nameplate capacity, NC leads the reactions with over 9% followed by GA at over 3%. All other SEUS states receive less than 1.7% of their electricity from utility scale solar power. KY, TN, MS, and AL all produce less than 1% of their power from utility scale generation. Overall, the SEUS averages 2.42%, which is increased by the large capacity found in NC. This regional average is above the average for the entire US at 2.26%.

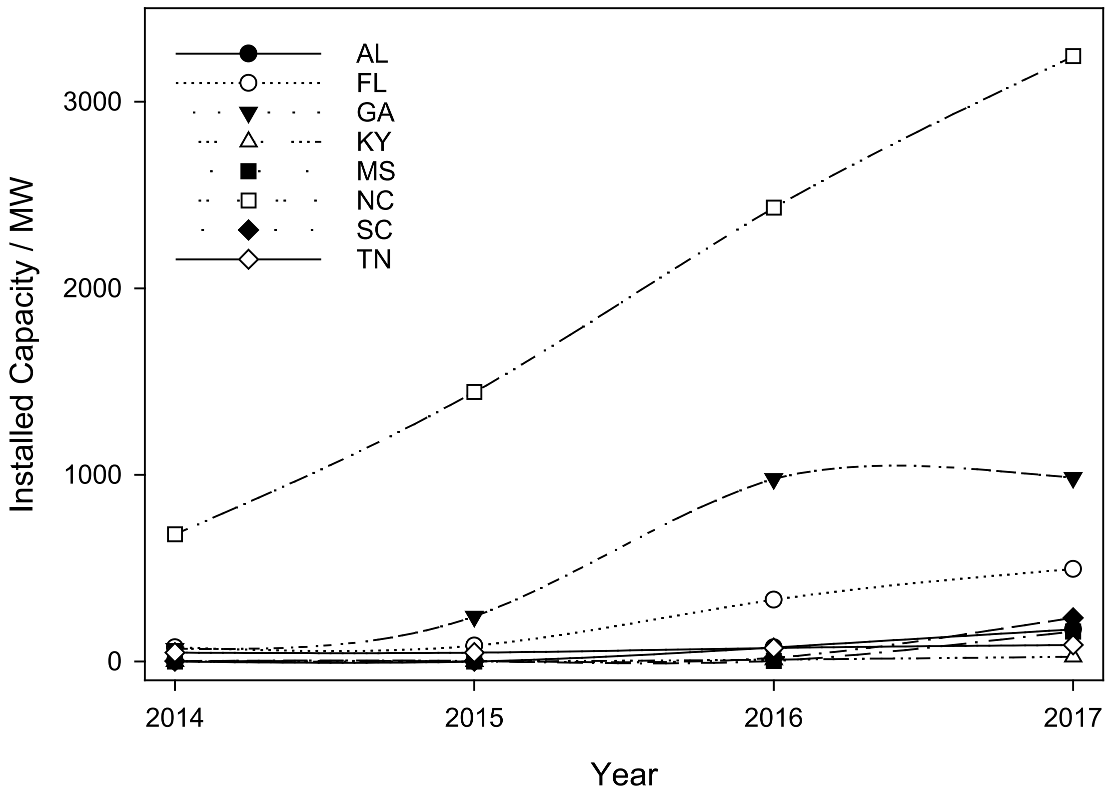

Figure 5. Utility-scale PV capacity for SE states from 2014 to 2017.

Trends for Commercial and Industrial (C&I) solar installations from 2014 to 2017 are found in Figure 6, while total capacity as of March 2018 and the calculated W per employer establishment is found in Table 3. C&I is defined as small-scale distributed systems without an EIA Utility ID, and may be found in EIA form 861M. [27] C&I Georgia data is obtained in ref. [28] in the 'non-residential' category. No state in the SEUS has greater than 100 MW of C&I capacity. The largest, NC's 70MW us closely followed by 65MW in FL and 52MW in GA. SC and TN have approximately 40MW of installed C&I capacity, while KY, MA, and AL have 10MW or less of C&I capacity. The SEUS averages 197 W installed per employer establishment, which is 22% of the national average.

