5 Competitive Suppliers

In states with restructured electricity markets,[6] retail electricity customers can choose to buy electricity from a number of providers known as competitive suppliers (Figure 14). Many customers choose to switch to competitive suppliers that offer green power products.

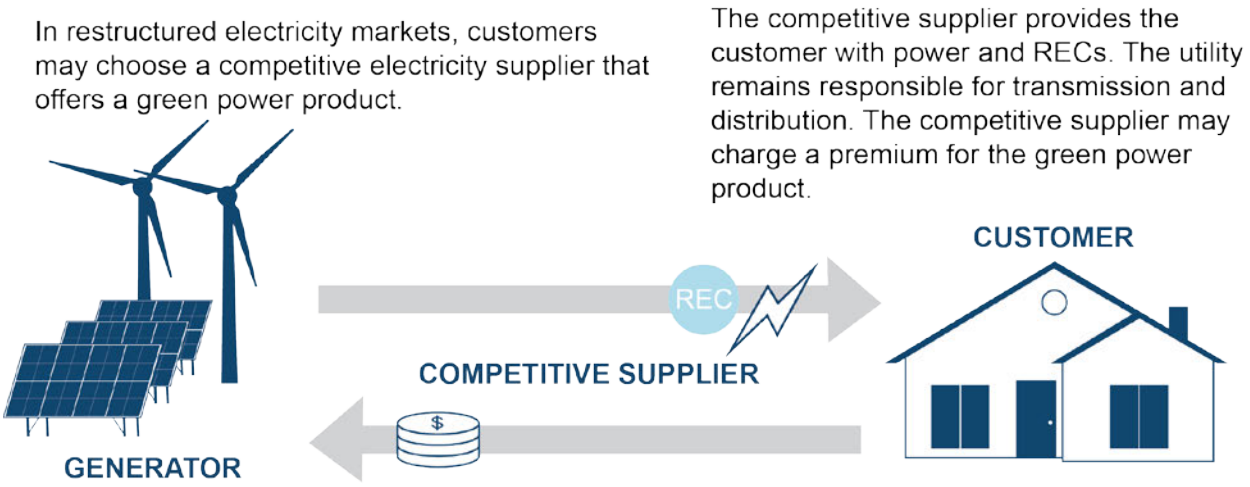

Figure 14. How competitive suppliers work

The figure provides a simplified schematic for visualization purposes. Specific transactions may vary.

5.1 Status of Competitive Supplier Green Power

In 2017, competitive suppliers sold about 18.1 million MWh of renewable energy to about 1.7 million customers (Figure 15).

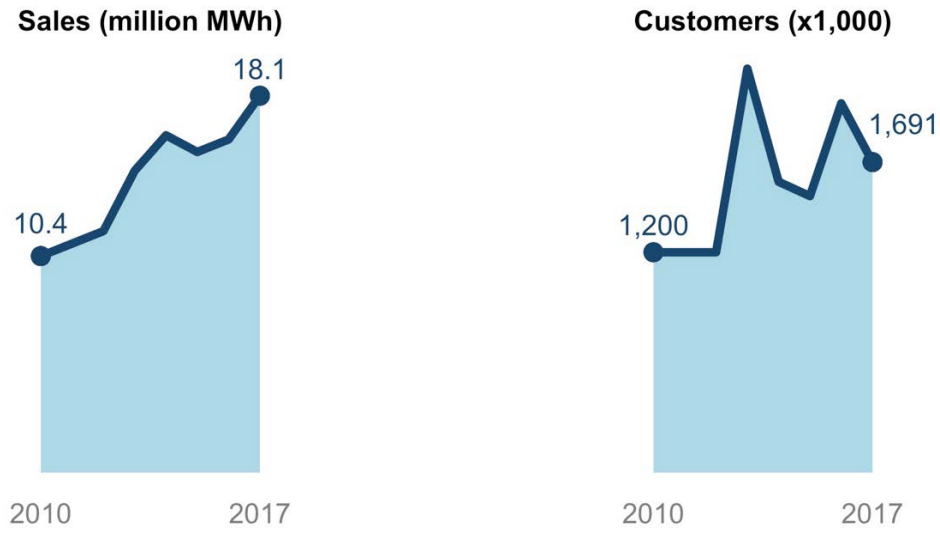

Figure 15. Competitive supplier sales and participation, 2010–2017

[6] The term "restructured" refers to markets where non-utility suppliers are allowed to compete with utilities to supply retail electricity. 15 states currently have fully restructured retail electricity markets: CT, DE, IL, MA, MD, ME, MI, NH, NJ, NY, OH, OR, PA, RI, TX.

5.2 Trends in Competitive Supplier Green Power

Similar to trends in utility green pricing, we estimate that steady growth in competitive supplier green power sales is primarily attributable to a few large suppliers. Figure 16 depicts green power sales for eight suppliers that offer 100% renewable energy products and had data reported in EIA Form-861 in every year from 2014 to 2017 (EIA 2018a).[7] The figure shows how the top suppliers increased green power sales by around 1.6 million MWh from 2014 to 2017. These trends suggest large suppliers are finding ways to increase green power sales, possibly through economies of scale. In contrast, we estimate that the remainder of the market has stagnated, with sales increasing by about 0.3 million MWh from 2014 to 2017. Over 90% of the sales of the top suppliers occurred in Texas (80%), New York (7%), Pennsylvania (5%), Ohio (2%), and Illinois (2%).

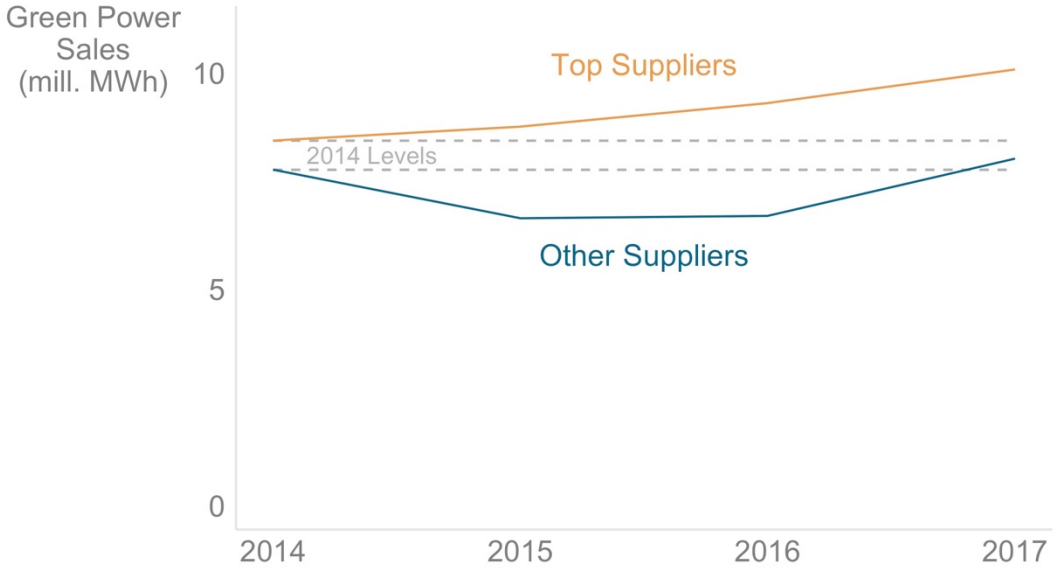

Figure 16. Competitive supplier green power sales by top eight suppliers and other suppliers

[7] Breeze; Collegiate Clean Energy; Green Mountain Energy; Kiwi Energy; MPower Energy; Spartan Renewable Energy; SmartEnergy Holdings; Star Energy Partners.

