Status and Trends in the U.S. Voluntary Green Power Market (2014 Data)

Eric O'Shaughnessy, Jenny Heeter, Chang Liu, and Erin Nobler
National Renewable Energy Laboratory (NREL)

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
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Technical Report
NREL/TP-6A20-65252
October 2015

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Additional information on green power market trends and activities can be found on the Department of Energy's Green Power Network website at greenpower.energy.gov.

List of Acronyms

CCA	community choice aggregation
EIA	Energy Information Administration
kW	kilowatt
kWh	kilowatt-hour
GWh	gigawatt-hour
MW	megawatt
MWh	megawatt-hour
NREL	National Renewable Energy Laboratory
PUC	Public Utility Commission
PPA	power purchase agreement
REC	Renewable Energy Certificate
RPS	Renewable Portfolio Standard

Executive Summary

The voluntary or "green power" market is that in which consumers and institutions voluntarily purchase renewable energy to match all or part of their electricity needs. Voluntary action provides a revenue stream for renewable energy projects and raises consumer awareness of the benefits of renewable energy. There are numerous ways consumers and institutions can purchase renewable energy. Historically, the voluntary market has consisted of three market sectors: (1) utility green pricing programs (typically in states with regulated electricity markets), (2) competitive suppliers (in states with restructured electricity markets), and (3) unbundled renewable electricity certificate (REC) markets, where RECs are purchased by consumers separately from electricity ("unbundled"). Some new purchasing options such as community solar and power purchase agreements (PPAs) are providing a hedge against future electricity price increases or other benefits. However these new purchasing options do not always provide the environmental benefit to the customer (i.e., the REC is transferred to another party), which can cause confusion about what constitutes a "green power" option.

This report covers the following purchasing options: utility green pricing, competitive suppliers, voluntary unbundled RECs, community choice aggregation (CCA), community solar, PPAs, and large commercial green power rates (or "green tariffs").

The voluntary market overall continued to exhibit growth in 2014, though growth varied by purchasing option. Based on our review of the voluntary market, we identified the following market trends:

- In 2014, voluntary retail sales of renewable energy totaled 74 million megawatt-hours (MWh), representing about 26% of total U.S. non-hydropower renewable generation, and approximately 2% of total U.S. electricity sales. From 2013 to 2014 total green power market sales increased 10%.
- Approximately 4.9 million customers are purchasing green power, a decrease from 2013. The decrease came primarily from a decline in customers participating in a competitive supply options, and to a lesser degree, a decline in the number of customer purchasing unbundled RECs. The number of customers in utility green pricing programs, community solar, and CCAs increased by 5%, 62%, and 4%, while the number of organizations signing PPAs increased by 15%. See Figure E1 for a summary of changes in participation and sales in six green power options.
- Utility green pricing sales grew by 5% in 2014, with the growth driven by existing large programs. A few utilities are offering large customer renewable energy tariffs, but to date, only two companies have utilized these options; Apple signed a 20 MW agreement for solar and Switch Ltd. signed a 100 MW agreement.
- Competitive markets grew to 16.2 million MWh, a 12% increase from 2013. While the market continued to grow, the number of customers declined. The competitive market continues be challenging to track. Competitive suppliers were increasingly reporting to EIA in Form 860, but EIA discontinued its green power data collection mid-2014.
- Unbundled REC markets, after seeing little movement in 2013, increased by 15% in 2014 to 36.0 million MWh. REC prices declined slightly over the same period, to less than $1/MWh.

- The number of community solar programs continues to increase. In 2014, community solar projects had approximately 42,000 participants, representing 150,000 MWh of sales. As of September 2015, at least 90 community solar projects totaling more than 80 MW existed in the United States. The RECs from these projects are typically used to meet RPS compliance, and therefore, are not included in our summary market totals.
- For 2014, we found approximately 2.5 million customers participating in CCAs that source renewable energy, totaling 7.7 million MWh of renewable energy. Renewable energy sales in CCAs declined slightly due to dynamics in Illinois, currently the largest CCA market.
- This year's report captures trends in the voluntary PPA market for the first time. As of July 2015, more than 550 PPAs for renewable energy had been signed, representing over 6,400 MW of capacity. PPAs for large (>50 MW) wind are concentrated in Texas and Iowa, while small scale PPAs for solar are concentrated in California and New Jersey. State and local governments have signed the largest number of PPAs, but the average capacity of PPAs signed by technology companies is the largest of all sectors.

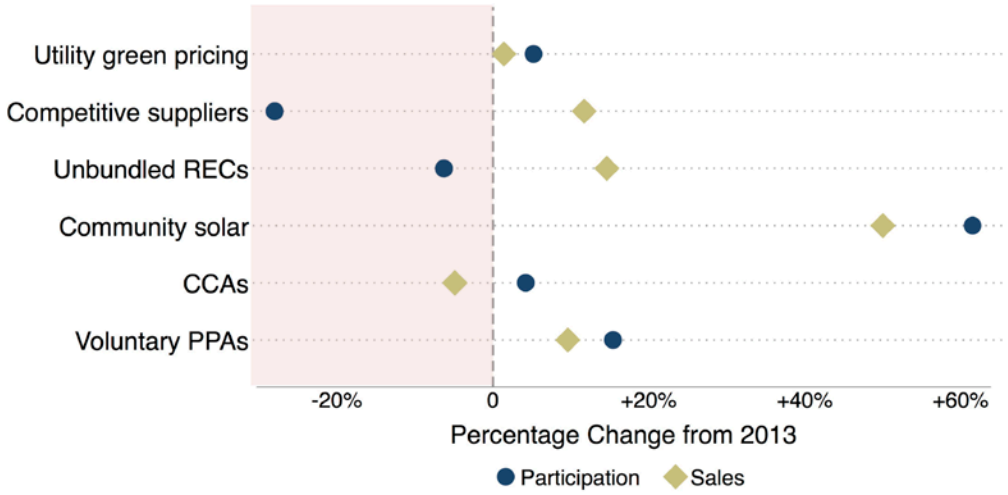

Figure E1. Percentage changes (2013-2014) in green power market participation and sales.

For the first time, this report presents an assessment of green power options, from customer and policymaker/utility perspectives. This assessment is designed to help customers understand the availability of green power options, the treatment of environmental attributes, and payment mechanisms and costs for each option. We provide a summary of green power policies from a policymaker's perspective, which examines renewable energy capacity potential, eligible customer base, and participation rates of each green power option.

Table of Contents

List of Figures

List of Tables

1 Introduction

Purchasing options in the voluntary markets for renewable energy—or green power markets—continue to evolve in 2014 and early 2015. Voluntary or green power markets are those in which consumers and institutions voluntarily purchase renewable energy to match their electricity needs. These purchases are in addition to renewable energy that is used to fulfill renewable portfolio standards (RPS).[1] Some new purchasing options are providing a hedge against future electricity price increases or other benefits, but do not always provide the environmental benefit to the customer (i.e., the renewable energy certificate (REC) is transferred to another party), which can cause confusion about what constitutes a "green power" option.[2] The following options are covered in this report:

- **Utility green pricing (regulated utility markets).** Utility green pricing programs began in the early 1990s when a few utilities offered options to their customers. These programs continue to be offered by utilities in traditionally regulated electricity markets. In utility green pricing programs, RECs are obtained by the utility and offered to customers bundled with electricity. Utilities differ in how they procure RECs for their green pricing programs but often enter into power purchase agreements (PPAs) for the energy and RECs. In other cases, they may procure unbundled RECs and sell them with electricity as a package.
- **Competitive suppliers (competitive electricity markets).** In states with competitive (or restructured) retail electricity markets, electricity customers can often buy electricity generated from renewable sources by switching to an alternative electricity supplier that offers green power. In some of these states, default utility electricity suppliers offer green power options to their customers in conjunction with REC marketers so that switching is not required. More than a dozen states that have opened their markets to retail competition have experienced some green power marketing activity.[3]
- **Unbundled REC market (separate from electricity).**[4] Whether or not customers have access to a green power product from their retail power provider, they can purchase green power through unbundled RECs. More than 50 companies offer unbundled RECs to retail customers via the Internet, and a number of other companies market RECs solely to commercial and wholesale customers.
- **Community solar.** Community or "shared" solar programs allow utility customers to purchase or subscribe to a portion of a larger solar project. Customers then receive the benefits of the energy that is produced by their shares. Structures differ, but a common model is for the RECs to be transferred to the utility to meet compliance with an RPS.

[1] The voluntary green power market represented about 26% of U.S. non-hydro renewable generation in 2014. The remaining non-hydro renewable generation is used by load-serving entities to comply with state-level renewable portfolio standards and for other purposes (e.g. least-cost procurement).
[2] RECs represent the environmental benefits of one megawatt-hour of generation. For more information on REC claims see: http://www.nrel.gov/docs/fy15osti/64558.pdf.
[3] States with competitive offerings include Connecticut, Delaware, Illinois, Maine, Maryland, Massachusetts, Michigan, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, and Texas. Washington, D.C. also has green power marketing activity.
[4] Throughout this report, we use the term "voluntary REC" to distinguish from RECs used for compliance purposes.

- **Community choice aggregation (CCA).** Authorized in seven states, CCAs allow communities to determine their electricity generation sources by aggregating the community load and purchasing electricity from an alternate electricity supplier while still receiving transmission and distribution service from their existing utility. CCAs are sometimes described as a hybrid between services offered exclusively by investor-owned utilities (IOUs) and municipal utilities. CCAs are typically opt-out programs, meaning that customers must take action to remove themselves from the program, whereas green pricing programs are opt-in programs, requiring customers to take action to subscribe. This distinction leads to much higher enrollment rates for CCAs compared to green pricing programs.

  CCA renewable purchases in 2014 totaled 7.7 million MWh, with approximately 2.5 million customers participating. Although most of the supply for CCAs is coming from competitive suppliers, we separate the figures in this report to show the relative size of each segment.

- **Voluntary PPAs.**[5] A number of corporations, universities, and others have negotiated long-term purchases of renewable energy through PPAs. Importantly, not all states allow for PPAs, but an increasing number of institutions are using the virtual PPA model to source renewable energy. PPAs are more commonly allowed in states with restructured electricity markets.

- **Large commercial green power rates (or "green tariffs").** A few utilities now have new tariffs that allow large utility customers to purchase, through the utility, renewable energy from a specific facility in the utility service territory instead of negotiating a PPA directly with a generator. Green tariffs may become important options in states where bi-lateral PPAs are not allowed.

This report presents data and analysis on voluntary market sales and customer participation, products and premiums, green pricing marketing, and administrative expenses. The report also details trends in community solar, community choice aggregation, PPAs, and REC pricing in voluntary and compliance markets.

The data on voluntary market trends presented in this report were formerly reported in *Status and Trends in the U.S. Voluntary Green Power Market (2013 Data)* (Heeter et al. 2014)*, Status and Trends in U.S. Compliance and Voluntary Renewable Energy Certificate Markets (2012 Data)* (Heeter and Nicholas 2013), *Market Brief: Status of the Voluntary Renewable Energy Certificate Market (2011 Data)* (Heeter et al. 2012), and *Status and Trends in U.S. Compliance and Voluntary Renewable Energy Certificate Markets (2010 Data)* (Heeter and Bird 2011). Voluntary market data are based on figures provided to the National Renewable Energy Laboratory (NREL) by utilities and independent renewable energy marketers. NREL also supplements this data with information from EIA, external sources such as Bloomberg New Energy Finance, REC certifiers, REC tracking systems, and press releases describing large voluntary green power purchases. Data cannot be obtained from all market participants, and thus the estimates presented here underestimate market size. Obtaining data on competitive markets is

[5] Throughout this report we use the term "voluntary PPA" to distinguish from PPAs used for other purposes (e.g., RPS compliance).

particularly challenging due to market sensitivity and rapid changes in offerings, estimates of the competitive market are even more uncertain.

2 Voluntary Green Power Participation and Sales

About 4,900,000 U.S. electricity customers (participation) purchased approximately 74 million MWh of green power (sales) in 2014 (Table 1). Voluntary green power participation was highest in CCAs, while voluntary green power sales were highest in voluntary unbundled RECs markets.

Table 1. Voluntary Green Power Participation and Sales in 2014

Green power option	Participation	Sales (MWh)
Utility green pricing	743,000	7,040,000
Competitive suppliers	1,584,000	16,250,000
Unbundled RECs	89,000	36,000,000
Community solar	42,000	150,000
CCAs	2,500,000	7,700,000
Voluntary PPAs	295	6,700,000
Total[6]	4,916,000	73,690,000

Figure 1 illustrates percentage changes in green power participation and sales from 2013 to 2014 for the green power options studied in this report. Green power sales increased by about 10% in 2014, while green power participation fell by about 12%. Community solar exhibited the strongest growth, increasing sales and participation by about 50% and 62%, respectively. Participation in competitive green power markets declined by about 32% due to several factors including changes in the relative competitiveness of renewable products to standard offers and declines in the number of competitive suppliers offering a renewable option. Green power sales in CCAs fell by about 5% due to dynamics in Illinois (see Section 5.2).

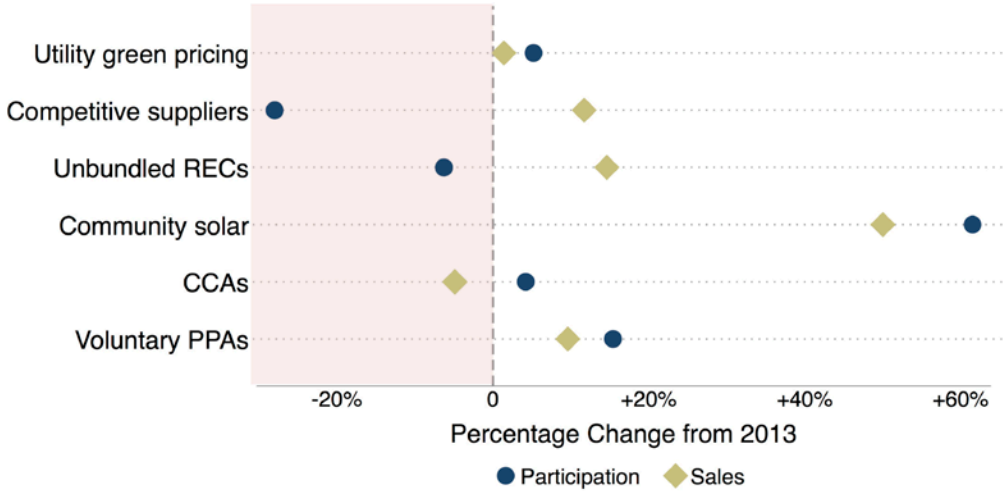

Figure 1. Percentage changes (2013-2014) in green power market participation and sales

Table 2 and Table 3 place this year's estimates in a historical context based on previous estimates for green power participation and sales.