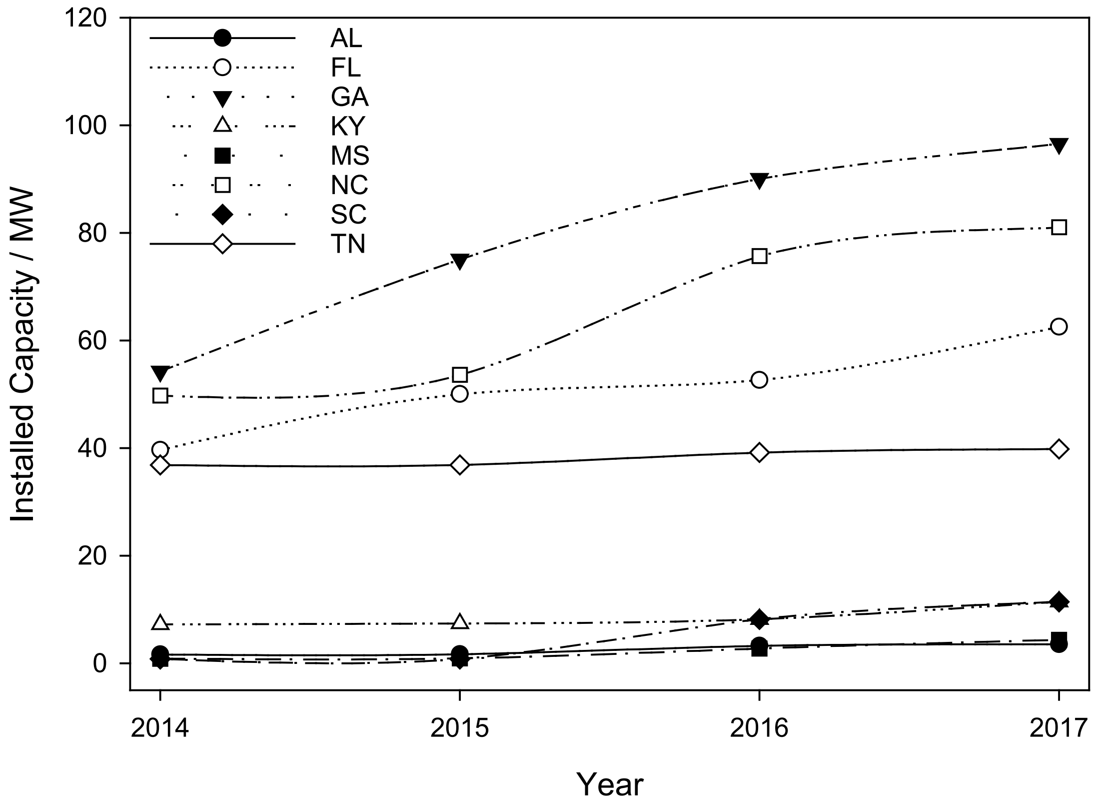

Figure 6. Commercial and Industrial PV capacity for SE states from 2014 to 2017.

An examination of residential installations, found in Figure 7 and Table 3, shows a very different trend than utility scale installations. FL is the largest residential installer with SC ranked second with over 98 MW of residential, distributed systems. Notably, NC and GA, which are often cited as top states for the solar industry have considerably less than SC. When all SEUS states are compared for residential systems on an owner-occupied housing basis, SC is the clear leader with over 60 W installed per household. The next closest is FL, with 23 W per household. All SEUS states fall below the nationwide average of 113 W per household.

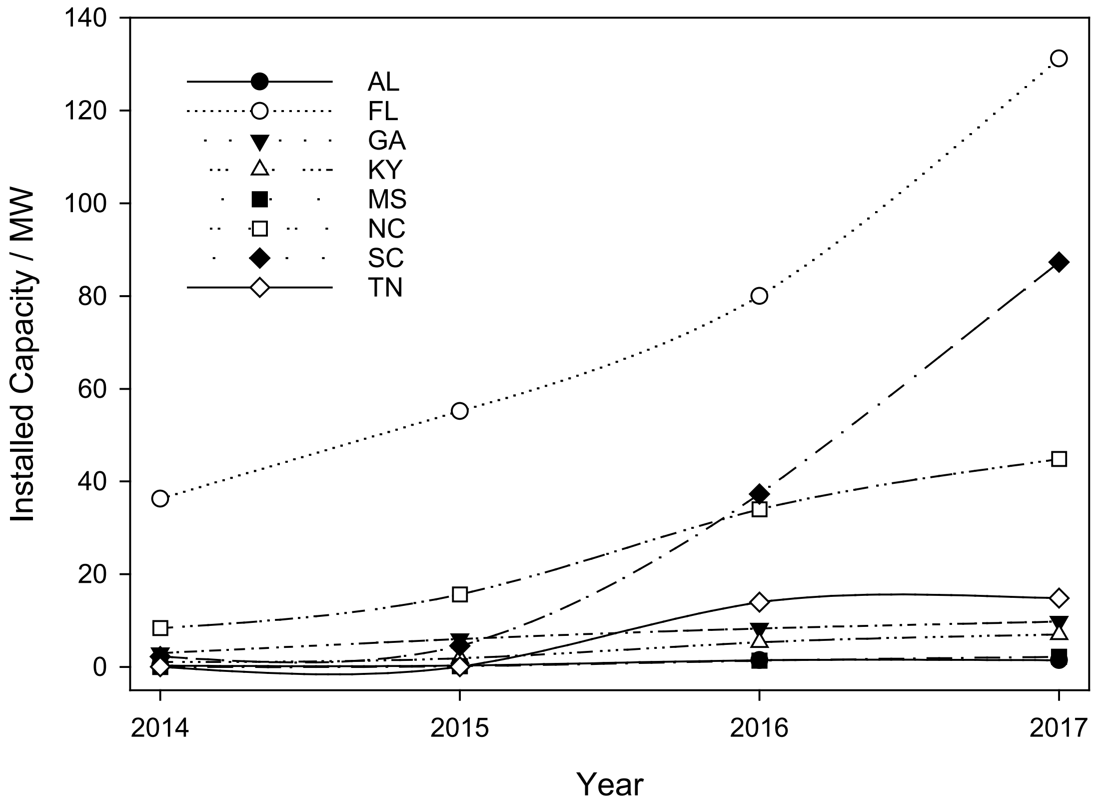

Figure 7. Residential solar PV capacity for SE states from 2014 to 2017.

Solar adoption in the Southeastern US is relatively low compared to other regions, but at the nationwide average, and has notable exceptions of: a) residential PV in South Carolina, and b) utility-scale PV in North Carolina and Georgia. To better compare adoption rates in residential, commercial, and utility scale solar, across the states, rates were normalized by watts per owner occupied household for residential systems, watts per employer establishment for commercial systems, and percent of total generation nameplate capacity for utility scale systems in Table 3. When comparing residential penetration alone, SC by far has the largest penetration at 60.1 W/household and FL is the next largest at 22.9 W/household, nearly a third of the installed capacity if SC. All other SE states fall below the SE average of 17.5 W/household. None of the SE states meet the US average of 113.4 W/household. Here the programs and incentives put in place by SC's Act 236 are particularly evident. This law includes a set aside of 0.25% from the 2% goal for systems smaller than 20 kW. The IOU incentives and rebates were crucial to helping reach this target. AL has 0.3 W/household. The lowest of all SE states.

When comparing C&I customers by W per employer establishment, SC again takes the lead at 394.3 W/employer. The next highest is NC at 313.6 W/employer. Four SE states surpass the US average of 197

W/employer, SC, NC, TN, and GA. AL has the lowest amount of C&I installations at 38.6 W/employer. When comparing utility scale systems as a percentage of nameplate capacity within a state, NC is the clear lead with 9.19%, followed by GA at 3.15%, and FL at 1.67%. The SE average is 2.42%, which is slightly higher than the entire US at 2.26%.