6 Unbundled RECs

When a renewable energy generator produces a megawatt-hour of output, the electricity may be sold into a wholesale electricity market while the REC is "unbundled" and sold into a separate REC market (Figure 17). This section provides data on sales of unbundled RECs directly to end-use customers. This section excludes sales of unbundled RECs through other green power products such as utility green pricing programs, competitive suppliers, and CCAs.

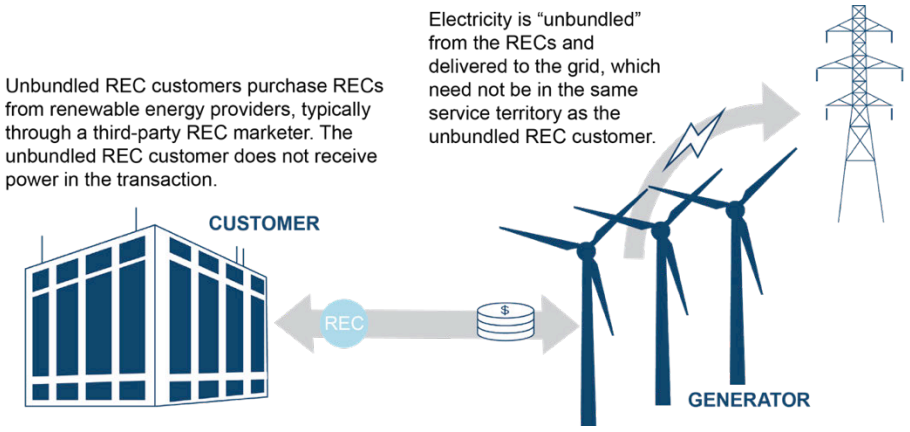

Figure 17. How unbundled RECs work

The figure provides a simplified schematic for visualization purposes. Specific transactions may vary.

6.1 Status of Unbundled RECs

We estimate that about 192,000 customers bought about 51.8 million MWh of green power directly through unbundled RECs in 2017 (Figure 18).

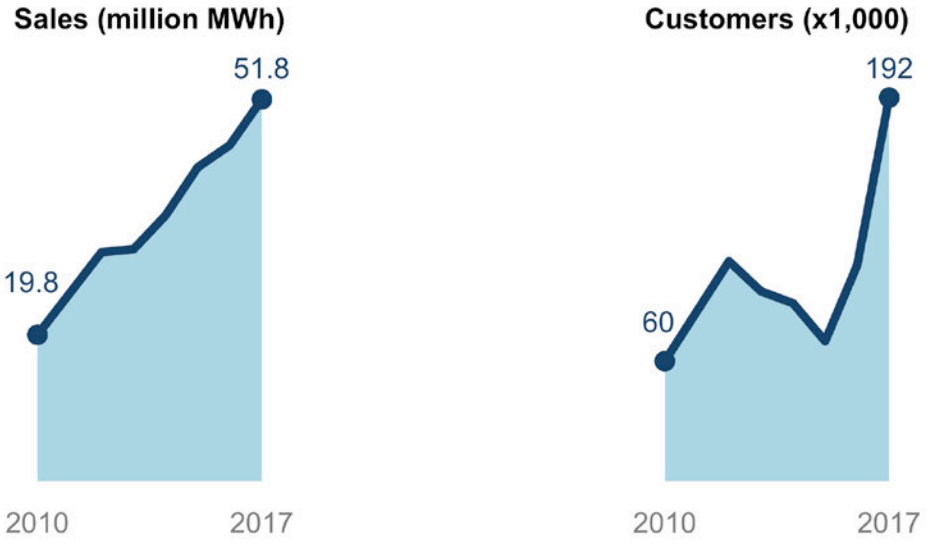

Figure 18. Unbundled REC sales and participation, 2010–2017

6.2 Trends in Unbundled RECs

Unbundled RECs have historically been procured through relatively large bulk purchases. As recently as 2015, the average unbundled REC customer procured about 610 MWh of unbundled RECs per year. For comparison, a typical residential home uses around 10 MWh per year. Beginning in 2016 and continuing in 2017, the average unbundled REC purchase size declined as more residential and small commercial customers began to procure unbundled RECs. The average unbundled REC purchase fell to 420 MWh per customer in 2016 and to 270 MWh per customer in 2017. The trend toward smaller unbundled REC purchases may reflect the successful efforts of REC providers to market unbundled RECs to smaller green power customers.

Relatively low REC prices are one contributing factor to ongoing increases in unbundled REC sales. From 2014 to 2017, REC prices fell by more than 50%, corresponding to a period of rapidly increasing unbundled REC sales. For the first time since 2013, prices for voluntary RECs increased for consecutive months in 2018 (Figure 19). Voluntary REC prices increased from $0.31/MWh in August 2017 to $0.70/MWh in August 2018. The recent increase in REC prices could reflect a market adjustment to the increasing demand for unbundled RECs. However, voluntary REC prices still remain below 2014 levels.

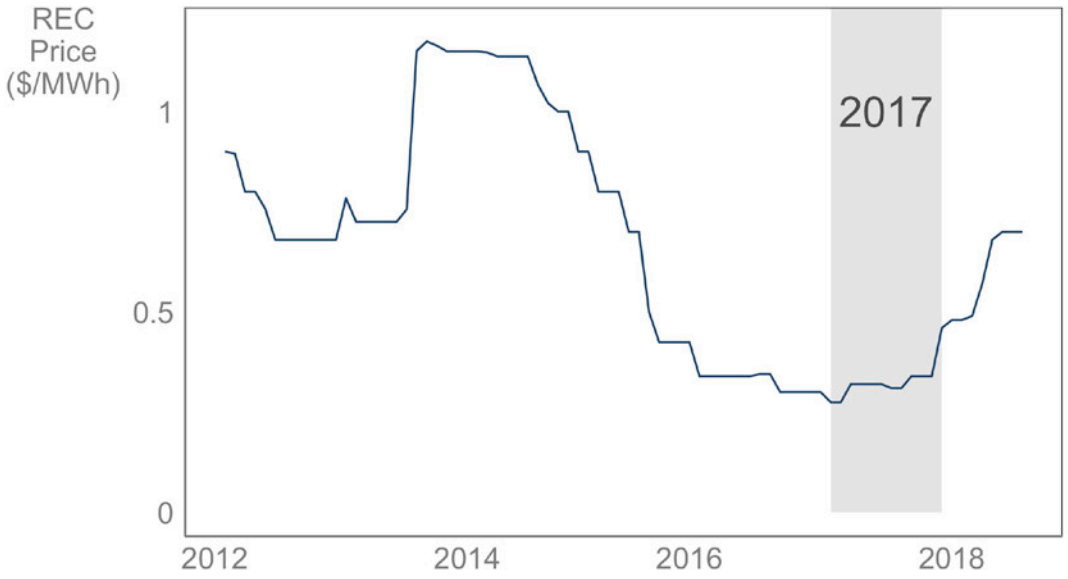

Figure 19. Voluntary national REC prices, January 2012–August 2018

Based on data from Spectron (2018)