[6] Totals exclude community solar because many community solar customers do not retain the RECs associated with their purchase.

Table 2. Estimated Green Power Participation (x1,000 customers), 2010-2014

Green power option	2010	2011	2012	2013	2014
Utility green pricing	570	570	570	706	743
%change from previous year	3.6%	0%	0%	24%	5.2%
Competitive suppliers	1,200	1,200	1,200	2,200	1,584
%change from previous year	45%	0%	0%	83%	-28%
Unbundled RECs	60	85	110	95	89
%change from previous year	200%	42%	29%	-14%	-6%
Community solar	1.4	16	22	26	42
%change from previous year	130%	1,043%	38%	18%	62%
CCAs	-	-	-	2,400	2,500
%change from previous year	-	-	-	-	4%
Voluntary PPAs	0.07	0.13	0.21	0.26	0.30
%change from previous year	32%	86%	62%	24%	15%
Total*	1,830	1,855	1,880	5,401	4,916
%change from previous year	31%	1.4%	1.4%	187%**	-9.0%

* Total does not include community solar (customers do not always retain the RECs)
** Large increase due to addition of CCA data

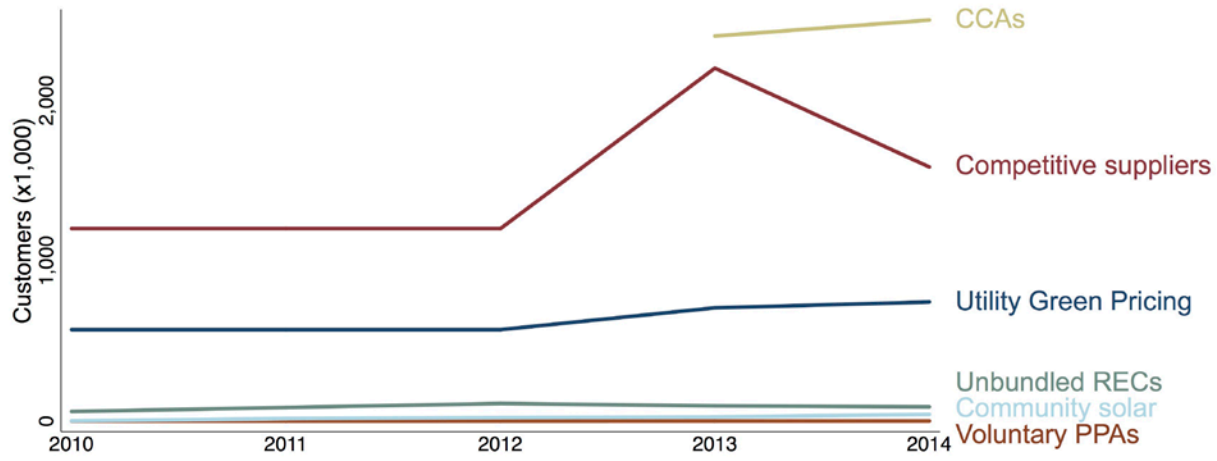

Figure 2. Estimated green power participation over time

Table 3. Estimated Green Power Sales (millions of MWh), 2010-2014

Green power option	2010	2011	2012	2013	2014
Utility green pricing	5.4	5.8	6.0	6.9	7.0
%change from previous year	3.8%	7.4%	3.4%	15%	1.4%
Competitive suppliers	10.4	11.0	11.6	14.5	16.2
%change from previous year	25%	5.8%	5.5%	25%	12%
Undbundled RECs	19.8	25.4	31.0	31.4	36.0
%change from previous year	5.9%	28%	22%	1.3%	15%
Community solar	0.05	0.06	0.08	0.10	0.15
%change from previous year	67%	20%	33%	25%	50%
CCAs	-	-	-	8.1	7.7
%change from previous year	-	-	-	-	-4.9%
Voluntary PPAs	3.2	3.5	4.6	5.9	6.7
%change from previous year	23%	9.4%	31%	28%	14%
Total*	**38.8**	**45.7**	**53.2**	**66.8**	**73.6**
%change from previous year	12%	18%	16%	26%	10%

* Total does not include community solar (customers do not always retain the RECs)

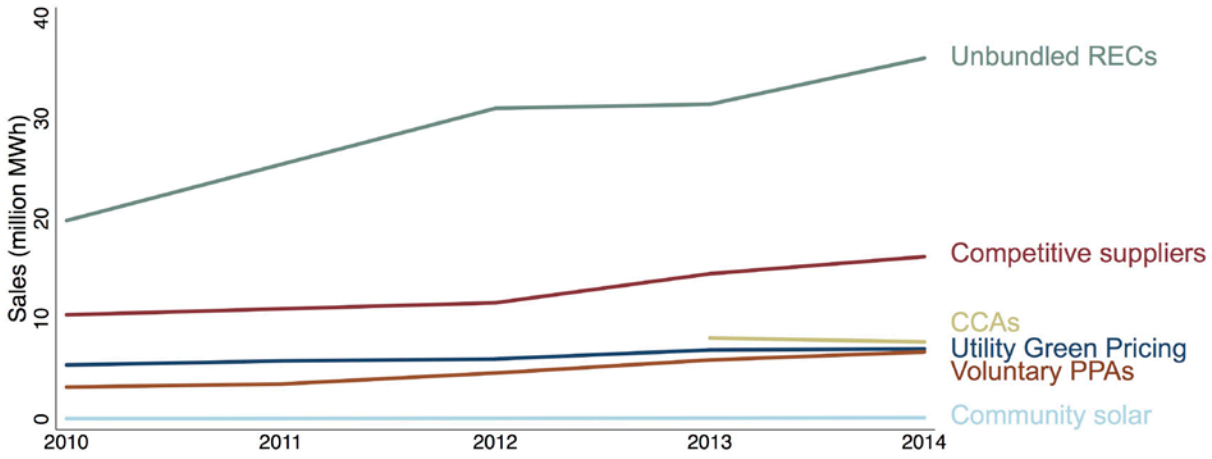

Figure 3. Estimated green power sales over time

3 Traditional Green Power Options

Until recently, the majority of green power purchases occurred through three "traditional" options: utility green pricing, competitive suppliers, and unbundled RECs purchases. These options remained important avenues for green power purchasing in 2014. This section presents highlights in recent trends in the three traditional green power markets.

3.1 Utility Green Pricing

Utility green pricing programs allow customers in a utility's service area to pay a premium to purchase RECs from qualified renewable energy projects. Table 4 summarizes the status of utility green pricing programs in 2014.

Table 4. Status of Utility Green Pricing Programs in 2014

	Participation	Sales	Availability
2014	743,000 customers	7,040,000 MWh	40 states
Change from 2013	+5%	+1%	no change

Green pricing programs continued to grow in 2014, particularly in the residential sector. Residential green pricing sales grew by about 4% and the number of residential green customers grew by about 7% in 2014. Non-residential green pricing participation grew by about 5% while sales fell slightly by about 1%.[7] While green pricing sales grew in aggregate, about 60% of green pricing programs reduced green sales in 2014. The net increase in green sales can be attributed to sales growth in relatively large green pricing programs. Seven of the ten largest utility green pricing programs increased sales in 2014.[8] We estimate that total green pricing program sales and participation reached over 7.0 million MWh and 743,000 customers in 2014.[9] In 2014, utilities continued to develop new models in order to offer programs comparable to green pricing, such as "green gas" programs (see Text Box 1) and renewable energy tariffs (see Text Box 2).

[7] This anomalous result is partially driven by dynamics in the Austin Energy program, where several large non-residential customers exited the program at the same time that many small customers entered the program.
[8] The ten largest programs accounted for about 67% of sales in 2014.
[9] All estimates are extrapolated from survey responses from 46 green pricing programs. NREL estimates that the survey data represents approximately 85% of green pricing sales. Previous reports used EIA data sets that were discontinued in 2014.

Text Box 1. Green Natural Gas Products

With growing customer demand, a few utility companies and natural gas marketers have started offering green natural gas programs. By bundling and selling natural gas with carbon offset products, natural gas marketers and utilities are providing options to offset up to 100% of the combustion emissions from natural gas use without changing the source and supply of their natural gas.

Most green gas programs were launched within the past decade. Both utilities and natural gas marketers have various criteria for choosing the carbon offset projects. For instance, the carbon offsets for the City of Palo Alto are purchased from livestock methane-capture projects at Green Valley Dairy in Krakow, Wisconsin while WGL Energy's CleanSteps program (DC, MD, PA, VA) sources carbon offsets from reducing truck emissions and limiting landfill greenhouse gases.

Different payment options are available for residential and business customers. Customers can pay a fixed monthly rate, pay by the amount of actual natural gas consumed, or combine the two options. The prices of carbon offset products currently range from $0.053 per therm to $0.75 per therm and $4 to $5.5 per month under the fixed monthly rate.

To ensure that their green gas products are of high quality, utilities and natural gas marketers primarily provide offsets that are certified by Green-e Climate, a third party certification for utility gas offset programs and competitive gas offset products.

Utilities and natural gas marketers who have green natural gas programs include the City of Palo Alto, WGL Energy, Direct Energy, Renewable Gas Constellation, TerraPass, NW Natural, Spark Energy, and Duke Energy Carolinas.

The average residential purchase in green pricing programs was 5.3 MWh per participant in 2014, down slightly from 5.4 MWh per customer in 2013. Average non-residential purchases declined from 248 MWh per customer in 2013 to 174 MWh per customer in 2014. The average green power purchase amount is influenced by multiple factors, including the green pricing premium. The average residential and nonresidential net green pricing premiums in our survey were $0.0170/kWh and $0.0174/kWh on average, respectively. These premiums reflect the net value the customer pays, relative to the conventional retail electricity rate, after accounting for fuel charge exemptions.

Figure 4 illustrates the slightly negative relationship between the average amount of green power purchased per customer and the green pricing premium. Residential customers in programs with a residential premium of less than $0.01/kWh purchased 5.6 MWh more renewable energy than green pricing customers in programs with higher premiums, on average. Non-residential customers in programs with premiums of less than $0.01/kWh purchased 115 MWh more renewable energy than non-residential customers in programs with higher premiums, on average.

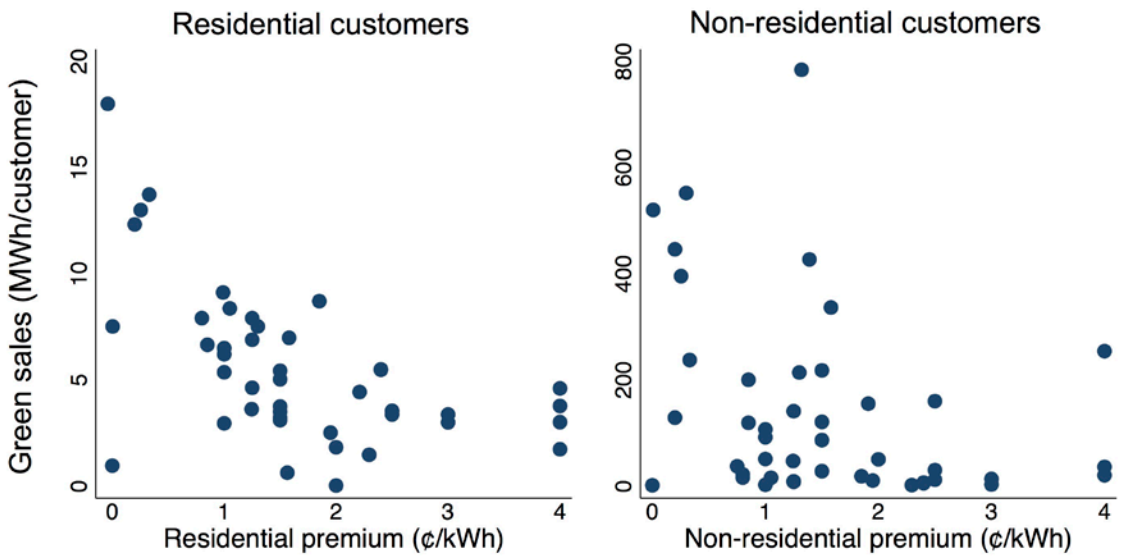

Figure 4. Green sales per capita (MWh/participating customer) relative to residential and non-residential net green pricing premiums (¢/kWh)

Green power procurement methods in green pricing programs were similar to previous years, with a slight increase in the prevalence of REC purchases bundled with electricity (see Table 5). Similar to past years, unbundled RECs are associated with shorter contract lengths than RECs bundled with electricity.

Table 5. Contract Length by Type of Utility Green Power Procurement (MWh), 2014

Contract length	Unbundled RECs	RECs bundled with electricity	Projects owned by utility	RECs produced by utility consumers
≤1 year	58%	0%	0%	0%
2-5 years	37%	9%	29%	0%
6-10 years	4%	0.7%	0%	25%
≥11 years	0.6%	90%	71%	75%
Percent of total procurement	42%	49%	6%	3%

Wind power remains the resource used most abundantly in green pricing programs, comprising about 65% of total green pricing sales in 2014. However, the prominence of wind in green pricing programs has fallen steadily over time relative to solar power. Solar power has grown from about 0.2% of utility green pricing resources in 2005 (Bird and Brown 2006) to about 8% of green pricing program resources in 2014.

The average marketing expenditure for green pricing programs was about $0.50 per eligible customer, and average administration costs were about $150 per participating customer. The survey results suggest that higher marketing expenditures are associated with higher participation rates. The four survey respondents that reported more than $1 per eligible customer in marketing costs achieved an average participation rate of 7%, whereas the utilities reporting lower

marketing costs achieved an average participation rate of 2%. The relationship between marketing expenditures and participation rates may be an area for further study.