Table 3. PV installation and adoption rated in each sector as of March 2018.

Southeast US state	Residential Solar Capacity [MW]	W per owner occupied household	C&I Solar Capacity [MW]	W per employer establishment	Utility-Scale Solar Capacity [MW]	% of total generation nameplate capacity	Total Solar PV capacity [MW]
AL	0.4	0.3	3.8	38.6	172	0.54	176
FL	150	22.9	65	122.0	1112	1.67	1,324
GA	5.8	2.2	52	231.5	1251	3.15	1,309
KY	7.4	5.5	10	108.9	25	0.10	42
MS	2.5	2.8	8.2	139.8	161	0.90	172
NC	46	15.6	70	313.6	3309	9.19	3,425
SC	98	60.1	41	394.3	261	1.04	400
TN	15	9.0	39	292.5	92	0.39	146
SE States	325	17.5	289	197.0	6383	2.42	6997
US	10,170	113.4	6,801	887.4	26,723	2.26	43,694

To help understand if electricity rates had an effect on solar adoption for residential and C&I customers, the price of electricity per kWh was compared for al SEUS states both in real and constant dollars, see Figure 8a and 8b. Between 1990 and 2000 all SEUS states ranged between 6 – 8 cents/kWh in real US$, but the price steadily climbed to between about 10.5 – 13 cents/kWh (Fig 8 a) in 2017. Throughout the twenty-seven-year period of 1990 to 2017, KY had the lowest residential electricity states in the SE states with TN as the second lowest. Initially, NC, FL, and SC had the highest relative electricity prices for the region. FL experienced an increase in pricing between 2004 through 2009 with prices falling to a stable rate of 11.50 cents/kWh through 2017. SC experienced the highest residential electricity rates in the SEUS since 2012. Due to the complexity of electricity production and delivery it is difficult to pin point one clear reason for the increase in prices, though large spikes in natural gas pricing starting in 2005 - 2008 likely affected electricity pricing in FL and MS which are highly dependent on natural gas turbine plants.

In Figure 8b the pricing in real dollars was adjusted to constant 2017 US$ by using of the US Department of Commerce - Consumer Price Index (CPI) inflation calculator. [29] When adjusted for inflation, per kWh costs are lower than they were in 1990,but have remained flat since 2010. A recent report by the US EIA indicates South Carolina has the largest monthly residential bill compared to all other US states, at $1,753. [30] AL has the next highest at $1,747/month, nearly $400/month above the US average household bill. The high monthly bill for SC is likely due to the dominance of electricity for heating, cooling, and household kitchen stoves, along with high summer temperatures. There are low adoption rates for natural gas and heating oil use for winter months.