For additional context, the following two figures provide information about REC pricing for compliance-based RECs. RECs used for RPS compliance have different pricing than RECs used for voluntary purposes. Prices for RECs used for compliance purposes tend to be higher due to RPS programs that require regulated entities to source RECs from specific states or regions. These restrictions limit the supply of eligible RECs while ensuring demand from load-serving entities, causing upward pressure on prices for RECs. This upward pressure on REC prices translates to higher prices for compliance-based and voluntary RECs in states with RPS. As a result, RECs (both compliance-based and voluntary) tend to exhibit higher prices in the states

with the strictest RPS requirements and lower prices in states with low or no RPS. As illustrated in the following figures, REC prices can be volatile due to changing RPS policies (Barbose 2017). For a more thorough discussion of compliance REC prices and trends see Barbose (2017).

Figure 20 illustrates REC prices for 12 states with sufficient data aggregated by SNL Energy (2018), excluding solar RECs (SRECs). The decline in REC prices in the northeastern states is attributable to increasing supplies in the region (Barbose 2017).

Figure 20. Prices of RECs used for compliance (excluding SRECs), January 2012—August 2018

Based on data from SNL Energy (2018)
The Ohio RPS program was frozen in 2015 and 2016.

Figure 21 displays trends in prices for SRECs for states with active SREC markets. SREC prices tend to be significantly higher than other REC prices, on the order of hundreds rather than tens of dollars. Washington, DC has generally been the highest-priced SREC market in the country, due to the District's solar carveout combined with the challenges of finding adequate PV host sites in a predominantly urban jurisdiction. However, Massachusetts surpassed DC as the most expensive SREC market in August 2018, as SREC prices in DC fell sharply and Massachusetts SREC prices increased beginning in April 2018. The recent increase in Massachusetts SREC prices may reflect a market adjustment to the expiration of the state's existing SREC program in April 2018.

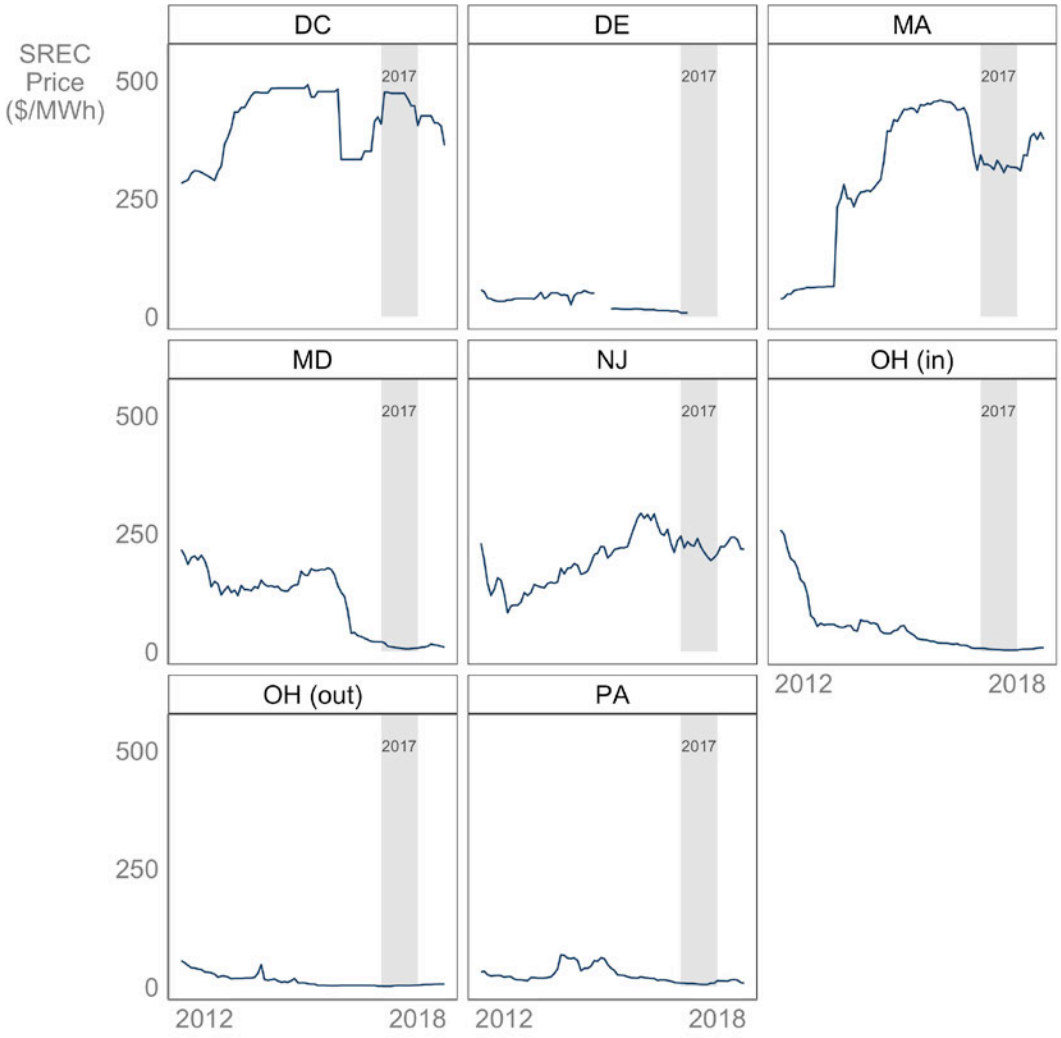

Figure 21. SREC pricing, January 2012–August 2018

Based on data from SNL Energy (2018). OH (in) refers to SREC prices in Ohio for in-state solar generation, while Ohio (out) refers to SREC prices in Ohio for out-of-state solar generation

7 Community Choice Aggregation

A community choice aggregation (CCA) is a governmental entity that procures electricity on behalf of retail electricity customers (Figure 22). CCAs can only exist within an investor-owned utility territory. Some CCAs choose to procure green power on behalf of their customers above and beyond state RPS requirements, though most CCAs only procure as much renewable energy as required by state RPS. This section only reports data on green power sales through CCAs. Unlike every other green power product, CCAs are "opt out," meaning customers are notified about the program, given the choice of opting out, and then automatically enrolled into the CCA unless they choose to opt out of the program and return to the investor-owned utility.