Text Box 2. Large Customer Renewable Energy Tariffs

Large utility customers continue to push utility companies to offer green power programs, such as green energy tariffs, catered to large customers. In 2013, Apple became one of the first companies to utilize a green energy tariff developed by NV Energy in Nevada. In 2015, Switch Ltd., a data center service provider, successfully negotiated a 100% green power supply through a green energy tariff after years of negotiation with NV Energy. Five utilities currently offer green energy tariffs for large customers:

- Dominion Power "Renewable Energy Supply Service" (Virginia): Customer pays the purchase and sales agreement price (negotiated by Dominion with the generator), less the energy component of Dominion's General Service tariff rate, plus a $500/meter/month administrative fee.
- Duke Energy "Green Source Rider" (North Carolina): Customer pays standard general service tariff plus the total cost of the PPA and RECs, a $2,000 application fee, a $500 administrative fee, and a $0.02/kWh surcharge on renewable energy.
- NV Energy "GreenEnergy Rider" (Nevada): Customers pays a Renewable Resource Rate that reflects the full cost of the renewable energy facility. Cost recovery is determined by PUC review.
- Puget Sound Energy (Washington): Customer pays energy charge determined by renewable energy contract plus other applicable tariff elements and rates (including administrative costs).
- Rocky Mountain Power "Service from Renewable Energy Facilities" (Utah): Customer negotiates the renewable energy charge with the developer. Distribution and delivery charges are set relative to the negotiated tariff rate. Customer pays monthly administrative charges of $150/meter and $110/generator.

For more information on large customer renewable energy tariffs see Tawney and Ryor 2015.

3.2 Competitive Suppliers and Voluntary Unbundled REC Purchases

In REC markets and competitive green power markets (i.e., in states with retail competition), an estimated 52.2 million MWh of renewable energy was sold to retail customers in 2014 (Table 3). Overall, 2014 saw gains in green power sales in both the REC markets and competitive electricity markets.

In competitive electricity markets, an estimated 16.2 million MWh were sold as a bundled green power product in competitive electricity markets—a 12% increase from 2013 (Table 6). While that is slower growth than in previous years, given the lack of data availability for this sector,

estimated growth is in the range of previous years, and while some competitive suppliers report data directly to NREL, they do not represent the bulk of the market and the EIA 861 and 826 data used in previous years were not available for 2014.

Table 6. Status of Competitive Markets in 2014

	Participation	Sales	Availability
2014	1,584,000 customers	16,200,000 MWh	15 states
Change from 2013	-28%	+12%	n/a

Unbundled REC sales, after being essentially flat in 2013, increased by 15% in 2014 (Table 7). In 2013, it is possible that the increase in REC pricing, from around $1.00/MWh to $1.20/MWh, impacted non-residential sales of unbundled RECs. However, in 2014, REC pricing dropped below $1.00/MWh, to around $0.80/MWh.

Table 7. Status of Unbundled REC Markets in 2014

	Participation	Sales	Availability
2014	88,608 customers	36,047,000 MWh	50 states
Change from 2013	-6%	+15%	n/a

While most unbundled REC buyers are residential customers, the majority of REC sales on a megawatt-hour basis are made to non-residential customers due to the much larger purchase sizes. As a result of large non-residential REC purchases, unbundled REC sales represented about half of total green power MWh sales in 2013 (Table 3) and have grown dramatically in recent years. Although some major companies have begun transitioning from purchasing unbundled RECs to on-site or off-site PPAs, unbundled RECs continue to represent more than half of voluntary green power market sales.

To inform customers of potential renewable offers by competitive suppliers, some states have developed databases of product offers. Table 8 provides a list of databases offered by states. These sites include all offers by competitive suppliers, but can be filtered or sorted to find offers for renewable electricity.

Table 8. State-Developed Competitive Supplier Search Options

State	Database	Link
Illinois	Plug In Illinois	http://www.pluginillinois.org/
New York	Power to Choose	http://www.newyorkpowertochoose.com/
Ohio	Energy Choice Ohio	http://www.energychoice.ohio.gov/
Pennsylvania	PAPowerSwitch	www.papowerswitch.com
Texas	Power to Choose	http://www.powertochoose.org/

Two other commercial services, Power2Switch (https://power2switch.com/) and SaveOnEnergy (www.saveonenergy.com) provide a zipcode-based service to search offers by a select list of suppliers, many of whom offer a renewable product. In order to find out whether suppliers in any state are third party-certified, Green-e Energy provides links to its certified suppliers through a "Find Renewable Energy for Your Home or Organization" tool: http://green-e.org/base/buy.

Figure 5 shows Green-e Energy-certified retail transactions from 1998 to 2014.[10] Green-e Energy certified 38.0 million MWh of retail transactions in 2014 (Terada 2015). After seeing a decrease in 2013, 2014 numbers increased to greater than 2012 levels. Certified retail sales increase in both the green pricing and unbundled REC segments of Green-e Energy-certified sales, but decreased in the competitive market segment.

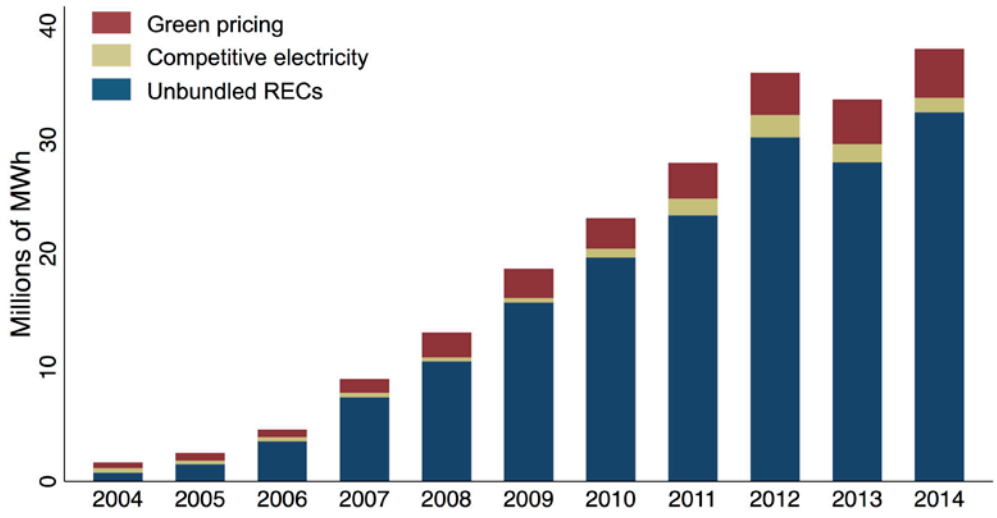

Figure 5. Total retail sales of Green-e Energy certified renewable energy, 2004–2014

Source: Terada 2015

[10] Although we focus on Green-e certification of unbundled REC sales, Green-e also certifies all renewable energy options. See www.green-e.org for more information.

The Green-e Energy program also certifies wholesale renewable energy transactions, which totaled 9.8 million MWh in 2014, consistent with the 2013 total of 9.7 million MWh but down from 15.7 million MWh in 2012. It is important to note that 5.6 million MWh sold in certified wholesale transactions were resold in Green-e Energy-certified retail transactions. The remaining 4.2 million MWh were sold in non-Green-e Energy-certified transactions, most likely to utilities and electric service providers, power marketers, or retail customers. In total, Green-e Energy certified 43.5 million MWh of unique transactions in 2014.

3.3 Voluntary and Compliance REC Pricing

Pricing for voluntary RECs differs from compliance REC pricing and from pricing offered by utility green pricing programs. Unlike compliance RECs, which typically must be sourced from within some geographic region to be eligible for RPS compliance, voluntary RECs can be sourced either regionally or nationally. With a few exceptions, there is little price transparency in REC markets. Most transactions are conducted as bilateral contracts between parties, and prices are not reported. In addition, prices can vary widely by region. Therefore, data presented here are only indicative and should be used with caution. We also present data on compliance REC pricing to provide further context for REC pricing (see Text Box 3).

REC values depend on several factors, including the technology, the vintage (year in which it was generated), the volume purchased, program eligibility (e.g., Green-e Energy), the region in which the generator is located, and the market supply/demand balance. Natural gas prices can also affect the cost competitiveness of renewable energy generation, which is reflected in REC prices. In general, REC prices fell in both voluntary and compliance markets from mid-2014 to mid-2015 (see Figure 6 and Text Box 3).

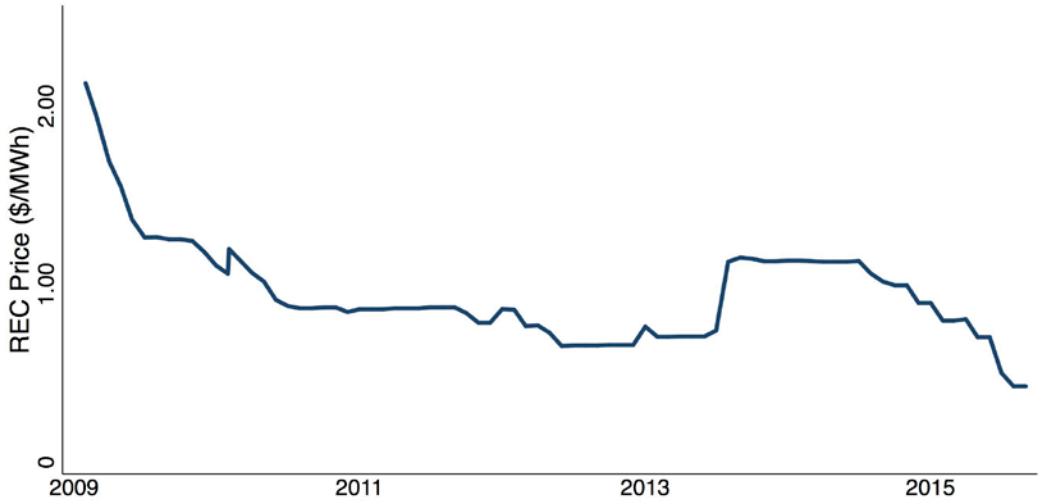

Figure 6. Voluntary national REC prices

Source: Marex Spectron (2015)

Text Box 3. Compliance REC Pricing

Compliance REC prices in the Midwest, mid-Atlantic, and Texas have continued to remain below $35/MWh (Figure A). REC trades in the mid-Atlantic were closing above $15/MWh in September 2015 in Maryland, New Jersey, and Pennsylvania. In Texas, REC prices fell to as low as $0.38/MWh in 2015 compared to highs in the mid-$2/MWh range in 2012.

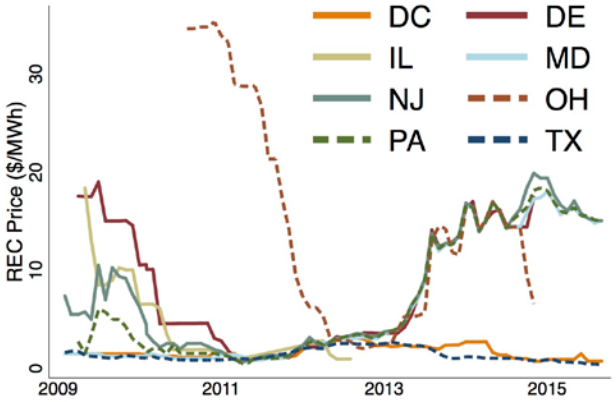

Figure A. Compliance REC pricing in the Midwest, Mid-Atlantic, and Texas

Prices in New England have decreased to just below $50/MWh since the first half of 2015 (Figure B). With the exception of Maine, New England's REC prices have increased and remained between $45 and $50/MWh after dipping below $20/MWh for most of 2010 through mid-2011. Maine has seen an increase in eligible generators, particularly biomass generators restricted from other state markets, causing REC prices to decline (Prince 2014).

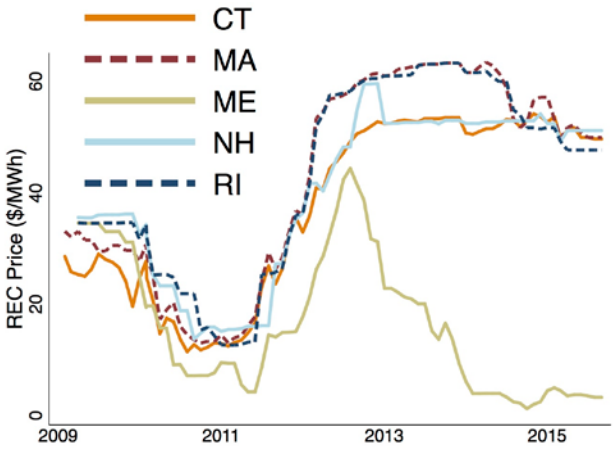

Figure B. Compliance REC pricing in New England

Spot pricing for solar RECs (SRECs) is publicly available via platforms like SRECTrade and Flett Exchange. SRECTrade hosts a monthly auction, while Flett Exchange is an online exchange. Both platforms cover markets in PJM states, Massachusetts, and Ohio, and similar price trends can be seen in reported data from both companies. Figure C shows SREC prices by year.

Source: Marex Spectron 2015

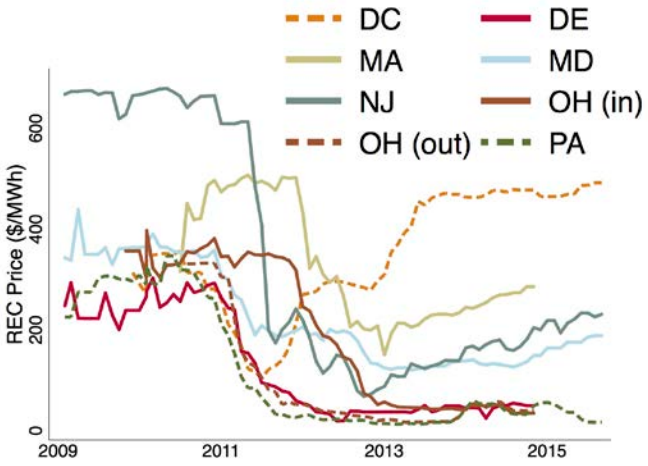

Figure C. SREC pricing

4 Community Solar

Community solar allows electricity customers to claim an ownership stake in a solar installation remote from their residence or building. In the "subscription" model, customers pay for a given share of the array's output (kWh), either up front or through ongoing payments. In the "purchase" model, customers make an up-front payment for a given portion of the array's capacity (kW) (Seligman 2015). In either model, local utilities receive and distribute the generated electricity and credit customers on their utility bills for their portion of the array's output. Table 9 summarizes the status of community solar markets in 2014.