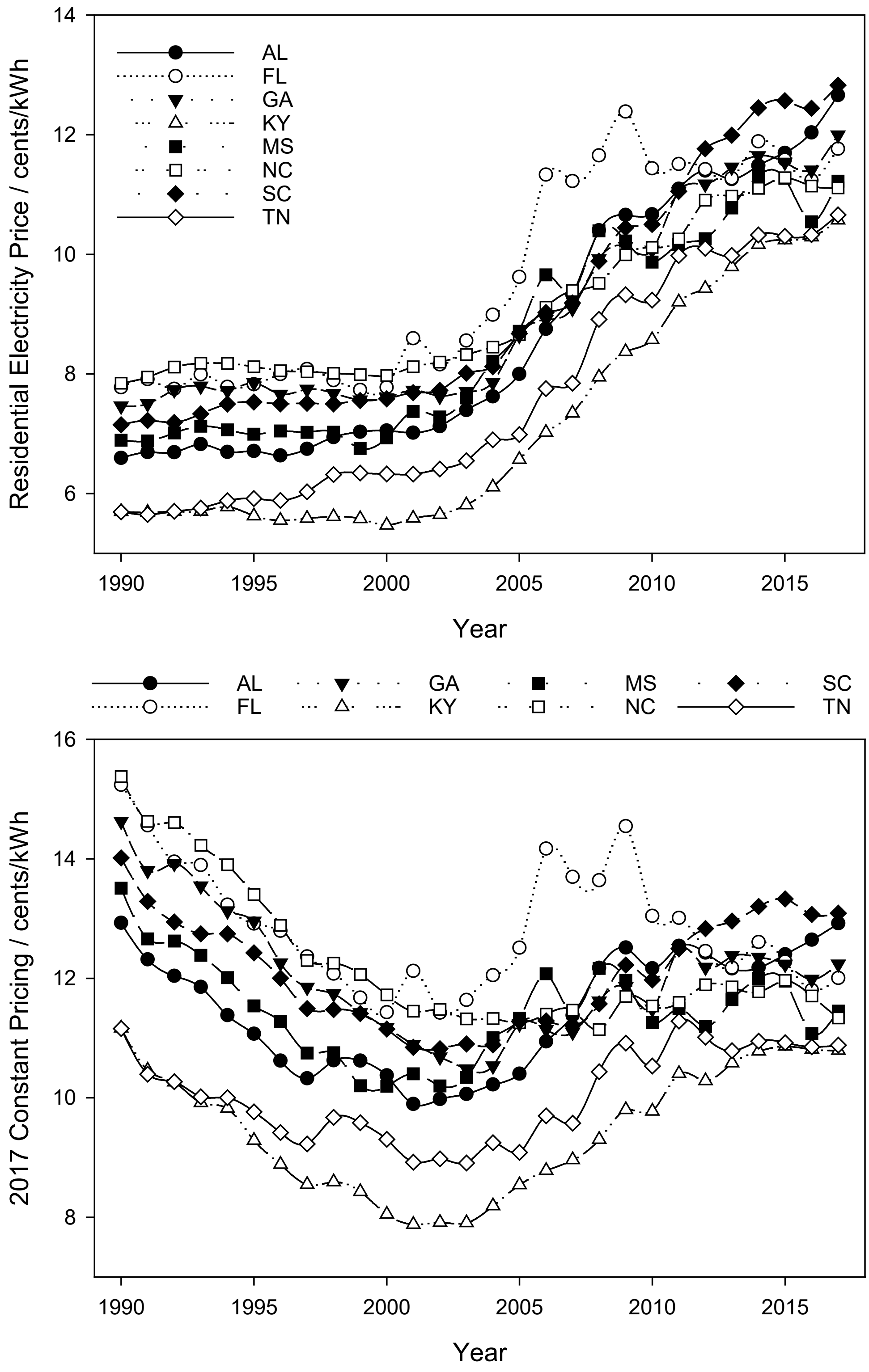

Figure 8. (a) Trends in electricity pricing for SE states. (b) electricity pricing in constant 2017 US$.

The installed cost of solar in SC was obtained through a series of surveys of SEUS solar installers, from 2014 to 2017. [10-13] It is important to note the dramatic drop in the price of PV installations in all three segments, see Figure 9. Using data collected from installers of all segments in SC the price dropped the larges between 2014 to 2015 when SC's Act 236 was signed. Utility scale installations dropped from \$2.39/W to \$1.74/W, C&I systems dropped from \$3.23/W to \$2.75/W, while residential systems dropped from \$4.40/W to \$3.53/W. Over the next two years, costs continued to drop in all segments to \$1.36/W for utility scale systems, \$1.98/W for C&I, and \$3.38/W for residential systems at the end of 2017. The cost of residential installations remains an impediment to access to solar energy, particularly in poor and rural communities. However, simply the action of signing Act 236 had a direct, immediate impact on the cost of solar energy in SC in the residential, commercial, and utility sectors. In 2014, residential systems installed for an average of \$4.40/W-DC. This immediately dropped by \$0.87/W-DC to \$3.53 in 2015 before Act 236 was fully implemented. In 2016, when third party leasing became available, the average cost decreased another \$0.19/W-DC, and the estimated cost at the end of 2017 was \$3.38/W-DC, for a total decrease of \$1.02/W-DC since 2014. Overall, total cost dropped 23% in the three-year period for residential systems. The cost dropped \$0.48/W-DC for commercial installations and \$0.65/W-DC for utility-scale installations between 2014 and 2015, respectively. Overall, the cost of commercial installations dropped by 39% over the three-year period, while the cost of utility-scale installations dropped by 43%. This large drop in price has allowed several power purchase agreements (PPAs) to be signed with the utilities for below avoided cost.

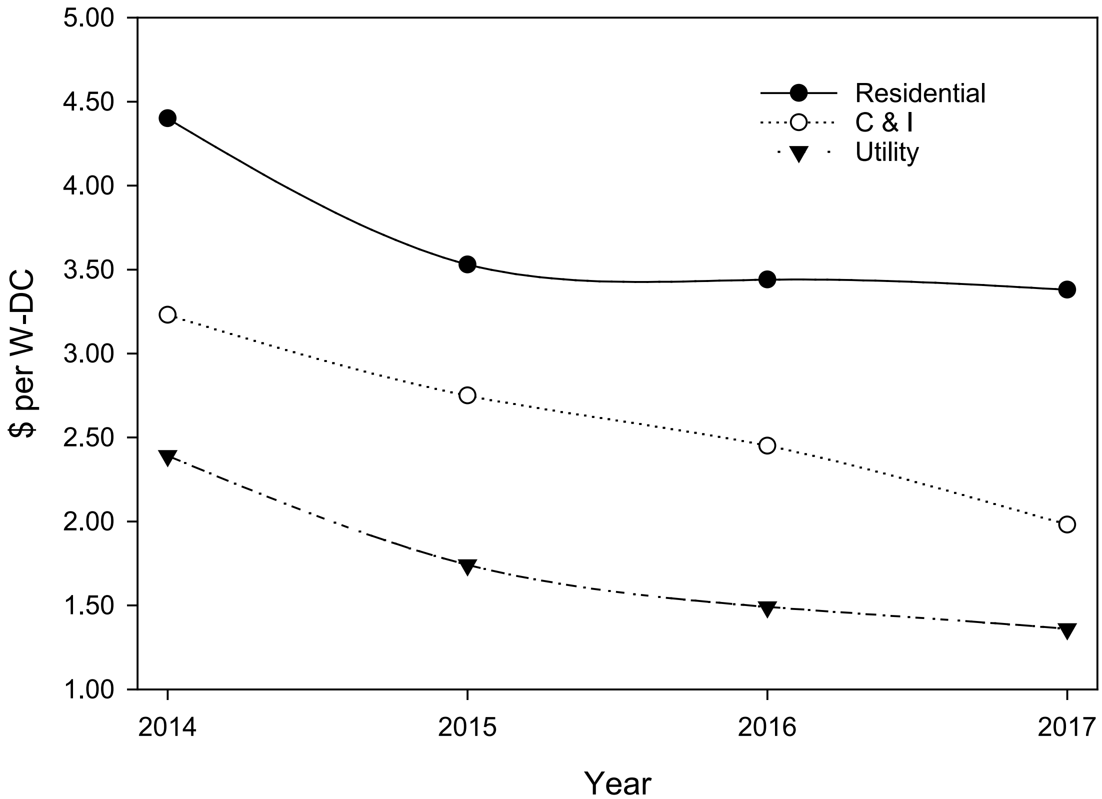

Figure 9. Total price of solar PV installations in South Carolina.