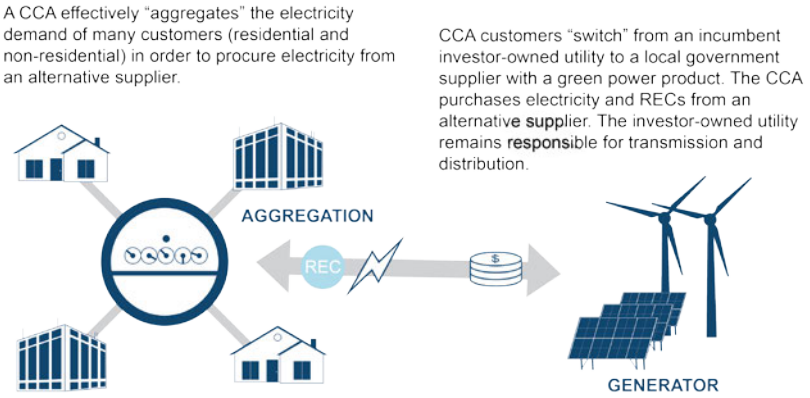

Figure 22. How community choice aggregation works

The figure provides a simplified schematic for visualization purposes. Specific program structures may vary.

7.1 Status of CCAs

In 2017, community choice aggregations sold about 8.9 million MWh of green power to about 2.7 million customers (Figure 23) in five states: California, Illinois, Massachusetts, New York, and Ohio.

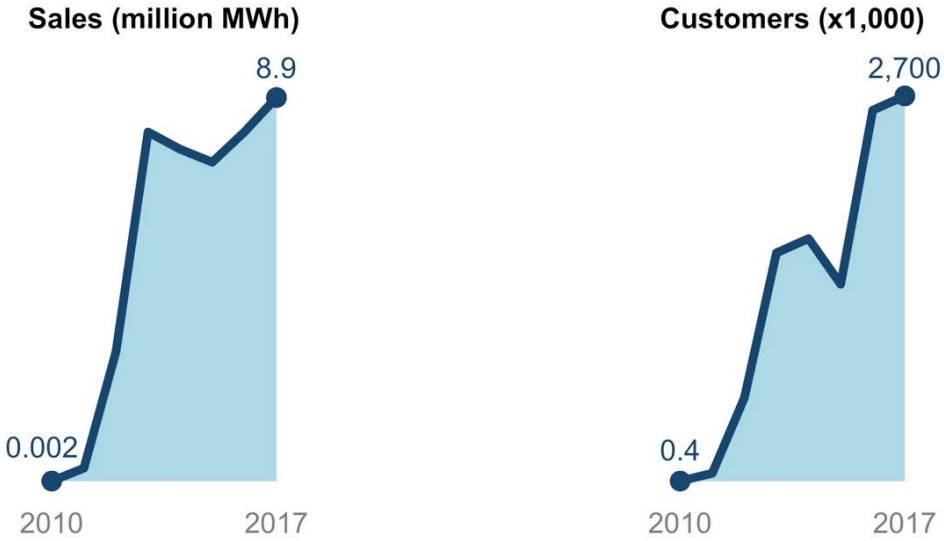

Figure 23. CCA sales and participation, 2010–2017

7.2 Trends in CCAs

Illinois remains the top state-level CCA green power market in terms of sales, though California is now by far the state leader in terms of CCA green power participation (Table 7). California will likely surpass Illinois in terms of green power sales in 2018, as CCA green power programs continue to shrink in Illinois and expand in California.

Table 7. CCA Green Power Sales and Participation by State, 2017

State	Estimated Green Power Sales (MWh)	Participants in CCAs with Green Power Products	CCAs with Green Power Products (as of 12/31/17)
Illinois[a]	3,511,000	463,000	50
California[b]	3,288,000	1,239,000	9
Massachusetts[c]	1,178,000	400,000	35
Ohio[c]	573,000	100,000	2
New York[d]	332,000	64,000	1
Total[e]	**8,883,000**	**2,726,000**	**97**

[a] Estimate extrapolated from publicly available reports of green power products in CCAs applied to historical data on electricity usage; [b] Based on data obtained from California Energy Commission and compiled by the UCLA Luskin Center for Innovation (Trumbull 2018); [c] Based on survey data; [d] Based on data from Westchester Power (2018); [e] Figures do not perfectly add due to rounding

As shown in Figure 23, CCA sales increased sharply from 2010 to 2013 and then fell from 2013 to 2015, and they have since rebounded and had surpassed 2013 levels by 2017. The 2013–2015 decline in CCA green power sales was driven by falling sales in Illinois and to a lesser extent in Ohio (Figure 24). At the same time, CCA green power sales steadily increased in California and Massachusetts. From 2015 to 2017, significant increases in green power sales in California and Massachusetts more than offset further sales reductions in Illinois and Ohio, driving an overall increase in CCA sales from 2015 to 2017. The implementation of a CCA in New York further contributed to increasing CCA green power sales. In the remainder of this section, we explore the state-level dynamics that explain these trends.