Table 9. Status of Community Solar Markets in 2014

	Participation	Sales	Availability
2014	42,000 customers	150,000 MWh	25 states
Change from 2013	**+62%**	**+50%**	**+7 states**

Community solar could expand solar access to about 49% of homes and about 48% of businesses that are unable to host an on-site solar power system (Feldman et al. 2015). Community solar also has the potential to expand solar power access to underserved communities. In July 2015, the White House launched the National Community Solar Partnership with an emphasis on solar power access for low- and moderate-income households.

Not all community solar transactions are voluntary green power purchases. Some community solar project developers sell RECs to regulated entities (e.g., utilities) for compliance purposes. Some state policies mandate that utilities purchase the REC output of community solar gardens. This section summarizes the current status and trends of all community solar markets without distinguishing voluntary green power purchases.

At least 90 community solar projects with over 80 MW of capacity were active in 25 states as of September 1, 2015 (Figure 7).[11]

[11] Community solar project data aggregated from the Community Solar Hub (CEC 2015) project database (as of 09/01/2015), Interstate Renewable Energy Council Shared Renewables Catalog (2014), and individual project websites.

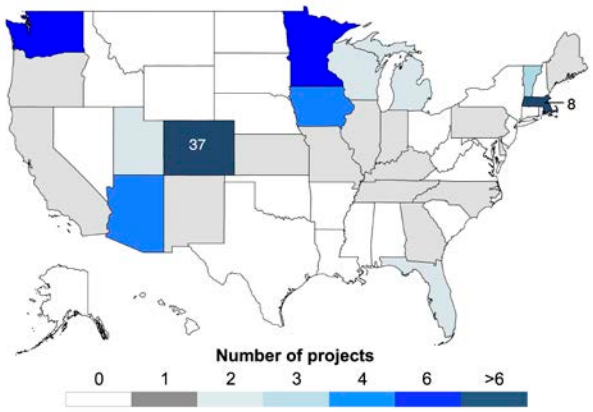

Figure 7. Number of community solar projects by state

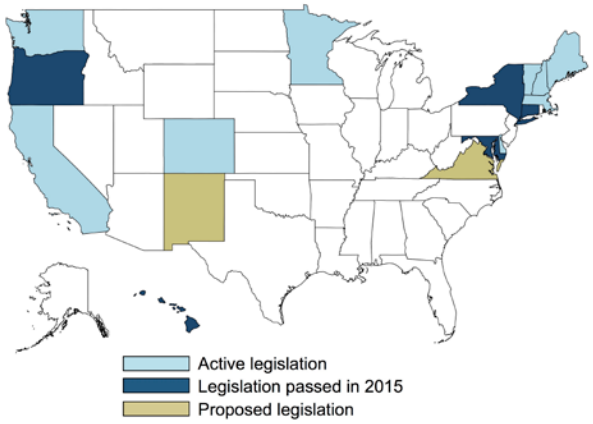

Figure 8. Community solar enabling legislation

Fourteen states have implemented policies to support community solar project development (Figure 8). Policies that require utilities to purchase unsubscribed community solar output (i.e., output not purchased by an electricity customer) increase the revenue certainty of community solar projects and can spur project development (Seligman 2015). Nonetheless, supporting policies are not a prerequisite for community solar markets. The majority of community solar projects outside of Colorado went forward without enabling legislation.

4.1 The Community Solar Landscape in 2014

Thirty-two community solar projects came online in 14 states in 2014 (Figure 9). Colorado, with 30 MW of installed capacity in 37 projects, maintained its prominent position as the state leader in community solar with more than six times as many projects as any other state except Massachusetts. Nine community solar projects with 11.6 MW of total capacity came online in Colorado in 2014. Massachusetts also exhibited signficant growth with six projects and over 6 MW of capacity installed in 2014.

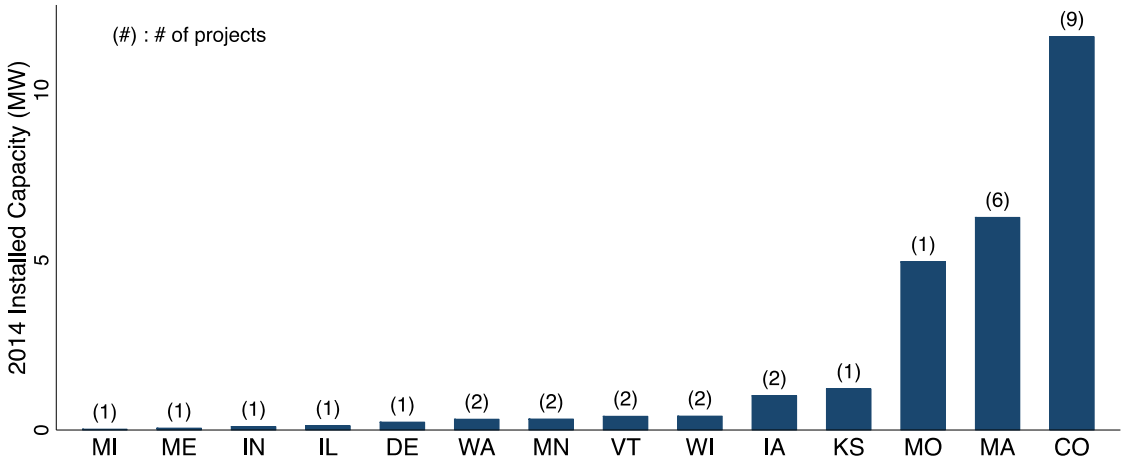

Figure 9. Community solar installed capacity (MW) in 2014, with number of new projects displayed in parentheses, by state

The community solar model has exhibited significant geographic expansion over time, with at least one project in 25 states by September 2015 (Figure 10). Seven states in Figure 9 are newcomers to the community solar scene: Delaware, Illinois, Indiana, Kansas, Maine, Missouri, and Wisconsin. North Carolina developed its first community solar project in 2015.

Additionally, five states enacted community solar-enabling legislation in 2015. The Connecticut Clean Energy Facility Pilot Program calls for a pilot project of no greater than 4 MW. The Hawaii Community-Based Renewable Energy Program requires electric utilities to establish tariffs to enable customer participation in community-based renewable energy projects. In response, the Hawaiian Electric Company launched a 260 kW pilot project in July 2015. The Maryland Community Solar Energy Generating System Program established a three-year community solar pilot project. The New York Community Distributed Generation program should enable community solar participation for all eligible customers by mid-2016. Last, legislation in Oregon requires the Oregon PUC to examine a range of community solar options.

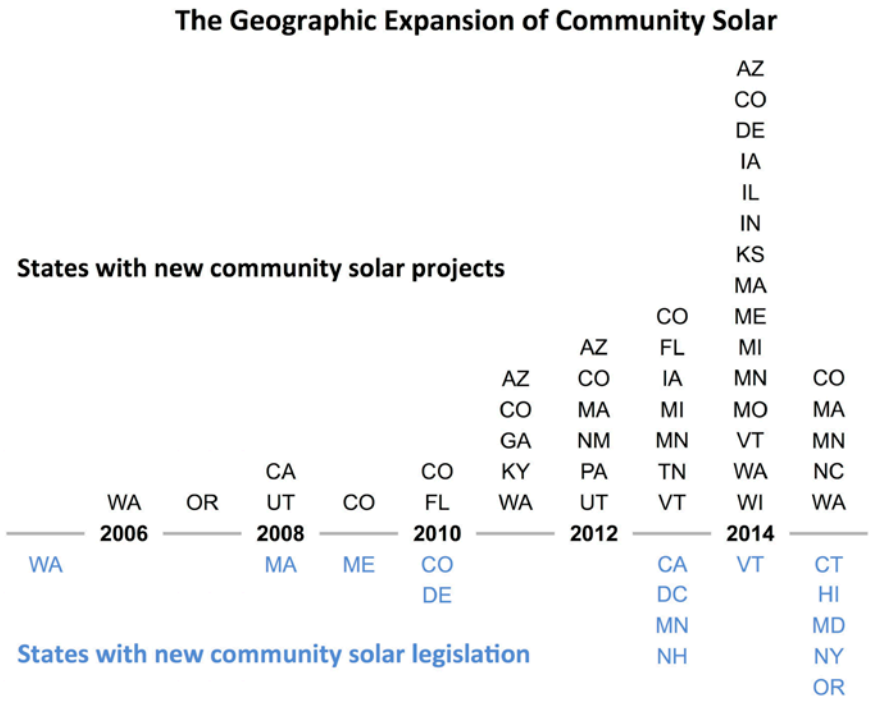

Figure 10. The geographic expansion of community solar

Note: Above the time lines are listed states with new community solar projects. Below the time line (in blue) are states that enacted new community solar legislation.

4.2 Projected Growth in Community Solar

Cumulative installed capacity of community solar is projected to increase nearly sixfold from about 80 MW in 2014 to 465 MW in 2016 (Honeyman et al. 2015). Community solar could represent up to 49% of the annual distributed PV market by 2020 (Feldman et al. 2015) (see Figure 11).

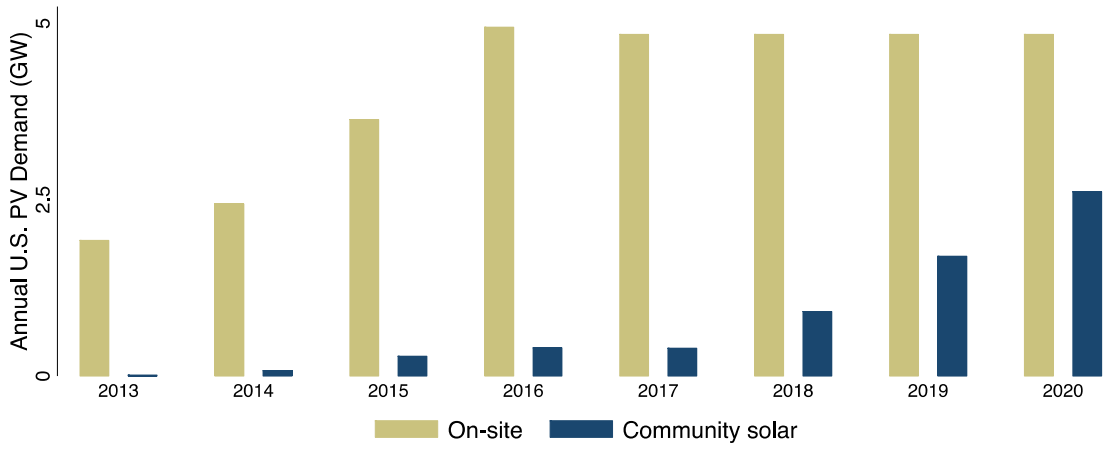

Figure 11. Projected U.S. PV demand from on-site and community solar through 2020

Source: Feldman et al. 2015

California, Massachusetts, and Minnesota are poised to significantly change the community solar landscape. As of 2014, about 11% of all community solar capacity was located in these three states, but the three states account for about 90% of planned community solar capacity (Honeyman et al. 2015). Figure 12 illustrates the changing landscape of community solar in terms of installed and projected capacity.

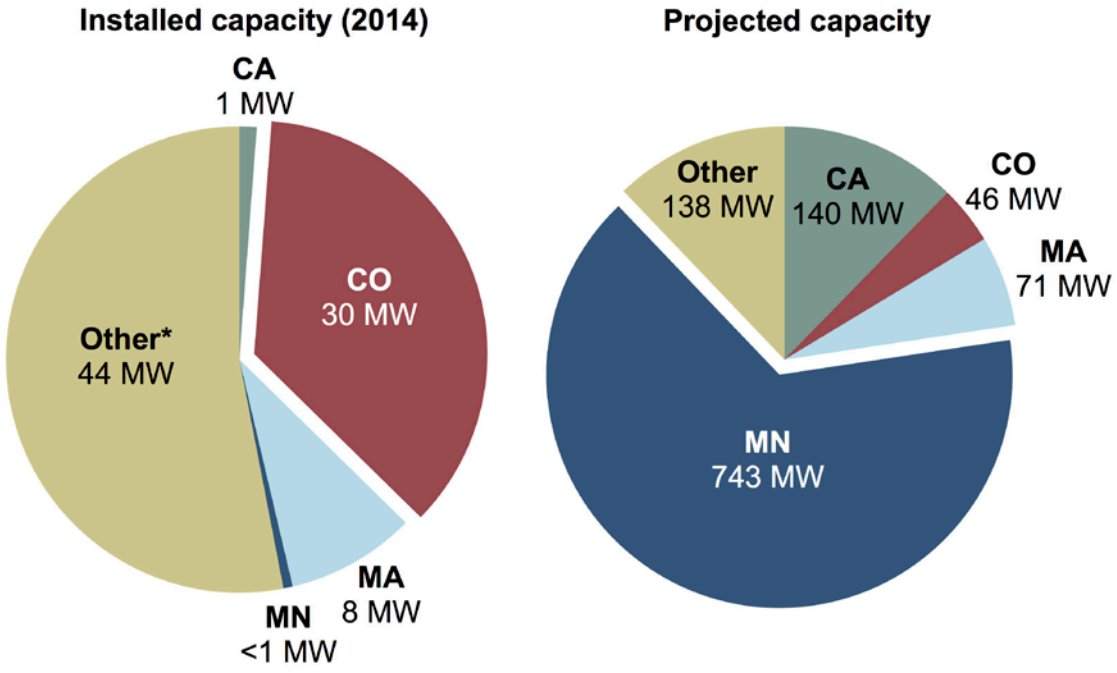

Figure 12. Installed and projected cumulative community solar capacity by state

Note: Projected capacity based on sum of installed and pipeline capacity data from Honeyman et al. 2015. * See Figure 10 for other states.

Developments in 2015 may affect projections of significant growth in community solar, particularly in Minnesota. Implementation of the state's community solar-enabling legislation has been delayed by Xcel's refusal to accept co-located projects that exceed a 1 MW cap stipulated by the legislation. A June 2015 agreement capped co-located project applications at 5 MW until September 2015, at which time Xcel will only accept co-located project applications up to 1 MW.