4.0 States Analysis

4.1 South Carolina and Alabama

South Carolina has seen dramatic growth in PV solar installations since 2015. The number of residential installations alone have grown from 830 in 2015 to over 10,000 installations in 2017 [13]. Utility scale capacity grew in this same period from less than 2 megawatt-direct current (MW-DC) to over 127 MW-DC in 2017. This dramatic growth coincides with implementation of solar PV incentives passed by the SC legislature, signed into law in 2014, "Distributed Energy Resources Program Act" [32], also known as Act 236, which established a voluntary 2% solar energy capacity goal for the state's IOUs. The 2% was further divided down into 1% utility scale systems, and 1% from distributed systems smaller than 1MW with 25% of it reserved for systems smaller than 20kW. Act 236 does not apply to electric cooperatives or the state-owned utility, Santee Cooper. The two percent derived from the peak retail electricity demand averaged over previous five years. Another key feature of Act 236 was to allow for third-party leasing of solar PV systems. Act 236 augments a state-wide tax credit for up to 25% of a residential or commercial system cost, enacted in 2006. Even with favorable tax credits, SC did not have a significant number of distributed energy systems until 2015, which indicates that the tax credits were not enough to spur the expansion of renewable energy use.

SC's rapid growth in PV capacity from 2015 through 2017 coincided with state and federal sales tax credits, coupled with DER-focused policy to promote solar PV electricity adoption. The latter resulted in solar equipment rebates by most of the large utilities (DEP, DEC, and SCEG), and state-wide PV system leasing for consumers. The federal and state incentives were in place for several years before large growth in PV occurred. Act 236 formalized the leasing option for residential PV and added a voluntary goal for the IOUs. The visibility of solar programs generated by utility incentives may have caused a spike in residential PV customers striving to have full advantage of the IOU rebates, while leasing certainly played a role in the expansion of DERs. However, leasing is predominate in IOU territories and is not common in electric cooperative territories.

Alabama, a state similar to SC in income and size, shows a sharp contrast to SC for solar PV penetration, with a total estimated residential PV capacity in 2017 of 300 KW. In addition, growth in residential solar from 200KW in 2014 represents a 50% increase but with less than 100 residential installations. Utility scale solar PV in Alabama grew from no installation prior to 2016 to 93 MW by the end of 2017. Utility scale solar in AL now exceeds three other Southeast states considered here: KY, MS, and TN. Solar generation in AL is primarily generated in the River Bend Solar power plant located in Florence, AL with 75MW capacity, which was completed in late 2016. Other utility scale systems are Alabama are located at US military bases within the state. An additional 20MW at the Cumberland Solar Farm installation near Huntsville, AL [37] should be online by the end of 2018. It is likely that the growth of solar in the state is inhibited by a lack of state net metering policy and utility policies covering distributed energy. For example, Alabama Power, charges $5/KW per month connection fee for rooftop solar. The utility cites low residential electricity rates and cost recovery for distributed energy as rationale for additional distributed solar charges.

AL residences and businesses can benefit from the nationwide federal tax credit, but AL does not have renewable portfolio standard, net metering, or any state-wide programs. State-wide zero interest loans are made available local governments and public schools and universities [39]. There are existing incentives within the TVA service area; approximately 17% of the state's land area, with about 500,000 households and 100,000 commercial and industrial customers [41]. There are three TVA programs for promoting renewables for Alabama residences and businesses within the TVA service area: Green Power Providers [42] and Renewable Standard Offer programs [43], and the Distributed Solar Solutions initiative [44]. The TVA Green Power Providers program started in late 2012 and is applicable to all residential, commercial and industrial segments. Government and non-profit organizations are also included. The minimum system size is 0.5kW and a maximum of 50KW for this program. The incentives are for up to twenty years of credit and retail rate of 9 cents/kWh for residential systems of less than 10kW, 7.5 cents/kWh for residential systems greater than 10KW, and a credit for commercial and industrial customers of 7.5 cents/kWh. The Renewable Standard Offer program started in 2006 for 50kW to 20MW systems and offers long-term contracts of up to 20 years for a rate which escalates 5% annually. Finally, the Solar Solutions Initiative has since early 2012 offered 4 cents/kWh for the first ten years with a minimum of 50 KW and a maximum 1MW system. Each program has annual caps on the total capacity offered.

4.2 North Carolina and Georgia

Georgia and North Carolina have nearly identical populations, poverty rates, and comparable median income (Table 1). Though, the rate of solar adoption in GA is less than NC. NC leads SE states in utility-scale solar installations, three-fold larger than GA and NC residential PV capacity is nearly six times greater than in Georgia (Fig. 5). Residential electricity rates are also comparable of the last decade, and in recent years has been lower than SC and AL electricity rates (Fig. 8). NC has about a 30% contribution to electricity production each by coal, nuclear, and natural gas, with the remaining 10% electricity capacity from hydroelectric and non-hydroelectric sources (particularly bio-mass). GA has a similar profile with a lower percentage of renewable energy sources and a much higher percentage of electricity by natural gas turbine plants. An additional 13% of electricity is imported to GA, compared to 6% net inflow to NC. GA is expected to have considerably greater share of the state's electricity generation from nuclear power by the end of 2022, with the addition of Vogtle units 3 and 4 in Waynesboro, Georgia, with 1,110 MW expected from each plant.

Solar incentives for GA and NC differ, providing insight of the effects of state and utility incentives on solar PV development for states with about 10 million in population. As with AL, GA does not have an RPS, does not require net metering, and has no state-wide solar incentives. Georgia Power, the state predominant utility has a limited net metering program. A number of the smaller utilities in the Georgia offer rebates for a portion of solar installations. Nevertheless, GA has experienced large growth in total PV capacity from about 6 MW total capacity in 2010 to 1.25 GW in 2017, with the predominate growth in 2015 and 2016. Residential PV grew from about 200 installations with less than one megawatt total capacity, to nearly 1,000 residential installations by 2017 with 5 MW capacity. Residential installations coincides with large populations near the cities of Atlanta, Athens, and Savannah [17]. Non-residential (commercial and industrial) solar PV has a broader distribution compared with residential solar, but the predominate location for non-residential PV is in the Atlanta area; reflecting the concentration in the number of businesses in

Fulton County and surrounding counties compared with other areas of the state. The most dramatic growth in GA in solar PV related to utility scale installations where a single installation of 1 MW in 2010. By 2017, state-wide utility-scale PV solar increased ten-fold with 219 installations with 1.2 GW capacity and 1.8 TWh annual production [17].