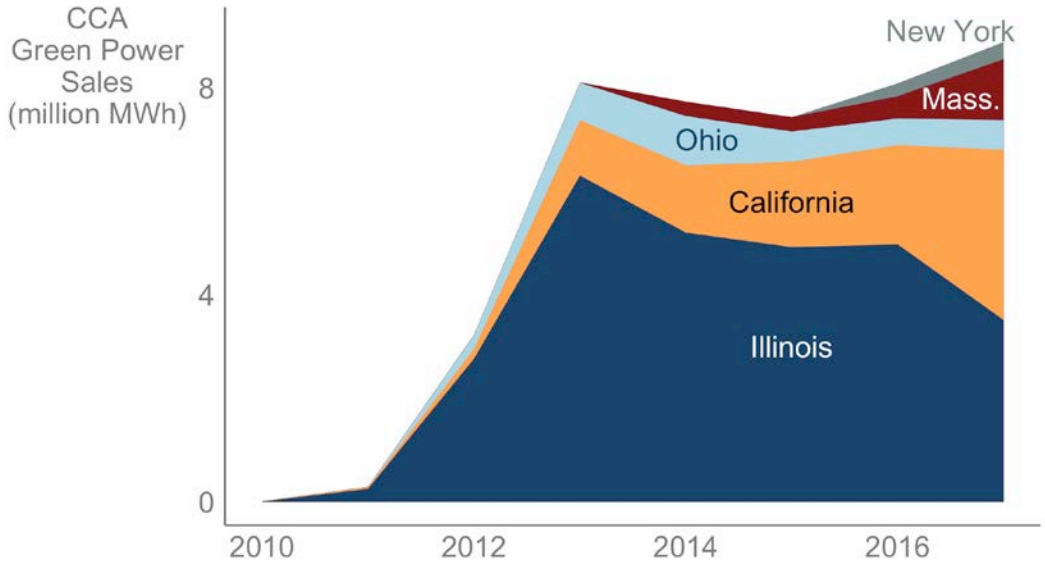

Figure 24. CCA green power sales (million MWh) by state

California

CCAs in California have expanded rapidly across the state and this expansion is accelerating. According to Gattaciecca, Trumbull, and DeShazo (2018), three communities implemented CCAs from 2010 to 2015, two communities implemented CCAs in 2016, four communities implemented CCAs in 2017, and eight additional communities are expected to implement CCAs by the end of 2018. We estimate that California CCA green power customers now outnumber CCA green power customers in all other states combined, and we project California will surpass Illinois as the leading state in terms of green power sales in 2018.

California is largely unique among the seven states that allow CCAs for two reasons. First, it has a regulated retail electricity market, meaning most retail electricity customers cannot procure power from competitive suppliers and are served exclusively by investor-owned or municipal utilities.[8] As a result, California CCAs incur additional responsibilities not borne by CCAs in other states. In California, CCAs will be required to ensure reliable electricity service by entering into long-term (e.g., 10 years) contracts with generators for the RPS portion of their renewable energy procurement, beginning in 2021 (Gattaciecca, Trumbull, and DeShazo 2018). In contrast, CCAs in other states primarily sign short-term (e.g., three years) contracts with competitive suppliers. The ability/requirement to sign long-term contracts represents both a challenge and a benefit in terms of CCA green power procurement. New California CCAs may face challenges in entering long-term contracts, such as lack of financial standing and creditworthiness. On the other hand, long-term contracts may allow CCAs to more effectively procure new local renewable energy generation, create more rate stability, and ensure programmatic longevity. Indeed, by 2018, California CCAs had procured more than 1,000 MW of in-state renewable energy capacity through long-term contracts (CalCCA 2018), though some of this procurement may be used to meet RPS.

[8] Some large non-residential customers are allowed "direct access" to wholesale markets, but residential and small commercial retail customers cannot participate.

Second, CCAs tend to be much larger in California than in the other states. On average, green power CCAs in California serve about 140,000 customers, compared to about 11,000 customers in Massachusetts and 9,000 customers in Illinois. The large size of California's CCAs stems from the prevalent use of joint powers agreements,[9] contractual structures allowing a single entity to procure power on behalf of many municipalities. Through joint powers agreements, several CCAs in California serve entire counties and three CCAs serve multiple counties. By allowing CCAs to serve broader customer bases, joint powers agreements may yield economies of scale and allow CCAs to offer more services, such as electric vehicle charging programs, demand response, and energy efficiency programs (Gattaciecca, Trumbull, and DeShazo 2018).

Illinois

Green power sales through Illinois CCAs continue to decline due to discontinued green power programs; they fell 29% from 2016 to 2017, both because some CCAs have discontinued entirely and because some CCAs have switched to lower-cost non-green power electricity products. About a dozen Illinois CCAs discontinued their green power products from 2016 to 2017. This ongoing trend is primarily attributable to changes in the cost-competitiveness of Illinois CCAs. In 2011, relatively high basic service rates (the rates offered by the state's investor-owned utilities) allowed CCAs to offer cost savings as high as $0.03/kWh (LEAN 2018). Many CCAs used their cost advantages to integrate green power into their electricity portfolios. However, from 2012 to 2014, falling basic service rates eroded the CCA cost advantage and drove many CCAs to discontinue their green power products (Figure 25). Basic service rates have risen since 2014, but CCA green power sales have not rebounded.

Figure 25. Illinois CCA sales and basic service rates, 2010–2017

[9] Some CCAs outside California have also used joint powers agreements, but their use outside is less prevalent in other states.

Massachusetts

The Massachusetts CCA landscape comprises dozens of individual municipality programs as well as the Cape Light Compact program, which aggregates on behalf of 21 municipalities in the Cape Cod region. Before 2017, customers of the Cape Light Compact had the option to opt *in* to a 100% renewable energy product. Similar to utility green pricing programs, participation in the opt-in program was relatively low and resulted in low green powers sales. In 2017, Cape Light Compact switched their service so that customers are automatically enrolled into a 100% renewable energy product. The result illustrates the significant impacts of CCAs with opt-*out* green power products: Cape Light Compact's green power sales increased from about 4,700 MWh in 2016 to about 880,000 MWh in 2017. Cape Light Compact's decision to switch to an opt-out structure drove a 170% increase in Massachusetts' CCA green power sales overall, although green power sales outside Cape Light Compact remained relatively stable.

In addition to switching to opt out, Cape Light Compact implemented a new structure to keep costs low in the near term while promoting local renewable energy in the long term. Partnering with its supplier, NextEra, Cape Light Compact provides green power consisting of 1% local renewables and 99% nationally sourced unbundled RECs. NextEra places the premium paid on the unbundled RECs into a Renewable Energy Trust overseen by an independent trustee (NextEra 2018). The use of nationally rather than regionally sourced RECs keeps program costs low. At the same time, NextEra can later use proceeds from the Trust to finance regional renewable energy projects (Lichtenstein and Reid-Shaw 2017).

New York

Westchester Power—New York's only active CCA in 2017—serves about 96,000 customers in Westchester County (Westchester Power 2018). In its first full year of operation, Westchester Power sold about 356,000 MWh of green power to 64,000 customers (Westchester Power 2018). As of December 2017, 56 other communities in New York had passed local laws to begin the CCA implementation process (Binns 2018). By January 2018, the New York State Public Service Commission had approved CCAs in the City of Elmira; the towns of Oneonta, Mountour, Horseheads, Union, and Binghamton; and the Village of Mountour Falls (NY PSC 2018).

Ohio

In Ohio, CCA green power sales increased by about 12% from 2016 to 2017, largely due to an increase in sales in the City of Cincinnati's program. Over 100 CCAs are active in Ohio, but to our knowledge, only Cincinnati and Cleveland have offered green power. The absence of green power from Ohio CCAs may reflect the difficulty of offering green power in markets with lower electricity costs. Of the seven states that have passed enabling legislation, Ohio has the lowest residential electricity rates (EIA 2016). In states with low electricity costs, CCAs may find it more difficult to justify paying green power premiums, especially if those premiums offset any cost savings achieved through aggregation.

8 Power Purchase Agreements

In a power purchase agreement (PPA), an electricity customer enters into a long-term contract with a generator to buy electricity. PPAs may be signed for on- or off-site systems. PPAs for residential on-site systems generally do not convey RECs to the end-use customers and therefore do not qualify as green power. Data for on-site nonresidential systems are relatively scarce, but these systems represent a small fraction of nonresidential PPAs (EPA 2017). For these reasons, our analysis in this section is limited to off-site PPAs where RECs are conveyed to nonresidential customers (Figure 26).