The significant anticipated capacity expansions in California, Massachusetts, and Minnesota will be supported by state-level community solar policies. California's Green Tariff Shared Renewables Program requires California's three IOUs to ensure sufficient community solar capacity to meet up to 600 MW of customer demand. Customers pay a premium over the retail electricity rate, estimated at $0.01 to $0.02/kWh, to participate. The program requires utilities to retire RECs on behalf of participating customers. Massachusetts' Green Communities Act enables the use of "neighborhood net metering credits" to compensate owners of neighborhood net metering facilities. The Act authorizes community solar subscriber compensation through neighborhood net metering credits at the full retail rate. Minnesota's Solar Energy Jobs Act requires Xcel Energy to purchase electricity from third party led community solar gardens of no greater than 1 MW of capacity.

4.3 Trends in Community Solar

Trends to date indicate that community solar is truly community scale. Community solar projects developed in 2014 generated on average about 1,600 MWh per project, or enough energy to meet the electricity demands of about 150 typical households.[12] In other words, community solar developers are implementing projects to meet the needs of relatively small communities of customers rather than developing large-scale projects capable of serving large numbers of customers.

The average community solar array size declined from 2.5 MW in 2011 and 1.3 MW in 2012 to 0.8 MW in 2014 (Figure 13). The 20 MW SRP Community Solar program in Arizona, which remains the only community solar program larger than 10 MW, drives the peak in 2011. The relative frequency of projects greater than 1 MW has not increased over time; rather, there were relatively fewer large projects in 2014 than in 2011 or 2012. Projects smaller than 1 MW outnumbered larger projects by more than a factor of two in 2014. An exemplary case study of the trend toward smaller projects is a 2015 announcement of a Community Solar Array (CSA) program in Vermont. The Vermont CSA program plans to develop 50 projects with a total of 13 MW of capacity and an average capacity of 200 kW per project.

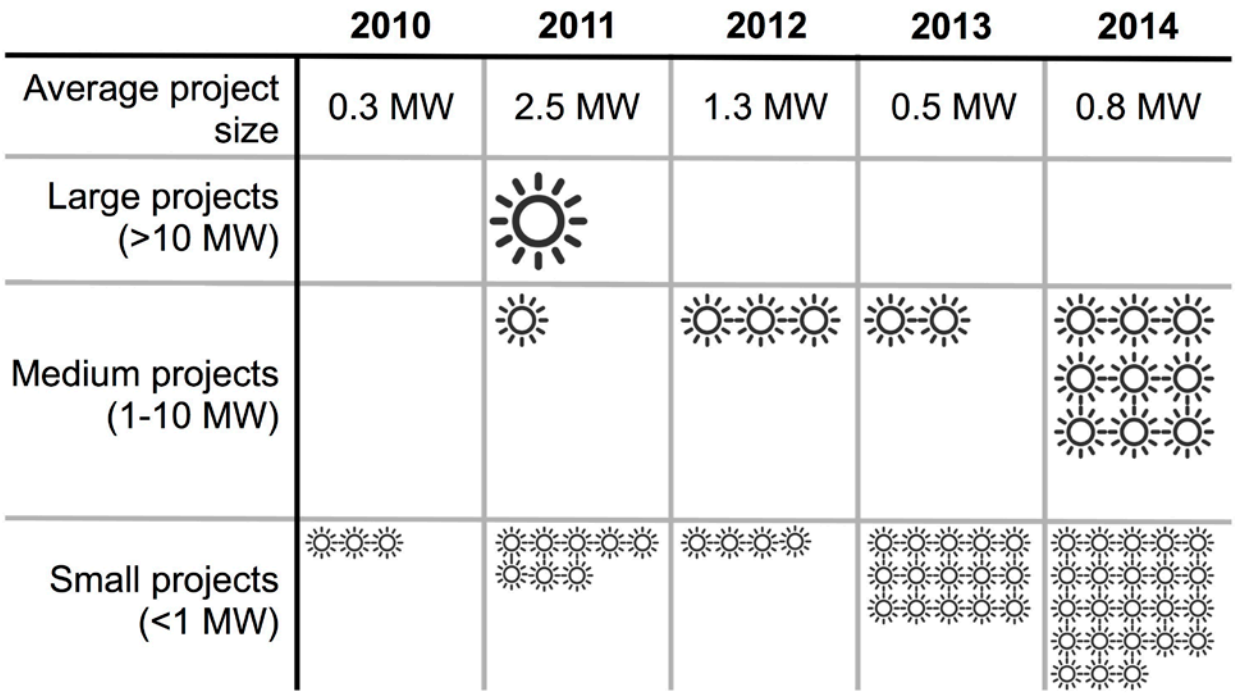

Figure 13. Schematic of community solar array size from 2010 to 2014

Note: Each sun icon represents a single community solar project.

[12] Output based on conversion of community solar capacity (kW) to output (kWh) using state-specific solar PV capacity factors from Lopez et al. (2012). Assumed typical annual household use of 10.908 MWh from EIA (2015b).

The trend toward smaller projects has several plausible explanations. First, some state-level community solar policies cap eligible system sizes. For example, the Colorado Community Solar Gardens Act caps eligible projects at 2 MW. Only six of the 37 projects in Colorado have been built within 0.5 MW of the program cap.[13] In contrast, in Arizona, where no community solar policy exists and thus no system size cap, three of the four community solar projects are larger than 1 MW. Second, community solar partners may prefer project development on brownfield or otherwise previously-developed sites with size constraints (see APA 2013). Third, community solar developers may have limited credit access in the early stages of this developing market. Credit committees may be wary of the complicated risk analyses required to evaluate a project with a mix of residential and commercial customers (Seligman 2015).

Strong demand is a second early trend in community solar markets. As of September 2015, 75 of 90 active community solar projects were sold out or fully "subscribed," representing over 70 MW of fully subscribed capacity. Large projects were no less likely to be fully subscribed than small projects, suggesting that the trend toward smaller projects is not due to insufficient demand. Strong demand is exhibited in every active community solar market, with fully subscribed capacity in 22 states (only Colorado, Kansas, and Kentucky had under-subscribed projects). Nine of the 15 under-subscribed projects were co-located in cities with other community solar projects.

[13] Includes two projects that exceeded program cap of 2 MW.

5 Community Choice Aggregation

CCA enables local governments to aggregate electricity demand and procure electricity from alternative suppliers. Local utilities remain responsible for transmission, distribution, and billing services. Table 10 summarizes the status of CCA markets in 2014.

Table 10. Status of CCAs in 2014

	Participation	Sales	Availability
2014	2,500,000 customers	7,700,000 MWh	7 states
Change from 2013	+4%	-5%	+1 state

Seven states allow CCAs and at least three other states have proposed legislation to enable CCAs (Figure 14). In 2015, New York became the seventh state to allow CCAs when the New York Public Service Commission approved a CCA pilot project for a consortium of 38 local governments.

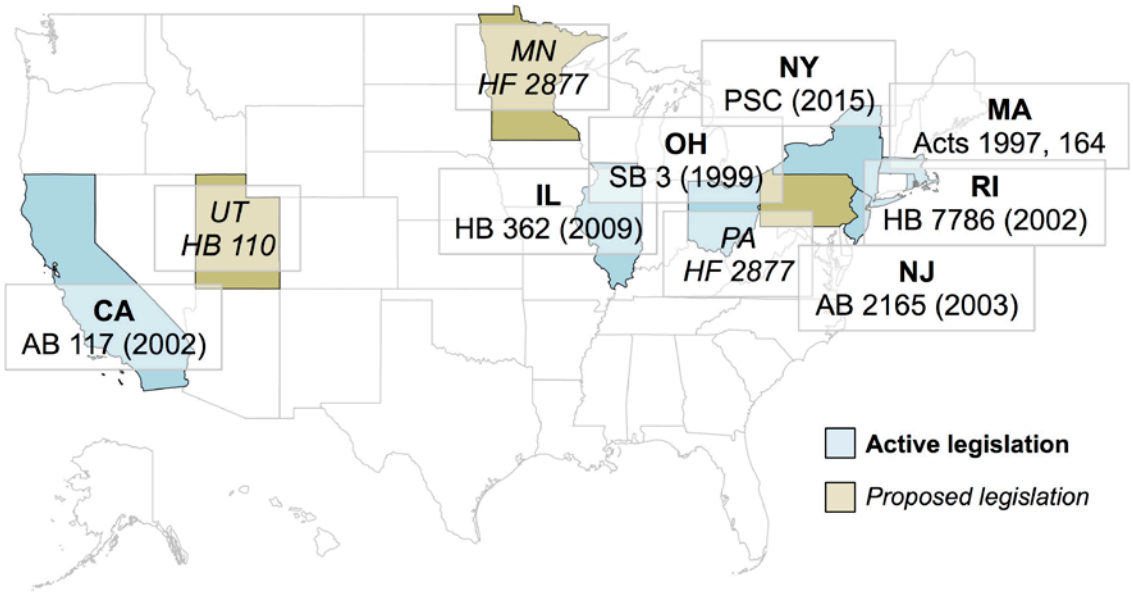

Figure 14. Active and proposed CCA legislation

Note: Year of legislation passage in parentheses

5.1 Renewable Energy in CCAs

Local governments can use CCAs to procure electricity from any source, including fossil fuels; however, our emphasis here is the use of CCAs for renewable energy procurement. For the purposes of this section, the term "renewable product" refers to an electricity mix with a renewable energy component exceeding the minimum requirements of a state's RPS. Local governments use CCAs to offer renewable products either by default (opt out) or by customer choice (opt in).

5.1.1 Default Renewable Products

CCAs can enroll their customers into a renewable product by default. Customers must actively opt out if choosing not to participate. Default renewable products are highly effective for renewable energy promotion due to the high participation rates of opt-out CCAs. Customer participation in CCAs is typically above 75% and exceeds 90% in several programs.[14] Participation rates may also tend to increase over time as customers become more familiar with aggregation (GE 2015). Nearly 90 communities in Illinois and several cities in Massachusetts and Ohio enroll customers into 100% renewable products by default.

5.1.2 Opt-in Renewable Products

Many CCAs offer customers the option to pay a premium to "opt in" to a renewable product. Opt-in renewable products typically consist of 50% to 100% renewable energy and can be offered in conjunction with a default product that has a lower amount of renewable energy. For example, the Cape Light Compact CCA in Cape Cod, Massachusetts offers the choice to opt in to a 100% renewable product rather than enrolling customers in the renewable product by default. Customer participation in opt-in renewable products is generally below 2%.

5.1.3 The Economics of CCA Renewable Products

Unlike other voluntary market products explored in this report, CCAs are not explicitly a renewable energy product. Potential cost savings for participants are typically the primary factor in the decision to aggregate (GE 2015). CCAs provide cost savings to participants through the margin between the CCA rate and the prevailing utility rate. High CCA margins due to high prevailing utility rates will generally result in more aggregation as communities justify CCA based on cost savings potential. In turn, low CCA margins due to low utility rates reduce the economic rationale for aggregation.

CCA renewable products are also sensitive to CCA margins. High CCA margins allow communities to re-direct a portion of electricity savings toward investment in renewable projects or REC purchases to offer participating customers a renewable product. Low CCA margins reduce disposable cost savings available for investment in renewable products (GE 2015). As a result, renewable products may be re-structured during contract renewal to reflect prevailing CCA margins. The relationship between aggregation decisions and prevailing CCA margins may result in a cyclical demand for renewable energy from CCAs. A dynamic of high demand for renewable energy products during high CCA margins and reduced demand in response to lower CCA margins is already evident in Illinois (see discussion in following section).

5.2 CCA Market Overview

Seven states allow CCAs; however, only four of these states have used CCAs in a significant capacity as a mechanism for voluntary green power: Illinois, California, Ohio, and Massachusetts (Table 11).

[14] Based on NREL survey data. Marin County and Cape Light Compact programs reported 75% participation rates. The City of Cincinnati and Sonoma County CCAs reported participation over 90%.

Table 11. CCA Renewable Energy Statistics by State[15]

State	Estimated 2014 renewable energy sales (MWh)	Participants in CCAs with RE products	CCAs with RE products
Illinois	5,200,000	2,100,000	>90 communities
California	1,300,000	287,434	Marin County Sonoma County
Ohio	950,000	121,406	City of Cincinnati City of Cleveland
Massachusetts	280,000	32,300	Cape Cod & Martha's Vineyard City of Lancaster City of Lowell

Illinois

The CCA landscape in Illinois has evolved rapidly since the passage of enabling legislation in 2009 and the implementation of the first CCAs in 2011. CCAs were active in 647 communities in Illinois in January 2014. Fifty-five communities aggregated in 2014 and 97 CCAs expired so that 605 CCAs remained active by the end of 2014 (ICC 2015). CCAs in Illinois are comprised primarily (about 85%) of residential customers (GE 2015).

About 27% of Illinois CCAs offered a renewable product in 2014, resulting in an estimated 5,200,000 MWh of renewable energy sales, down from about 6,400,000 MWh in 2013.[16] About 23% of new or renewed contracts in 2014 included a renewable product, including about 17% of contracts with a 100% renewable product by default. About 6% of new or renewed contracts offered an opt-in only renewable product.[17]

The economics of aggregation in Illinois depend on prevailing utility electric supply and transmission service charges, collectively referred to as the "price to compare." Relatively high prices to compare allowed aggregators to offer high CCA margins and fueled the initial expansion of aggregation in Illinois (LeanEnergy 2015). A total of 673 communities had submitted CCA referenda in the first three years following legislation, with 450 referenda in 2012 alone. More than 3 million residential customers, representing about 68% of residential electricity users in Illinois, had aggregated by January 2014. CCA residential electricity sales reached about 25,400,000 MWh in 2014, peaking at about 2,900,000 MWh/month in January

[15] Data sources – IL: Dynegy 2015, Englum et al. 2014, ICC 2015; CA: NREL survey; OH: NREL survey; MA: CGP 2015; NREL survey.
[16] The 2014 estimate is based on assumed participation rates, eligible customers, typical electricity use, and renewable energy content of CCAs. The 2013 estimate is revised from NREL's 2013 estimate of 7,800,000 MWh. The new 2013 estimate corrects for double-counting of city-level electricity sales within county-level electricity sales.
[17] Figures are based on data from the largest Illinois retail electric supplier, which represents approximately 47% of CCA programs.