Georgia has three EMC's (Cooperatives) which offer rebates to off-set part of residential solar installations. The incentive is a rebate of $450/KW-AC up to 10KW-AC for a total possible rebate of $4,500. The three Georgia cooperatives are associated with TVA: Greystone Power Membership Corporation, Central Georgia EMC, and Jackson EMC. Georgia utilities including the EMC's are not required to offer net metering, however Georgia Power and many of the EMC's offer net metering for residential solar and non-residential solar generators with facilities less than 100KW. Net metering is capped by the Georgia regulatory policy as a 0.2% of a utility's peak demand of the previous year [31]. The net metering policy has been in effect since 2001 but with no difference Georgia state law and regulations until a 2015 law, known as House Bill 57, allowed for third party financing and leasing of residential and commercial solar PV systems. Third party systems are capped at 10KW for residential installations and 100 KW for commercial systems.

Given the limited solar PV marketing and relatively low incentives allowed for by state law, and few rebate incentives, GA solar PV capacity is nearly all utility-scale installations. Combined residential and non-residential solar PV represents about 1,500 installations with 57 MW total capacity or 3% of the total capacity from all segments (residential, non-residential, utility) [17]. Comparatively, SC with half of Georgia's population, and state-wide 25% tax credit, IOU rebates, and a third-party leasing starting in 2016, has over 10,000 solar PV installations with 137 MW capacity in the combined residential and commercial/industrial segments by mid-2017. The dramatic differences in solar PV penetration between SC and GA suggest strong impact of incentive programs for increasing solar PV adoption. GA and SC both passed legislation in 2015 with SC's Act 236 resulted in far greater solar PV installation compared with GA House Bill 57.

NC has established a number of solar PV incentives: Renewable Energy Portfolio, net metering requirements, state-wide tax credits, and utility-based rebates. Some of these programs have expired after reaching renewable energy objectives. By mid-2017, NC had 25 MW of residential PV capacity with 4,700 customers-generators and a larger non-residential PV segment of 141 MW capacity with 773 installations. Utility-scale solar was over 100 times the size of residential PV with 2.9 GW generating capacity at 400 sites. NC has a strong RPS with a requirement for the Investor-Owned Utilities (IOUs) of 12.5% renewable sources by 2021. 10% of electric cooperative and municipal utilities to use renewable energy sources by

2018. The present electricity generation profile for NC sources are about a third share of nuclear, coal and natural gas each with nearly 10% renewables. Nine percent of the NC's electricity is imported from other states.

Residential electricity pricing for NC is less than most other SE states at 11 cents/kWh. It is important to note that NC had the highest residential rate from 1990 – 2000 in real and constant dollar values (Figure 8). A major incentive for solar PV installations, the NC Renewable Energy Tax Credit, expired at the end of 2015 allowed for a state tax credit of 35% with a maximum credit of $10,500 for residential systems. Battery storage was allowed in the residential system cost, capped at 35 kWh capacity. Even though the tax credit expired in 2015, the same solar PV capacity continued to grow in 2016 and 2017 (Figure 7). This suggests that the state tax credit alone may not determine residential solar adoption rate in NC and is likely combined with the falling cost of installation and broader awareness. The state has an aggressive net metering program with IOUs crediting Net Excess Generation at the retail to the next month's bill. The size limit for net metering in NC is up to 1 MW for customer owned systems. In the case of leased systems, up to 20KW for a residential system or 1 MW for non-residential customers.

In addition to the IOUs in NC (Duke Energy Carolinas, Duke Energy Progress, and Dominion Energy North Carolina), some electric cooperatives have incentive programs. For example, Blue Ridge EMC has a net excess generation credit at the retail electricity rate for residential customers up to 25 KW systems, but this incentive is partially reduced by the residential customer having larger facility charges. Duke Energy Carolinas offered a rebate program for solar installations, which ended in January 2017. In addition to the incentives from TVA covered areas in NC, the state has specific incentive for residential systems of less than 5 KW offered by a NC based non-profit, NC GreenPower with 6 cents/kWh credit for up to five years.

4.3 Kentucky and Mississippi

The two Southeastern states with the highest poverty rates in the SE region are Kentucky (KY) and Mississippi (MS), with 18.5% and 20.8% respectively (Table 1). Lower residential penetration is common in areas with high poverty rates due to the financial barrier or upfront costs or credit qualifications. KY has a low utility scale capacity of 18.5 MW, from a 10 MW plant that came on line in 2016 and a recent additional 8.5 MW in 2017. The latter is a community solar farm for the East Kentucky Power Cooperative [32]. The residential solar PV capacity for Kentucky is 5.4 MW and 1.4 MW for MS. The utility scale solar capacity for MS is much greater than KY with 110 MW. The profile for MS is similar to Alabama where the residential solar PV capacity is very low, however large gains were made in 2017 with utility-scale solar. Two large utility-scale facilities in MS are a 52 MW installation in Lamar county and a 50 MW plant located near Hattiesburg, Mississippi. Low adoption for MS residential solar may reflect the high poverty rate and low median income. KY has slightly higher residential solar penetration.

In KY coal-fired power plants to provide 84% of the state's electricity output, which is a likely contributor to low solar power generation. Additional electricity production is obtained from natural gas and hydroelectric plants (Figure 3). The primary fuel for electricity production in MS is natural gas at over 70% and the next largest source of electricity is nuclear power at nearly 20%. Neither MS or KY have a RPS, however both have net metering programs. KY's net metering program applies to IOU's and electric cooperatives, but not to TVA. Up to 30 KW systems are credited at the retail electricity price, with a one-percent cap on total electricity production. MS's net metering program includes up to 20 KW for residential solar and non-residential up to 2 MW. Net Excess Generation (NEG) is at the utilities avoided cost and with 2.5 cents/kWh added. Net metering is capped in MS at 3% of the utilities peak demand in the previous year. Neither MS or KY offer state-wide tax credits and utilities do not have rebate programs.