PPAs have two primary forms. In a physical PPA, the customer enters into a contract to buy electricity at a negotiated PPA rate. The purchased electricity is credited toward the customer's electric demand such that, from a billing perspective, the customer uses the electricity (regardless of whether the electricity is physically delivered to the customer's site). In a financial PPA, the customer enters into a contract for differences for electricity at a negotiated PPA rate. The generator sells electricity into the local grid at the local wholesale rate. The customer and generator are financially obligated to settle differences between the PPA rate and the wholesale rate; the customer pays the generator the difference when the wholesale rate is less than the PPA rate, and the generator pays the customer the difference when the wholesale rate is greater than the PPA rate. The financial PPA structure allows both the customer and the generator to hedge against wholesale market price volatility.

PPA sales and participation estimates in this report are based on data from BNEF (2018) and S&P Global Market Intelligence (2018).

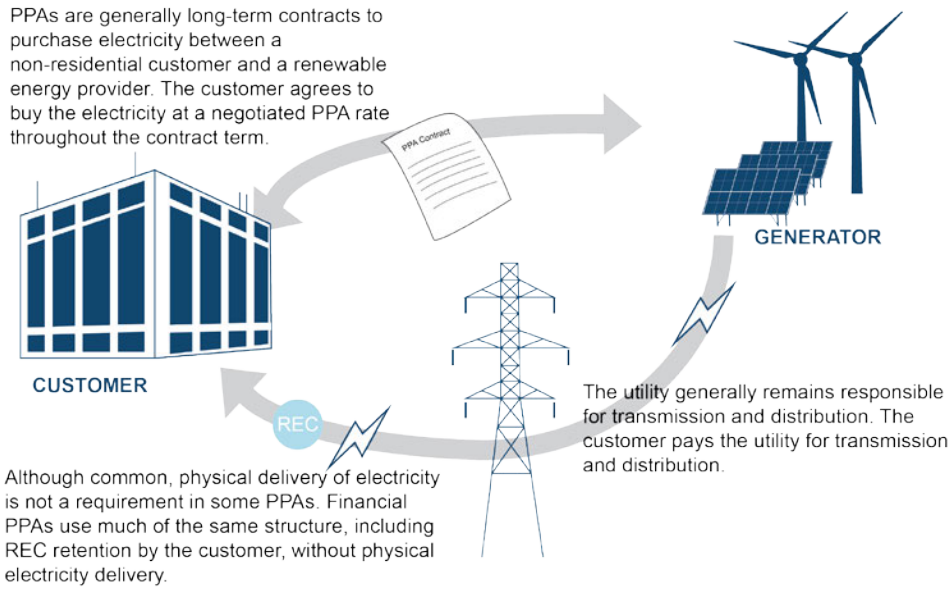

Figure 26. How power purchase agreements work

The figure provides a simplified schematic for visualization purposes. Specific contract structures may vary.

8.1 Status of PPAs

In 2017, 21.3 million MWh of green power were consumed through 273 PPAs; these results reflect projects commissioned by the end of 2017 where we estimate that the customer purchases the RECs for voluntary purposes (Figure 27). The large increase in sales from 2016 to 2017 is the result of projects signed in 2015 being commissioned. Though not shown in Figure 27, sales as of July 2018 have not grown much from end of year 2017 because projects signed in 2018 have for the most part yet to come online.

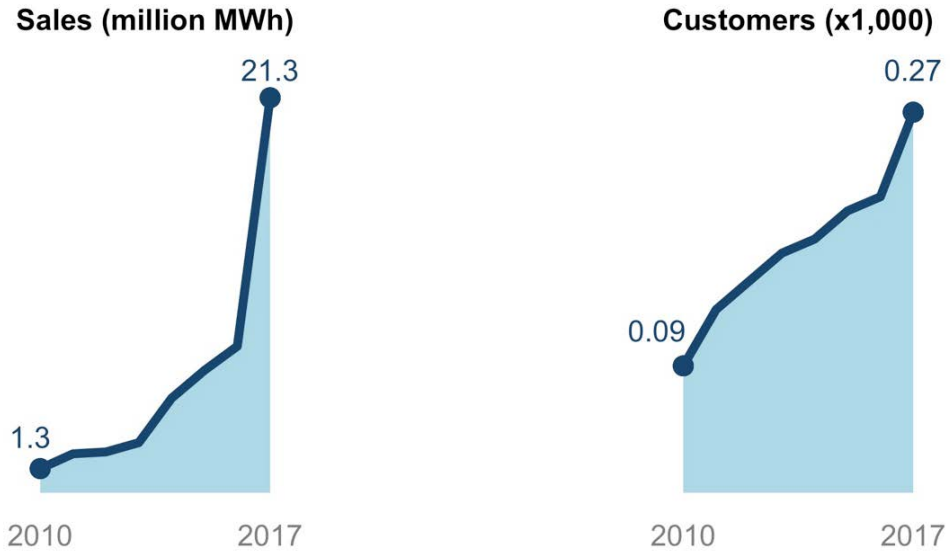

Figure 27. PPA sales and participation, 2010–2017

8.2 Trends in PPAs

While the data presented in Figure 27 reflect only PPAs where the customer owns the RECs, the remainder of this section presents trends in PPAs generally, regardless of whether the RECs are retained by the PPA signer.

PPA project implementation can take months or years between contract signing and project commissioning. As a result, some PPAs that are signed in one year may not actually begin to generate electricity until the following year or even later. In 2015, 3,683 MW of project capacity was contracted for through CCAs, but 2,779 MW of that capacity remained uncommissioned by the end of 2016. In 2017 and 2018, about 2,364 MW of the 2015 contracts came online, which is the primary driver of the significant increase in PPA sales from 2016 to 2017 (Figure 28). These projects contribute to the vast majority of the increase from 2016 PPA sales to 2017 PPA sales, though projects signed in 2016 are also a contributor: as of July 2017, only 501 MW of projects signed in 2016 were commissioned, compared to 1,037 MW as of July 2018.