2014 (see Figure 15).[18] However, falling prices to compare in recent years have reduced CCA margins and slowed the growth of CCAs (Pruitt 2014). One hundred seventeen CCAs, about 16% of Illinois CCAs, had expired without renewal as of June 2015. Customer participation fell to a two-year low of 60% in March 2015 (ICC 2015).

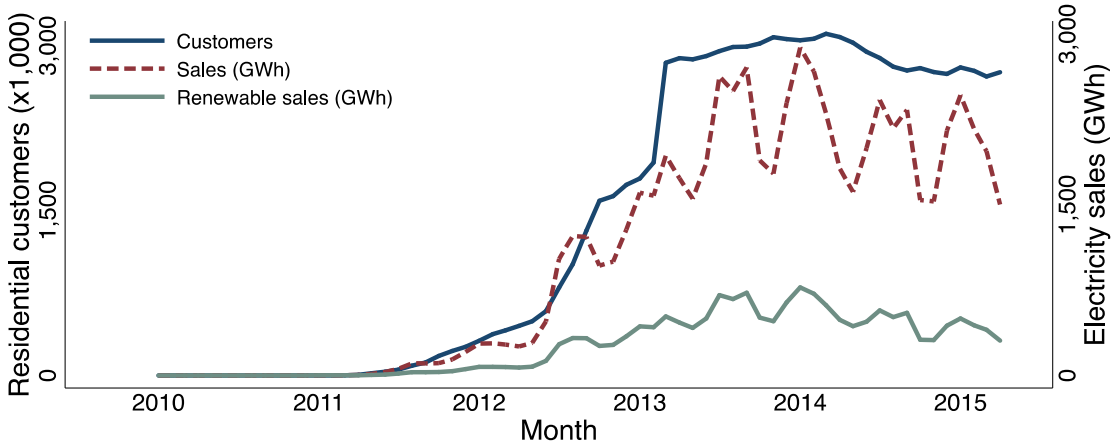

Figure 15. Number of customers and electricity sales (GWh) associated with Illinois CCAs by month from 01/2009-04/2015

Figures are NREL estimates based on ICC 2015.[19]

Illinois CCA renewable products have also fluctuated with the prevailing economics of aggregation in Illinois. From 2011 to 2013, high CCA margins allowed more than 90 communities to offer a renewable product (Englum et al. 2014). Many Illinois communities that negotiated renewable products have chosen to reduce or eliminate renewable products during contract renewal in response to lower CCA margins. In 2014, at least 35 of the state's 100% renewable CCAs discontinued their renewable products during contract renewal.[20] We estimate that these discontinued renewable products reduced CCA-based renewable energy consumption in Illinois by about 1,600,000 MWh/year. Additionally, nine programs reduced renewable products to 50%, and two programs reduced their products to 25% (Dynegy 2015).

Thirty-six CCAs elected to renew renewable products in 2014 despite lower CCA margins. CCAs that chose to renew renewable products under tighter margins were typically communities that used renewable products to achieve broader community sustainability goals (GE 2015). Such mission-based renewable products represent a more stable source of voluntary renewable power demand than renewable products that fluctuate with CCA margins.

Prices to compare for Illinois' second largest utility began to rise again in 2015. The mean price to compare from the utility's three zones increased from $0.0456/kWh in May 2015 to $0.0595/kWh in July 2015 (ICC 2015). It remains to be seen whether the renewable energy

[18] Residential customers comprise about 85% of Illinois CCAs. Small businesses that use less than 15 MWh/year are also eligible for CCAs. However, the majority of businesses that choose to switch to an alternative electric supplier do so through a private contract rather than through a CCA (Good Energy 2015).
[19] NREL estimated residential sales to CCAs based on difference between pre-2011 baseline sales from alternative electric suppliers and post-CCA implementation sales. Renewable energy sales based on renewable energy content of CCAs over time, incorporating expired renewable energy contracts in 2014.
[20] NREL estimate based on renewable energy content in renewed contracts reported by CCA providers in Illinois.

content of Illinois CCAs will rebound with higher prices to compare and more competitive CCA rates.

California

Two CCAs in California collectively sold about 1,300,000 MWh of renewable energy in 2014.

The Marin Clean Energy (MCE) CCA in Marin County sold about 720,000 MWh of renewable energy to 125,310 customers in 2014. MCE's default renewable product was 54% renewable energy and an opt-in 100% renewable product. MCE will also offer a 100% local solar product beginning in Spring, 2016, which is already about 50% subscribed. In 2014 MCE's renewable energy supply consisted of a mix of local suppliers (26%) and unbundled RECs (28%), but in 2015 unbundled RECs dropped to 15% as three large California-based projects became operational. In 2014, the MCE CCA added unincorporated Napa Valley, and in 2015 added three cities outside Marin County to its service area, growing by about 45,000 customers.

The Sonoma Clean Power (SCP) CCA in Sonoma County sold about 580,000 MWh of renewable energy to 162,214 customers in 2014. SCP offers a "CleanStart" default renewable product of 33% renewable energy, and an "EverGreen" opt-in renewable product of 100% renewable energy. SCP's default renewable product consists mostly of hydro-electric power and wind while the EverGreen product is sourced entirely from geothermal power. In 2014, SCP grew to include all eligible cities in Sonoma County with the incorporation of Petaluma in December. SCP offers a net metering program for its customers with distributed generation (DG) systems. Under the program, SCP allows customers to feed excess DG electricity into the grid and receive net metering credits. SCP's net metering credits are in the amount of the full retail rate plus an additional incentive of $0.01/kWh. SCP net metering credits may only be used to offset SCP charges. SCP customers retain the RECS from net metered electricity.

In 2015, the City of Lancaster implemented California's third CCA. The Lancaster Choice Energy (LCE) CCA offers a default renewable product of 35% and a "Smart Choice" opt-in product of 100% renewable energy. LCE plans to obtain its entire renewable energy portfolio through local resources, including customer-owned solar and local wind. The program began a limited enrollment with 850 accounts in May 2015, and will begin mass enrollment in October 2015.

Several California communities are in the planning stages of CCAs. The CleanPowerSF CCA in San Francisco would provide a default renewable product and a 100% renewable opt-in product. Political opposition has delayed the implementation of CleanPowerSF; however, the City of San Francisco released a Request for Offer for Power Supplies in August 2015, calling for renewable energy resources with delivery no later than March 1, 2016. The South Bay Clean Power initiative is targeting 16 cities in Los Angeles County for aggregation. The estimated potential electric sales of the proposed CCA is nearly 4,000,000 MWh to over 800,000 residents. Similarly, the Monterey Bay Community Power initiative is working with over 20 municipalities to develop a CCA in the Monterey Bay Area. Other municipalities exploring CCAs include Alameda County, the City of San Diego, the City of San Luis Obispo, San Mateo County, and the City of Santa Monica.

Ohio

The Cities of Cincinnati and Cleveland are the largest cities to enroll electric customers into 100% renewable products by default. The City of Cincinnati CCA served about 64,000 customers in 2014 with a participation rate of over 90%, selling about 470,000 MWh of renewable energy. The City of Cleveland CCA served about 57,000 accounts with a participation rate of 85%, selling about 480,000 MWh of renewable energy in 2014. Both CCAs' renewable portfolios are comprised entirely of unbundled REC purchases.

Massachusetts

Three Massachusetts CCAs offered renewable products in 2014. The Cape Light Compact serves about 138,000 customers in 21 cities on Cape Code and Martha's Vineyard, selling about 5,600 MWh of renewable energy in 2014. The Cape Light Compact does not offer a default renewable product (the base product is compliant with the state RPS). About 950 Cape Light Compact customers (less than 1%) opted into 50% and 100% renewable products. The Cities of Lowell and Lancaster administer CCAs with 100% renewable default products. The City of Lowell CCA sold about 250,000 MWh to 29,500 customers in 2014. The City of Lancaster CCA sold about 21,400 MWh to 1,850 customers. Nine communities in western Massachusetts aggregated in November, 2014 with 100% renewable default products (CPG 2015) (Figure 16).

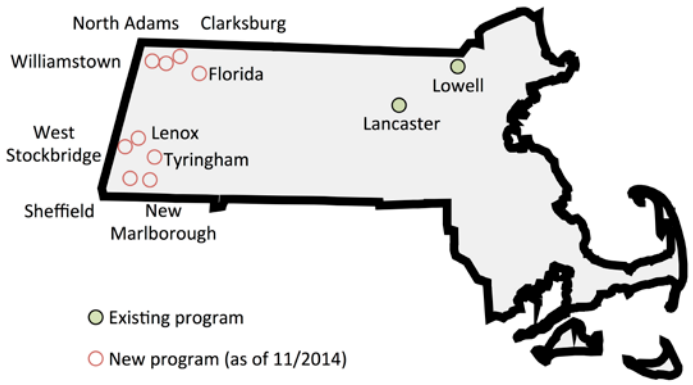

Figure 16. The changing CCA landscape in Massachusetts

Displays CCAs with 100% renewable products

6 Voluntary Power Purchase Agreements

PPAs represent a mechanism for purchasing energy in which a seller (or generator) and a purchaser (or off taker) enter into a contract for the sale of electricity and in some cases RECs. Two primary benefits for off takers entering into a PPA are to: 1) incorporate renewable generation into their energy mix and 2) set a known price for their electricity consumption from the source for a predetermined period of time. For the purposes of this report, a "voluntary PPA" is an agreement in which a non-utility, non-residential off taker makes a voluntary green power purchase through a PPA. Table 12 summarizes the status of the voluntary PPA market in 2014.

Table 12. Status of Voluntary PPAs in 2014

	Participation	Sales
2014	295 customers	6,700,000 MWh
Change from 2013	**+15%**	**+14%**

Large institutions, particularly in the information and communication technology (ICT), government, and education sectors, are increasingly signing long-term voluntary PPAs. In the summer of 2015 alone, HP, Washington D.C, Amazon Web Services, Facebook, and Google announced voluntary PPAs. ICT companies are setting renewable energy and/or carbon reduction goals and using long-term procurement as a strategy to accelerate new renewable project development (Miller et al. 2015).

Large corporate voluntary PPAs are part of a larger trend of corporate interest in new purchasing options. Forty-three corporations, representing 30 million MWh of renewable demand, have signed on to the Renewable Energy Buyers' Principles. The Buyers' Principles outline six principles that corporations who are looking to procure more renewable energy follow (greater choice in procurement options; more access to cost-competitive options; long term, fixed-price contracts; access to new projects that reduce emissions beyond business as usual; streamlined third party financing; and increasing purchasing options in collaboration with utilities and regulators).

To study the voluntary PPA market we used data from the Bloomberg New Energy Finance (BNEF) US Corporate PPA Project Database from July 7th, 2015. We excluded nine PPAs where the RECs would be used to meet RPS.[21] We excluded 19 PPAs signed before January 1, 2005 to avoid including outdated data. We also excluded 27 PPAs signed after December 31, 2014 to avoid including incomplete data from PPAs signed in 2015. For the purposes of this report, which seeks to identify the voluntary PPA market, we exclude on-site renewable systems. According to our data set, voluntary PPAs have been signed in 39 states.[22] Of these states, six

[21] Our results may overestimate voluntary PPAs because contract details and information on the treatment of RECs is largely unavailable. While we do include PPAs procured by federal agencies as voluntary, it is important to consider that these projects may be developed to comply with Executive Order 13693, which requires federal agencies to procure 25% of their energy from renewable resources by the year 2025 (Executive Order No. 13693, 2015).

[22] BNEF defines a Corporate PPA off taker as a non-utility entity. Typically, these are private for-profit companies, but can also include schools, universities, and other non-traditional off takers.

have over 160 MW of capacity installed to serve voluntary PPAs: Texas, Iowa, California, Oklahoma, New York, and New Jersey (Figure 17).

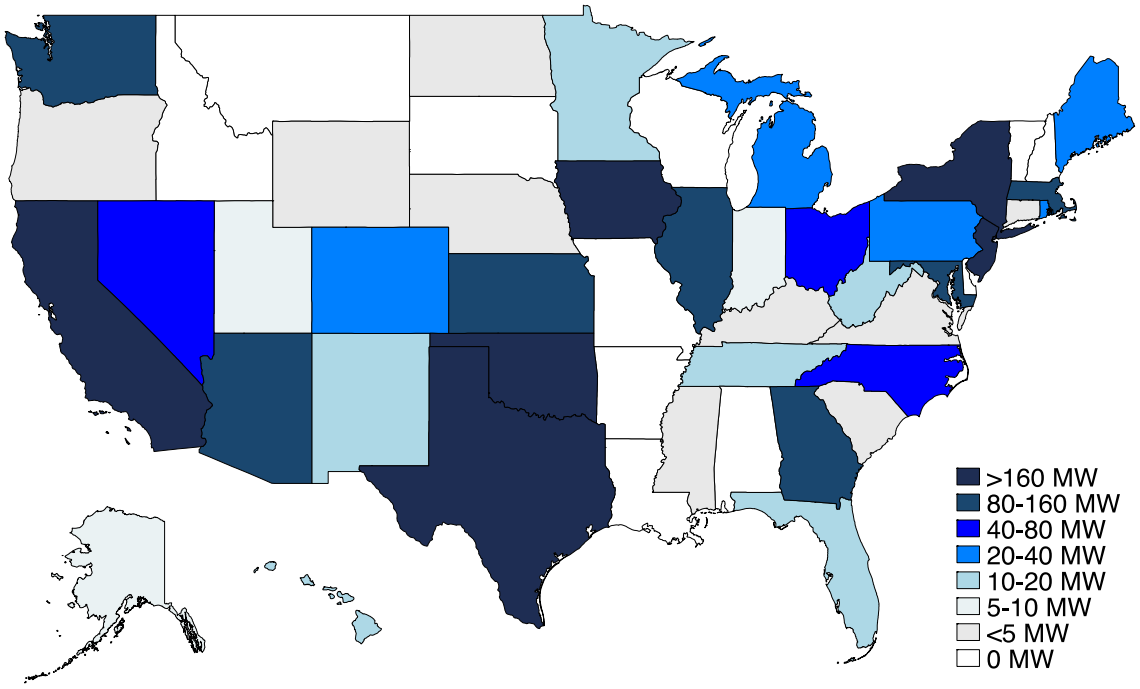

Figure 17. Cumulative voluntary PPA capacity (MW) by state

Data from BNEF (2015)

Both California and New Jersey have trended towards a higher volume of smaller voluntary PPAs rather than a lower volume of large PPAs. These two states have an average capacity of less than 4 MW, while the other four states topping the list have considerably larger average capacity (Table 13).