The very low utility-scale penetration in KY may be a result of the dominance of coal as a fuel source in electricity production and export. Other examples of this trend are by coal producing states: West Virginia (WV), Montana, Pennsylvania, and Illinois (IL). Although IL has a very low poverty rate of 13%, a high median annual income of $59,200 and sizable state population (12,801,559), total utility-scale solar PV is about 30 MW; a surprisingly low capacity given that IL has an aggressive RPS of 25% renewables by 2025. However, IL does have about 1 GW wind energy generation capacity. WV has nearly the same energy source mix as KY with 84% electricity generation by coal-fired plants and 8% from natural gas generation. Total renewable generation is about 11% primarily with about 700 MW of utility-scale wind power, followed by 2% of the total energy source by hydroelectric. Interestingly, WV as nearly 66 MW of battery energy storage. This includes a 32 MW lithium-ion Beach Ridge storage facility, and the 32 MW Laurel Ridge project [33, 34]. These states have a very dominant fossil fuel source, coal or natural gas, with low PV utility-scale solar penetration, and are more likely to meet the state's renewable energy production goals from wind generation.

4.4 <u>Florida</u>

FL's electric production profile is similar to MS's (Fig. 3), with 75% of electricity produced by natural gas fired plants. Coal and nuclear have the next largest shares of fuel source with 7% and 12%, respectively. Total renewable energy generation in FL is very low, with about 2% of the total. This is in part due to the lack of hydroelectric sources, and a utility-scale solar capacity of nearly 500 MW (Fig. 5). FL has the largest population of the Southeast States, 20.6 million, twice that of the next largest state, GA. FL has the lowest poverty rate for the SE states with 14.7% and the second highest household median income of $48,900 (Table 1). About six percent of electric energy is imported.

The residential electricity price in FL has been in the mid-range for SE states since 2013 [Fig. 8]. Prior to that, it was among the highest of SE states. Electricity price for Florida was exceptionally high for a ten-year period starting in 2002, ranging from 15 to 20 percent higher than any other state in the region. At the peak price between 2005 and 2010, the residential price of electricity was 14 cents/kWh in inflation adjusted constant 2017 dollars. These trends coincide with natural gas pricing for electricity production [35].

Florida does not have a RPS, unlike other states of similar size across the US. The population of New York (NY) is 19.8 million, with the same poverty rate as FL, but with substantially higher median household income of $60,741. Though, NY has an RPS for 50% electricity production by renewable sources by 2030 [36]. The majority of new sources of renewable energy in NY will be through wind generation. Other large US states such as Texas (TX) and California (CA) have ambitious renewable targets of a 10 GW voluntary goal for TX in 2025 [37], and 50% RPS goal in California by 2030 [38]. FL had 150 MW of residential solar PV by March 2018, nearly 35% greater than the next SE state, SC at 98 MW, which is a quarter of the size of FL. The smaller capacity of utility-scale solar PV in FL (1112MW) contrasts with NC which has about 3.3 GW capacity of utility-scale solar (Fig. 5). A major reason for the low solar adoption in FL is likely limited state policy support. While a net metering program is in place, added incentives, such as state income tax credits, are not available.

4.5 <u>Tennessee</u>

Electricity generation in Tennessee (TN) is primarily contributions of nuclear power (40%) and coal (34%) with natural gas as 13% (Figure 3). Hydroelectric power contributes 9.7% to the state's electricity production, larger than any other state in the SE region. TN has a large inflow of electricity at 34% of the total use (Figure 4). 97% of all large-scale electricity generation capacity in TN is part of the TVA, a US Government entity. This includes the two Cumberland 1,300 MW coal fired plants in Stewart county, and four nuclear power plants, each with over 1,200 MW capacity. The US government initially funded TVA in the 1930's, however federal funding was phased by 1999 [39]. Over 130 local utilities obtain electric power from TVA in seven states. The TVA service area ranges from the complete coverage of TN to a small portion of NC and VA. TVA power is largely distributed to customers through electric cooperatives of municipal utilities and the TVA has established a Green Power Providers (GPP) program for the utilities it supplies [40]. As with other SE states, low adoption of residential solar PV in TN may be the result of customers utility rates. Residential electricity rate in TN is among the lowest of the Southeastern states as shown in Figure 8. TN electric rates have been consistently lower than Kentucky from 1990 to the present;

with the same trend in constant dollars. The low residential electricity rates may help account for low solar penetration. Conversely, SC has the region's highest residential electric rates and high growth rates in residential PV capacity.

5.0 Conclusions

Solar PV penetration in the Southeast United States is largely influenced by state policy. in the case of NC, GA, and SC, state law helped spur major development and the way the laws were crafted. In SC, specific carveouts for residential solar helped spur the industry, which was aided by the federal tax credit and a favorable state tax credit, third party leasing guidelines, along with investor-owned utility incentives. Growth in NC was led by a mandatory state renewable energy goal. GA was also influenced by state law that encourage the growth of utility scale solar for IOUs, but growth has stagnated since then.
States that have less robust solar PV development in the other SE states is due to a mixture of factors: a) no stated goal by state government on solar development, net-metering, and leasing policies, b) market concentration for a dominant utility to be a unitary statewide electricity provider, and c) customer facing distribution by electric cooperatives or municipal-owned utilities creating off-setting incentives through connection fees, and lowering visibility of the solar PV options provided by wholesale generator and transmission operators.