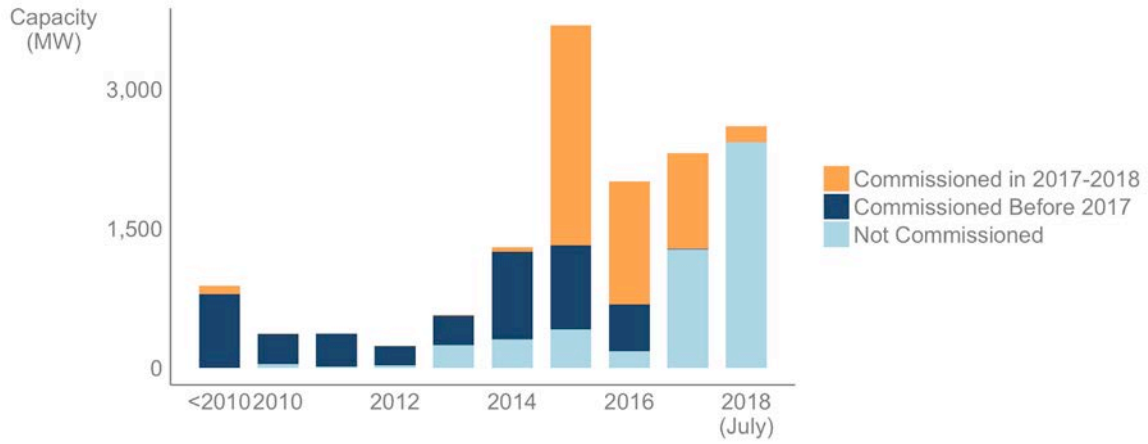

Figure 28. Project capacity and commissioning status by year

The height of the bars represents capacity contracted for in a given year, while the colors represent whether those contracts have been commissioned (i.e., projects have begun producing electricity) and in which year.

In 2017, the tech sector contracted for the largest amount of MW via PPAs (Figure 29). The tech sector has not rebounded to 2015 levels but was showing a large increase into the first part of 2018, with nearly 1,400 MW signed as of July 2018. Manufacturers also signed large deals in 2017, due to signings by Kimberly-Clark (245 MW in two transactions) and General Mills (100 MW).

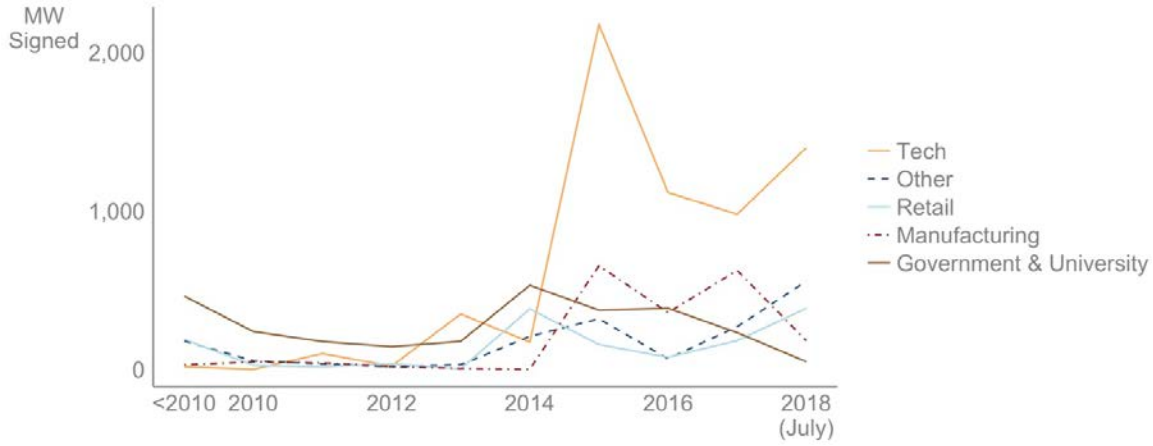

Figure 29. PPA MW signed by sector, through July 2018

The largest purchasers cumulatively through July 2018 were mostly the same as in previous years, with the additions of AT&T, General Motors, and Target to the top 15 list (Figure 30). AT&T signed 820 MW in 2018 from wind facilities in Texas and Oklahoma; General Motors signed 200 MW in 2017 from wind in Illinois and Ohio, and Target signed 100 MW in 2017 from wind in Kansas.

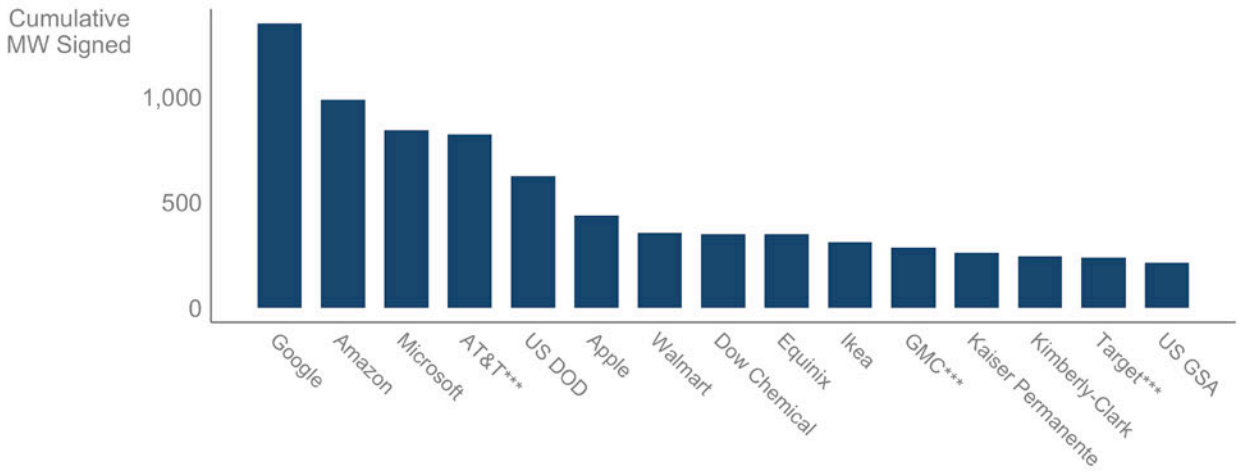

Figure 30. Leading institutions signing PPAs, through July 2018

*** Company new to the top 15 in 2017
US DOD = U.S. Department of Defense; US GAS = U.S. General Services Administration

Wind resources continue to dominate the PPA market (Figure 31), maintaining 60%–70% share in recent years. Solar resources are the second most common but have not increased annually as quickly as wind resources. Only minimal amounts of biomass and waste resources are being contracted via PPAs.