Table 13. States with Most Voluntary PPA Capacity (MW)

State	Number of PPAs	PPA Capacity (MW)	Average System Size (MW)
Texas	19	1,005	53
Iowa	6	659	110
California	129	483	4
Oklahoma	4	257	64
New York	13	255	20
New Jersey	77	233	3

The average system size in these states is likely driven by the technology type being deployed. Figure 18 demonstrates that the states with larger average systems size all have large wind PPAs, while the states with smaller average PPAs primarily consist of small-scale solar PPAs.

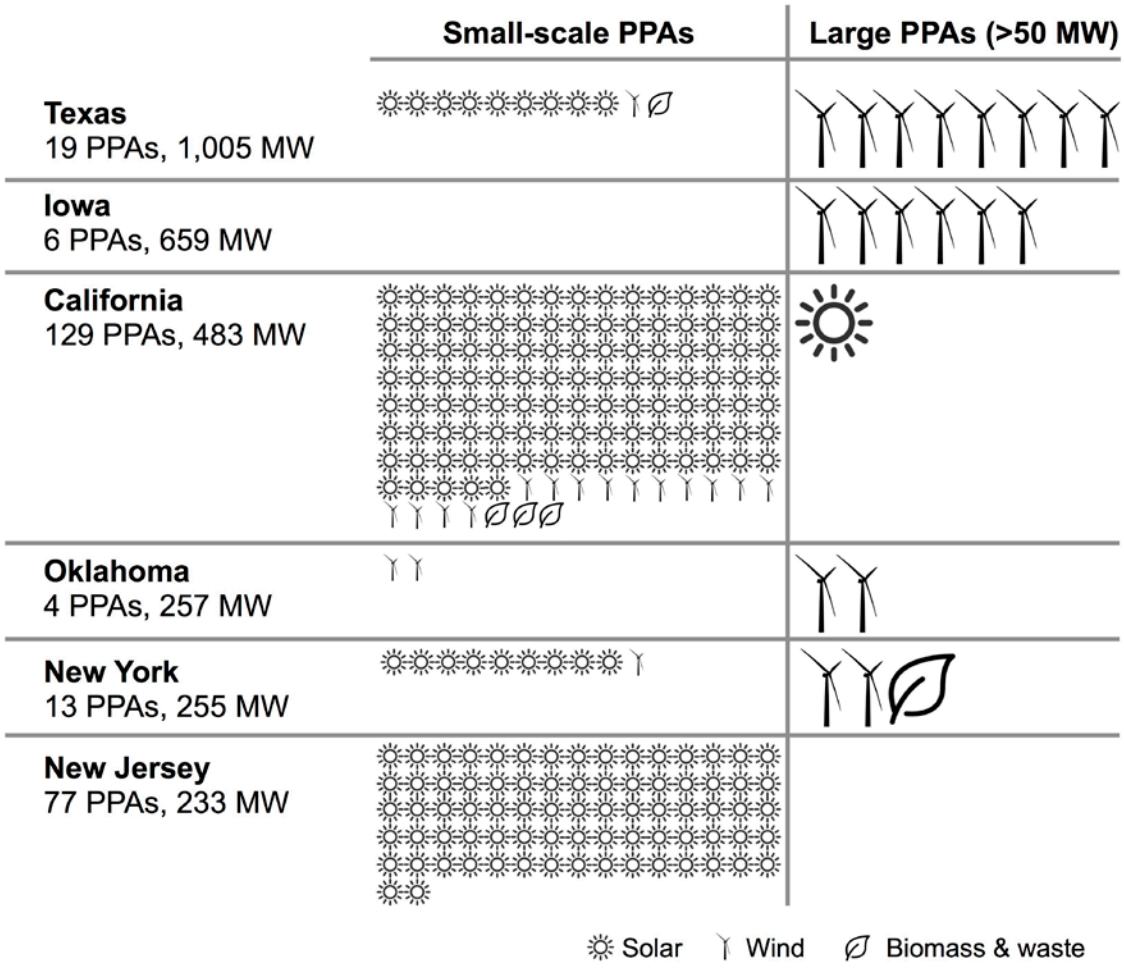

Figure 18. States with most voluntary PPA capacity (MW) by technology[23]

Data from BNEF (2015)

This trend of increasing average voluntary PPA capacity is not unique to the top procuring states. The average capacity of voluntary PPAs across the United States has taken off since 2012, mostly driven by a few very large projects (Figure 19).

[23] Figure excludes one PPA signed in 2012 in California that hasn't confirmed operational capacity.

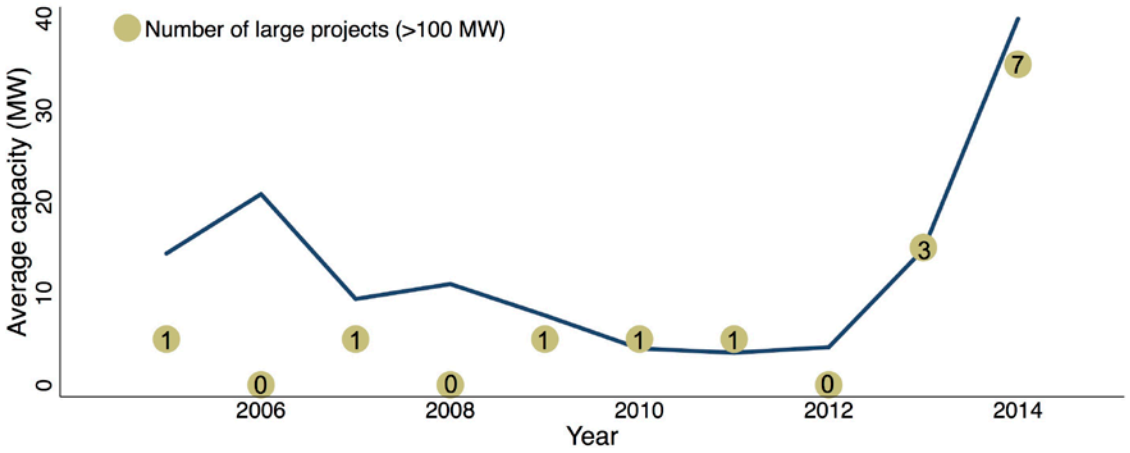

Figure 19. Average capacity (MW) and number of large projects (>100 MW) of voluntary PPAs

Data from BNEF (2015)

Voluntary PPAs are being procured across a range of sectors. While there has been relatively little movement in voluntary PPAs signed by government and educational institutions, there has been a significant uptick in private-entity voluntary PPAs (commercial and technology sectors) in recent years (Figure 20).

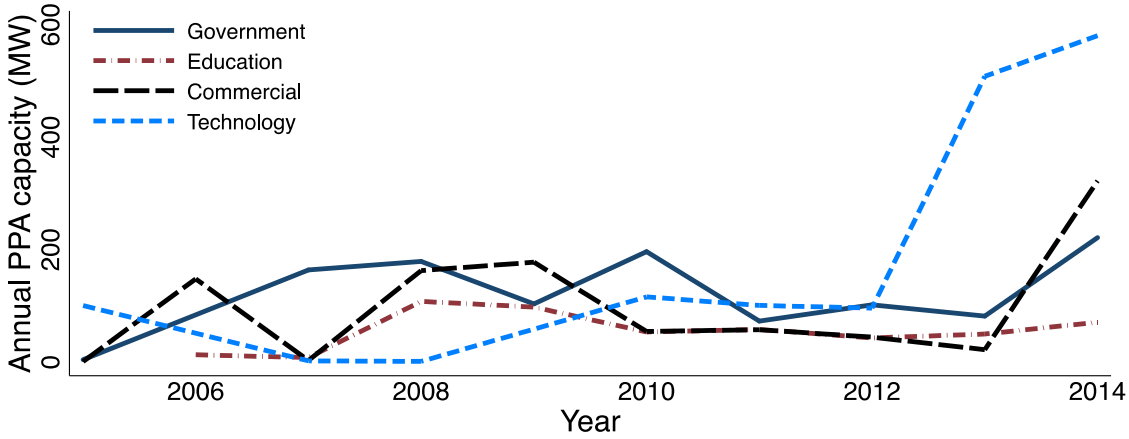

Figure 20. Annual capacity of new voluntary PPAs (MW) by sector

Data from BNEF (2015)

In 2007, government and education accounted for about 97% of new voluntary PPAs by capacity that, but only accounted for 24% of voluntary PPA capacity by 2014. At the same time, the technology industry grew from about 1% in 2007 to about 48% in 2014. The technology industry signed five voluntary PPAs over 100 MW in 2014; in four of these projects the off taker was Google. This trend continues in 2015 with two contracts being procured at over 150 MW each.

The commercial sector includes industry sectors such as retail, food and beverage, and finance and insurance. The spike in recent years in this sector is largely driven by two large PPAs, a 201 MW contract by Mars Inc., and a 116 MW contract by WalMart, both in 2014.

Some sectors are procuring larger voluntary PPAs, on average, than others (Figure 21). For example, the tech industry has, by far, the largest average procurement size, at nearly 80 MW, compared to about 6 MW for all other sectors. In terms of the number of PPAs (rather than capacity), government entities (federal, state, and local) account for 30% of voluntary PPAs while education institutions account for 26%.

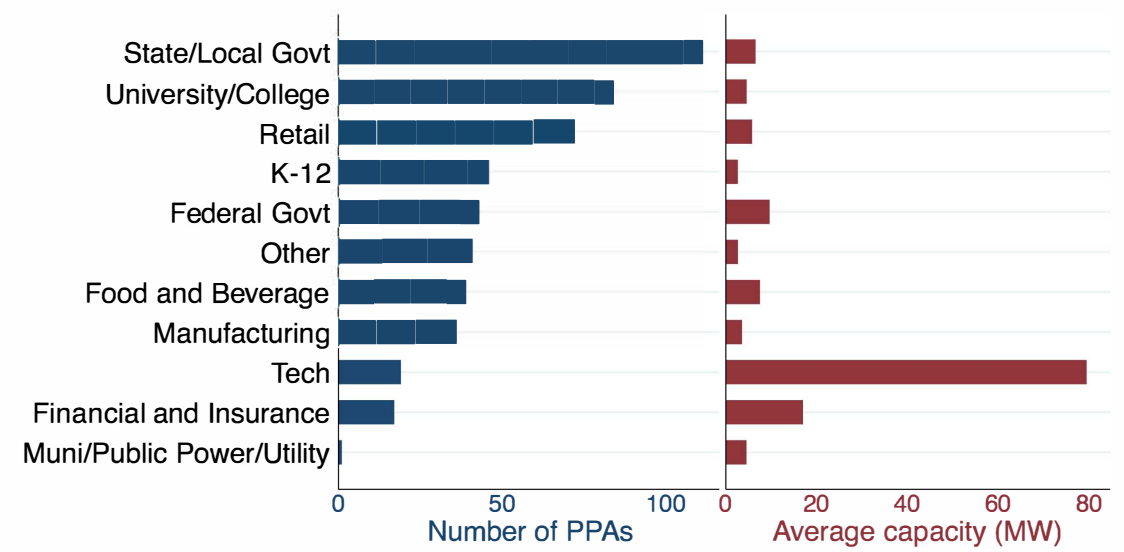

Figure 21. Number of voluntary PPAs and average capacity of voluntary PPAs (MW) by industry sector

Data from BNEF (2015)

7 Assessing Voluntary Green Power Options

The addition of new voluntary green power purchasing options has increased the complexity of green power supply and demand decision making. Customers wanting to buy renewable energy now have multiple options, each with their own set of costs and benefits. Likewise, policymakers and utilities now have a suite of options available to offer green power options to their constituents and customers.

For the first time in NREL's *Status and Trends* annual series, we compare green power market options from customer, policymaker, and utility perspectives. A comparison of green power options will allow customers to make more informed decisions, and allow utilities and policymakers to draft and implement green power programs and policies to achieve specific goals according to the relative benefits of the options. Table 14 summarizes the content of this section with the pros and cons of green power options from consumer and policymaker/utility perspectives.

Table 14. Assessment of Green Power Options

	Customer perspective	Policymaker/utility perspective
Utility green pricing	+ Widely available - Customers pay a premium over retail electricity rate	+ Expand renewable energy access to a large number of eligible customers - Low participation rates
Competitive suppliers	+ Widely available in re-structured markets - Customers pay a premium for green power option, premium varies over time with wholesale prices	+ All customers within a re-structured market are eligible to switch electricity service providers - Low participation rates
Community solar	+ Costs are competitive with solar system ownership - Subscribers do not necessarily own RECs	+ High participation rates - Relatively small projects mean low renewable energy output
CCAs	+ CCA rates can be competitive with retail electricity rates - Only allowed in seven states	+ High participation rates - Eligible customers limited by the size of the community
Voluntary PPAs	+ Customers benefit from cost stability of long-term fixed price - Rate can be higher than retail	+ Large projects result in significant new renewable energy capacity - Generally limited to non-residential customers

7.1 Green Power Options: a Customer Perspective

Electricity customers demand green power primarily for its environmental attributes (NMI 2011). In theory, green power customers should seek green power products with desirable environmental attributes at the lowest possible cost. We model green power customer decisions through three questions:

1. What green power options are available?
2. What are the environmental attributes of the available options?
3. What are the payment mechanisms and costs of the available options?

7.1.1 Availability

A 2011 study found that only one in six customers were aware of available green power options, despite the fact that about 50% of customers were able to buy some form of green product directly from their retail provider (NMI 2011). An improved customer understanding of green power product availability is a first step toward more informed green power purchasing.

Electricity customers in the majority of states have access to at least three green power options: utility green pricing, unbundled RECs, and voluntary PPAs. Utility green pricing programs are active in 40 states, with service areas comprising about 36 million ratepayers. The purchase of unbundled RECs is a green power option available to electricity customers in all states. Commercial customers have signed voluntary bi-lateral PPAs in 40 states.

State-level policies enable or limit customer access to some green power options. Competitive suppliers of green power are only active in 15 states with re-structured retail electricity markets. Enabling legislation is required for communities to aggregate into CCAs. Community solar policies, while not a prerequisite for project implementation, have been an important support for strong community solar markets. Figure 22 illustrates green power market enabling legislation by state.