6.0 References

1. Taxation, U.C.J.C.o., *Present Law and Analysis of Energy-Related Tax Expenditures.* JCX-46-16, 2016.
2. Matisoff, D.C. and E.P. Johnson, *The comparative effectiveness of residential solar initiatives.* Energy Policy, 2018. **108**: p. 44-54.
3. Speer, B., *Residential solar photovoltaics: Comparison of financing, benefits, innovations and options.* NREL/TP-6A20-51644, 2012.
4. Farmer, J.D. and F. Lafond, *How predictable is technological progress.* Research Policy, 2016. **45**: p. 647-665.
5. E.I.A. *US Energy Facts Explained*. 2018 4/23/18]; Available from: https://www.eia.gov/energyexplained/?page=us_energy_home.
6. E.I.A. *Electricity Data Browser*. 2018 4/23/18].
7. Wiser, R. and M. Bolinger, *2016 Wind Technologies Market Report.* DOE/GO-102917-5033, 2016.
8. *BP Energy Outlook.* bp.com/energyoutlook, 2018.
9. E.I.A., Today in Energy: p. https://www.eia.gov/todayinenergy/detail.php?id=34472.
10. Fox, E.B., M.D. Drory, and T.B. Edwards, *2016 End of Year South Carolina PV Soft Cost and Workforce Development.* DOE Technical Report, 2017. **SRNL-STI-2017-00474**.
11. Fox, E.B. and T.B. Edwards, *2015 South Carolina PV Soft Cost and Workforce Development Part 1: Inital Survey Results.* DOE Technical Report, 2016. **SRNL-STI-2016-00177**: p. https://www.osti.gov/scitech/biblio/1252420-south-carolina-pv-soft-cost-workforce-development-part-initial-survey-results.
12. Fox, E.B. and T.B. Edwards, *2015 South Carolina PV Soft Cost and Workforce Development, Part 2: Six month confirmation of anticipated job growth.* DOE Technical Report, 2017. **SRNL-STI-**

2017-00039: p. https://www.osti.gov/scitech/biblio/1342716-south-carolina-pv-soft-cost-workforce-development-part-six-month-confirmation-anticipated-job-growth.
13. Fox Elise, B., T.B. Edwards, and M.D. Drory, *South Carolina Solar Development - Tracking the Effects of Act 236 (2014-2017)*. DOE Technical Report, 2018. **SRNL-STI-2018-00239**.
14. E.I.A. *Preliminary Monthly Electric Generator Inventory*. 2018 4/23/18]; Available from: https://www.eia.gov/electricity/data/eia860m/.
15. E.I.A. *Electric Power Sales, Revenue, and Energy Efficency*. 2018 4/23/18]; Available from: https://www.eia.gov/electricity/data/eia861/.
16. E.I.A. *Electric Power Monthly Report*. 2018 4/23/18]; Available from: https://www.eia.gov/electricity/monthly/.
17. Southface. *Georgia Energy Data*. 2018 4/23/18]; Available from: http://www.georgiaenergydata.org/solarmap.
18. *https://www.iea.org/topics/renewables/solar/*.
19. CensusBureau. *Quick facts*. 2018 4/23/18]; Available from: https://www.census.gov/quickfacts/fact/table/US/PST045217.
20. Mundaca, L. and J.L. Richter, *Asssessing green energy economy stimulus packages: Evidence from the US porigrams targeting renewable energy.* Sustainable Energy Reviews, 2015. **42**: p. 1174-1186.
21. E.I.A., *Country Analysis Brief Japan.* 2017.
22. E.I.A., *Annual Energy Outlook 2018 with projections to 2050.* www.eia.gov/aeo, 2018.
23. Colman, Z., *Tariffs could fall heaviest on Southeastern states.* E&E News, 2018. **January, 18, 2018**.
24. *https://www.energy.gov/savings/residential-renewable-energy-tax-credit*.
25. SC_Department_of_Revenue, *Solar Energy or Small Hydropower System or Geothermal Machinery and Equipment Credit.* http://www.energy.sc.gov/files/view/TC38_2016.pdf.
26. North_Carolina_Utilities_Commision, *Renewable Energy and Energy Efficency Portfolio Standard (REPS).* http://www.ncuc.commerce.state.nc.us/reps/reps.htm.
27. EIA, https://www.eia.gov/electricity/data/eia861m/.
28. SouthFace, *Georgia Energy Data.* http://www.georgiaenergydata.org/solarmap.
29. US_Department_of_Labor_Bureau_of_Labor_Statistics, https://www.bls.gov/data/inflation_calculator.htm.
30. EIA, *Electricity prices are highest in Hawaii but expenditures are highest in South Carolina.* https://www.eia.gov/todayinenergy/detail.php?id=34932#, 2018.
31. *GA House Bill 57.* http://www.legis.ga.gov/Legislation/20152016/153399.pdf, 2016.
32. *https://www.ekpc.coop/committed/Cooperative%20Solar%2001_18_2018.html?v=Vb0Vgt2f1Rc&list=PLW3IZVhyJGTvHrfguFrO8bl0Jg9pxvjIi&index=3*.
33. *https://www.renewableenergyworld.com/articles/2014/02/beech-ridge-energy-plans-battery-system-at-west-virginia-wind-farm.html*.
34. *https://www.neces.com/our-experience/project/laurel-mountain-wv-2/*.
35. EIA, *U.S. Natural Gas Electric Power Price.* https://www.eia.gov/dnav/ng/hist/n3045us3m.htm.
36. *https://www.nyserda.ny.gov/All-Programs/Programs/Clean-Energy-Standard/Renewable-Portfolio-Standard*.
37. *http://www.puc.texas.gov/agency/rulesnlaws/subrules/electric/25.173/25.173ei.aspx*.
38. *https://www.energy.ca.gov/portfolio/16-RPS-01/index.html*.
39. TVA, *TVA at a glance.* https://www.tva.gov/file_source/TVA/Site%20Content/About%20TVA/2017_TVA_at_a_Glance_FINAL.pdf, 2017.
40. TVA, *https://www.tva.com/Energy/Valley-Renewable-Energy/Green-Power-Providers/GPP-Local-Power-Companies*. 2018.