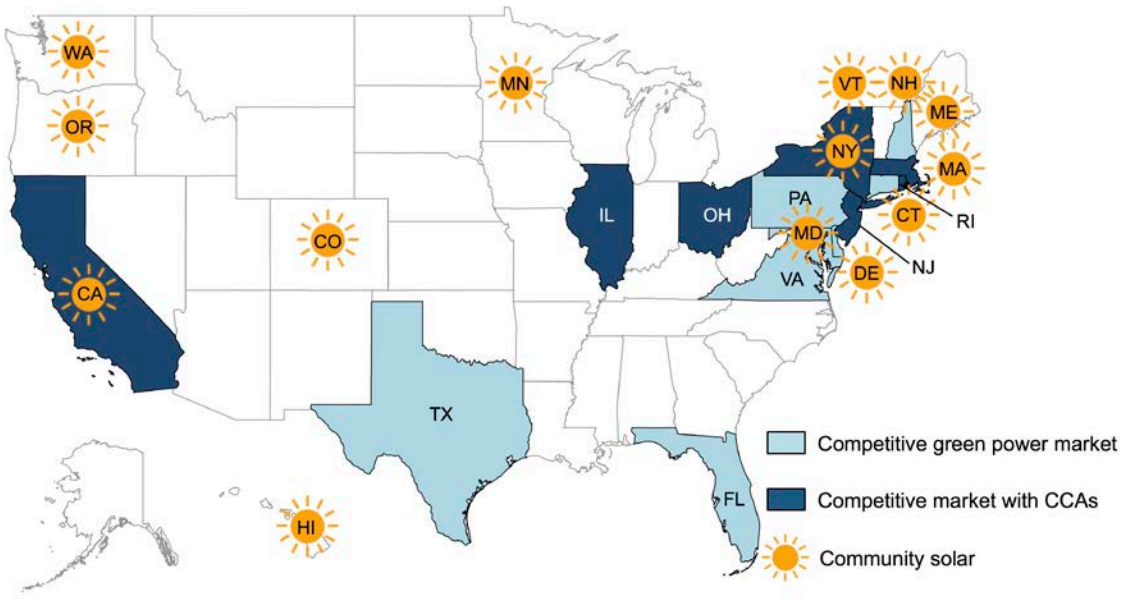

Figure 22. Green power-enabling legislation by state

7.1.2 Environmental Attributes

The environmental attributes of green power are embodied in RECs. In order to make a claim to the environmental attributes of renewable energy, or simply a "green claim," customers need to either own the RECs or have the RECs retired on their behalf, for example, by their utility. The transfer of RECs, not the transfer of energy, is the defining characteristic of a green power purchase. For example, a customer may purchase unbundled RECs and make a green claim without procuring any electricity. In contrast, a community solar customer that purchases the output of a community solar array but does not own the RECs cannot make a green claim. The latter example is not a voluntary green power purchase.

Some green power customers may have more specific preferences about the environmental attributes of their purchase. Some green power customers, especially commercial customers and large corporations, demand products that are sourced from new renewable energy facilities. For example, Google's "Green PPA" policy supports the development of new construction of renewable generation and has resulted in the construction of several large new renewable facilities (see Section 6). Customers may also demand renewable energy from local products. For example, the Lancaster Clean Energy CCA plans to develop 185 MW of local utility-scale renewable energy resources to provide its base default renewable product, and source other renewable energy from local distributed generation.

7.1.3 Green Power Costs

Green power customer decision making is sensitive to the prices of green power options (NMI 2011). Price-sensitive green power customers would benefit from a basic framework to compare green power products based on the payment mechanisms and costs of available options.

The majority of green power customers purchase green power output (e.g., kWh), although community solar allows customers to purchase green power capacity (e.g., kW). The economics of output-based products depend on a comparison of green power rates (e.g., $/kWh) as well as

an assessment of expected future rates. Utility green pricing programs, most competitive suppliers, and some CCAs recoup REC procurement costs through price premiums above the retail electricity rate. Some CCAs use the margin between aggregated electricity rates and utility rates to offer renewable products at no net cost relative to prevailing utility rates (GE 2015). Green power customers may also evaluate how different green power options provide future cost stability. PPA and CCA contracts lock customers into a long-term fixed rate that can reduce price volatility relative to fluctuating retail electricity rates.

7.1.4 Summary: the Customer Perspective

Table 15 provides a simplified evaluation of the availability, environmental attributes, and costs of the green power options studied in this report. In general, no single green power option emerges as clearly preferred for all green power customers. Ultimately, green power customer decision-making will depend on the options available in a given state and the customer's preference for the environmental and cost characteristics of the various green power alternatives.

Table 15. Evaluation of how well Green Power Market Options Achieve Green and Economic Objectives from a Customer Perspective

	Availability	Environmental attributes	Green power costs
Utility green pricing	40 states	RECs retired on behalf of customers. RECs are generally sourced from existing projects, although green pricing programs have supported development of new renewable generation.	Customers pay a premium above retail electricity rate, typically around $0.02/kWh. Some programs exempt customers from fuel charges.
Competitive suppliers	15 states (re-structured markets only)	RECs retired on behalf of customers. RECs are generally sourced from a mix of existing and new renewable sources.	Customers pay a premium above the competitive supplier's normal rate.
Community solar	25 states	State-level community solar policies determine the treatment of RECs. Not all community solar subscribers can make a green claim.	Subscribers generally make an up-front payment for capacity ($1.60/W-$5.60/W), in some projects subscribers may also pay on an ongoing basis (e.g., $/kWh, $/month).
CCA with renewable product	7 states (enabling policy required)	RECs retired on behalf of customers. RECs are generally sourced from existing projects, but some CCAs have sourced from new and local projects.	Aggregators offer customers rates competitive with prevailing utility rates. Some communities choose to invest savings in renewable energy products at no net cost relative to utility service.
Bi-lateral PPAs	All states	Customer exercises control over RECs. Customer can invest in new and local projects.	Customers negotiate a long-term fixed rate.

7.2 Green Power Options: a Policymaker and Utility Perspective

Policymakers and utilities use voluntary green power market supporting policies, or simply "green power policies," to achieve a variety of policy objectives. To some extent these objectives align; for simplicity, we will therefore refer to both groups collectively as "policymakers." Policymakers would therefore benefit from a framework to evaluate multiple green power policies. We develop three criteria to assess green power options from a policymaker perspective: new renewable capacity, the size of the eligible customer base, and customer participation rates (participating customers/eligible customers).

New Renewable Capacity

Most green power sales are sourced from new renewable resources developed to meet voluntary green power demand, due in part to certification programs such as Green-e Energy. The potential quantity of new renewable capacity developed under various green power policies varies significantly. For example, several private parties signed bi-lateral PPAs to develop projects with over 100 MW of new capacity in 2014. In contrast, most community solar projects are less than 1 MW in capacity.

Eligible Customer base

The majority of U.S. electricity customers support renewable energy and are ostensibly willing to invest in green power (NMI 2011). Green power products with larger numbers of eligible customers therefore have greater renewable energy output potential. Similar to potential capacity, the size of the eligible customer base varies significantly across green power products. For example, utility green pricing programs are open to all customers within a utility's service area, typically over 400,000 customers. Community solar projects, in contrast, usually serve about 200 customers (Campbell et al. 2014).

Participation Rates

Low portions of eligible customers generally participate in green power markets. Participation rates in utility green pricing programs and competitive green power markets have historically been below 5%. The recent emergence of CCAs with renewable energy products has illustrated the potential of higher participation rates to increase renewable energy sales. Figure 23 illustrates the relationship between participation rates and renewable energy output per eligible customer in utility green pricing programs and CCAs.

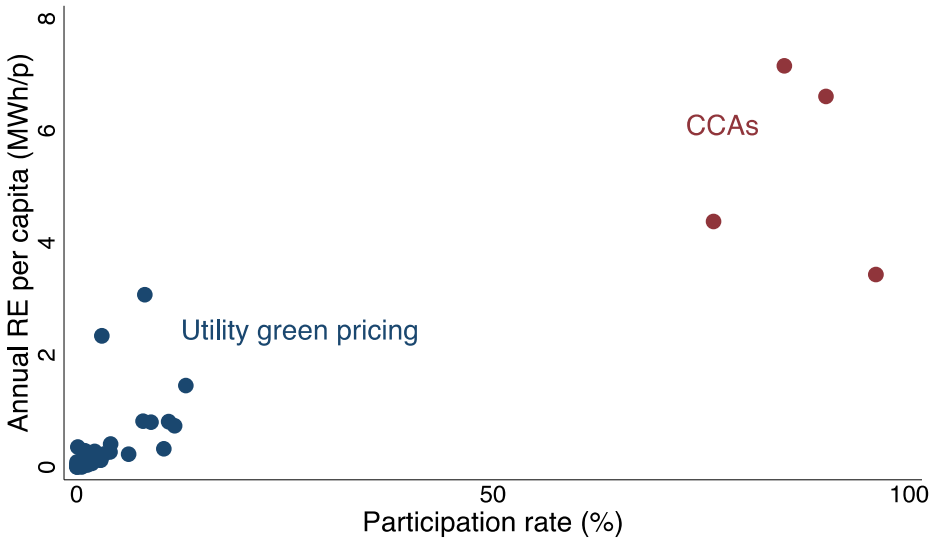

Figure 23. Renewable energy per capita (MWh/eligible customer) per participation rate for utility green pricing programs and CCAs

In Figure 23, we see that opt-out CCAs with relatively high participation rates achieve far greater renewable energy output per eligible customer. The City of Cleveland CCA, with a participation rate of 85%, resulted in about 7.2 MWh of renewable energy per eligible customer.

These results have two policy implications. First, policymakers may effectively increase the renewable energy output of green power policies through mechanisms to increase participation rates. Based on our data, a 10 percentage point increase in participation rate results in a 0.6 MWh increase in renewable energy output per eligible customer, or about a 120,000 MWh increase in renewable energy output for a medium-sized program of 200,000 customers. Second, the results suggest that policies to support CCAs may be more effective in terms of renewable energy output than policies for green pricing programs. Indeed, CCA-enabling legislation in Illinois has been arguably the most effective state-level green power policy to date, enabling the majority of residents in over 90 Illinois communities to consume 100% renewable energy.

Summary

Table 16 summarizes our assessment of green power options from a policymaker perspective. Similar to green power customers, policymakers may have other considerations beyond increasing renewable energy sales in green power markets. Policymakers may prefer a specific mix of renewable energy that takes advantage of local resources. Policymakers may also seek to improve renewable energy access to underserved communities (e.g., low income). The results of Table 16 should serve as a basic guide for informed decision making, but every policy decision should account for the specific goals of the policymaker.

Table 16. Summary of Green Power Policies from a Policymaker's Perspective

	Renewable energy capacity potential	Eligible customer base	Participation rates
Utility green pricing	**High** About 95% of utility green pricing sales are sourced from new capacity.	**Large** In general, all customers within a utility service area are eligible for participation.	**Low** Green pricing program participation rates are generally lower than 5%.
Competitive suppliers	**Medium** About 75% of competitive marketer green power sales are sourced from new capacity.	**Large** All customers in competitive markets are eligible to switch their electricity service provider to a competitive green power marketer.	**Low** In general, less than 5% of eligible customers participate in competitive green power markets.
Community solar	**Low** To date, output from community solar projects has been relatively small in comparison with other green power markets.	**Low** The relatively small size of most community solar arrays entails relatively small eligible customer bases, generally less than 300 customers per project.	**High** Most community solar projects are fully subscribed.
CCA with renewable product	**Medium** Most renewable energy sales to CCAs are sourced from existing projects, though some CCAs, especially in California, have developed new capacity.	**Medium** Most CCAs to date are relatively small communities, though several large cities have aggregated.	**High** Participation rates in opt-out CCAs typically exceed 75%.
Bi-lateral PPAs	**High** Renewable energy capacity development through bi-lateral PPAs has increased in recent years due to trends toward large new projects (e.g., >100 MW).	**Low** In general, only non-residential customers pursue bi-lateral PPAs.	**Low** The frequency of bi-lateral PPAs varies by state, but is generally less than 5 projects per year.

8 Conclusions and Observations

The voluntary green power market continued to expand in 2014 in terms of sales, customers, and the types of purchasing options available. Overall, the market expanded to 74 million MWh in 2014. Although unbundled REC sales continued to dominate the market in 2014, emerging options are expanding.

- Voluntary PPAs are becoming cost competitive and market players have gained more experience in these types of transactions. We estimate the green power sales from voluntary PPAs in 2014 at 6.7 million MWh, on par with sales by utility green pricing programs and CCAs.
- CCAs, though declining on a total sales basis due to transitions in the Illinois market are expanding in California and Massachusetts. We estimate renewable sales from CCAs at 7.7 million MWh.
- Community solar options were available in 25 states as of September 2015, representing over 80 MW of capacity, or about 0.15 million MWh. Importantly, not all community solar subscribers keep the RECs associated with their share's production.
- Traditional green power segments of utility green pricing, competitive suppliers, and unbundled RECs saw varying growth rates, with the largest growth seen in the unbundled REC market. Utility green pricing programs had nearly flat sales growth over all, though many large programs did see growth on the order of 5%-15%. Although there are now five utilities offering green tariffs for large consumers, so far uptake has been slow. However, contracts under these new tariffs have large potential; the project approved in Nevada for Apple was for 20 MW of solar, which is equivalent to a quarter of the community solar market.

Large corporate interest in new purchasing options has been increasing. 43 corporations, representing 30 million MWh of renewable demand, have signed on to the Renewable Energy Buyers' Principles. The Buyers' Principles outline six principles that corporations who are looking to procure more renewable energy follow (greater choice in procurement options; more access to cost-competitive options; long term, fixed-price contracts; access to new projects that reduce emissions beyond business as usual; streamlined third party financing; and increasing purchasing options in collaboration with utilities and regulators).

For the first time in NREL's *Status and Trends* annual series, we provide an assessment of green power options from customer and policymaker/utility perspectives. Each option has benefits and tradeoffs from both perspectives. Policymakers and utilities could consider revising existing options and/or enabling new purchasing options to meet the growing demand of voluntary consumers.

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