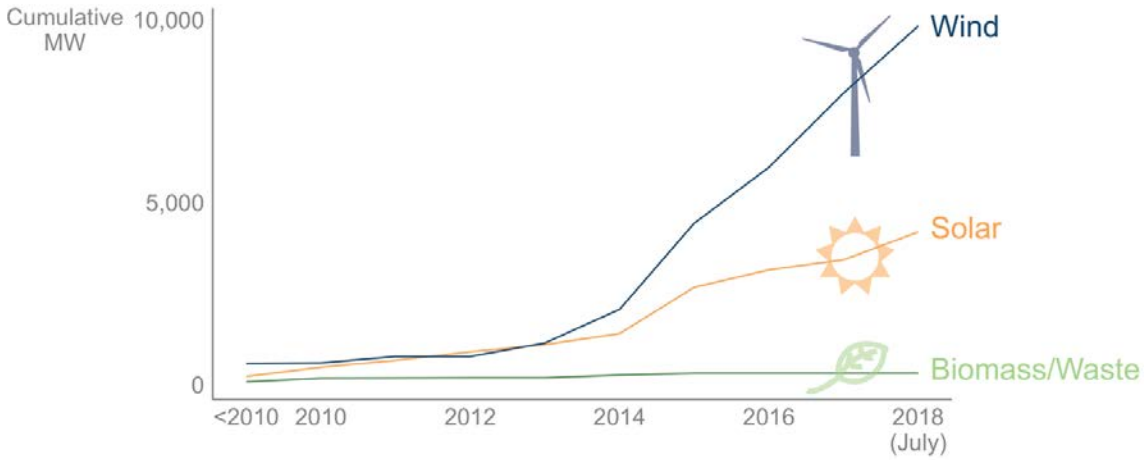

Figure 31. Cumulative MW of PPA renewable resources, through July 2018

The PPA market has seen some examples of buyer aggregation, though that structure is not yet commonplace. Buyer aggregation involves multiple purchasers signing PPAs with the same generator or generators. Buyer aggregation could reduce transaction costs, which pose barriers to financial PPAs for many small buyers (Heeter, Cook, and Bird 2017). These structures vary but typically involve at least one large buyer paired with additional medium to smaller sized buyers. In 2016, the Massachusetts Institute of Technology (MIT), Boston Medical Center, and the Post Office Square Redevelopment Corporation signed a 25-year PPA for 60 MW of solar. MIT's share was the largest, at 44 MW, while Boston Medical Center's share was 16 MW, and Post Office Square Redevelopment Corporation signed for less than 1 MW (Heeter, Cook, and Bird 2017). More recently, Akamai, Etsy, and Swiss Re partnered in 2018 to buy 290 MW of renewable energy (125 MW of wind in Illinois and 165 MW from solar in Virginia).

9 Community Solar

In a community solar program, a utility or third-party project developer develops a solar project and sells the output to multiple subscribers (Figure 32). Community solar subscribers are generally compensated through utility bill credits that are proportional to the size of their subscription.

To date, most community solar customers have not received the RECs associated with their energy subscriptions. Community solar output is often used by utilities to meet RPS compliance obligations. For this reason, most community solar sales do not meet our definition of green power.[10] In Section 9.1, we distinguish green power community sales data from sales representing the broader community solar market. In Section 9.2, we provide data on the community solar market as a whole, including data for sales that do not qualify as green power. In Section 9.2.2, we identify and summarize four innovative programs that are retiring RECs on behalf of subscribers and therefore do meet our definition of green power.

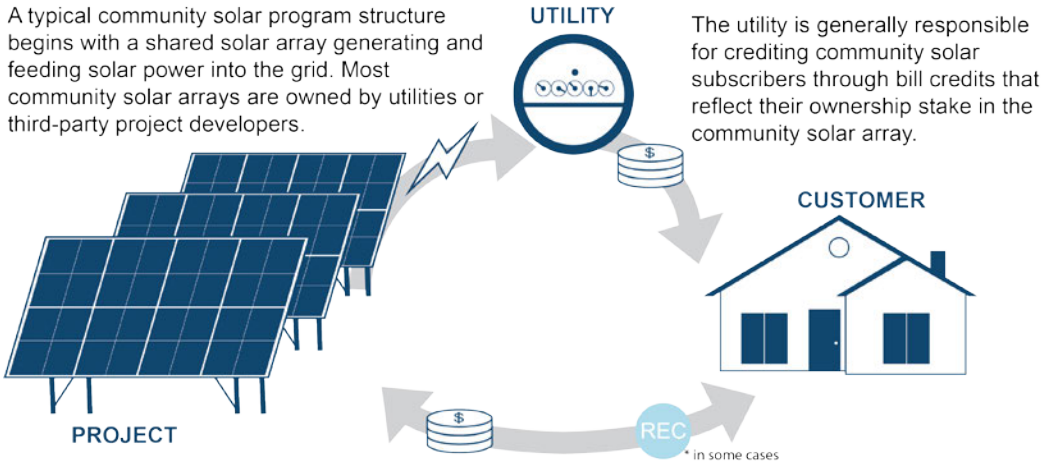

Figure 32. How community solar works

The figure provides a simplified schematic for visualization purposes. Specific program structures vary.

9.1 Status of Community Solar

In 2017, about 67,000 customers bought around 800,000 MWh of community solar output (Figure 33) in the United States. We estimate that a small fraction of these sales qualifies as green power: about 4,700 customers procured about 80,400 MWh of green power through four projects (see Section 9.2.2).

[10] It is important to note that most residential rooftop PV sales similarly do not meet our definition of green power, because PV system owners or PPA customers commonly give up RECs to participate in utility incentive programs.

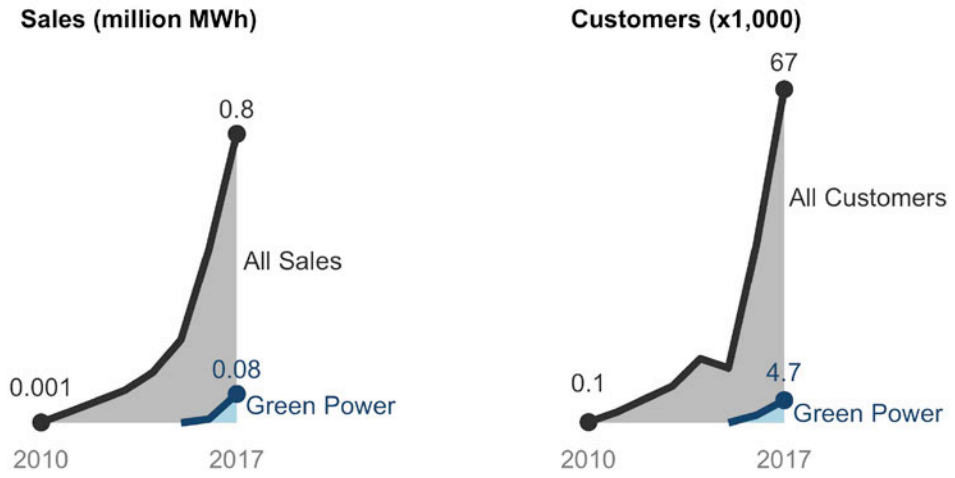

Figure 33. Community solar sales and participation, 2010–2017

9.2 Trends in Community Solar

Community solar continues to exhibit remarkable growth, reaching about 720 MW of installed capacity by the end of 2017, with about 387 MW installed in 2017 alone (Chwastyk et al. 2018), including projects that do not qualify as green power. By one projection, more than 2,000 MW could be installed between 2017 and 2021 (Honeyman, Shiao, and Krulewitz 2017). Community solar projects were active in 40 states by the end of 2017 (Figure 34).[11]

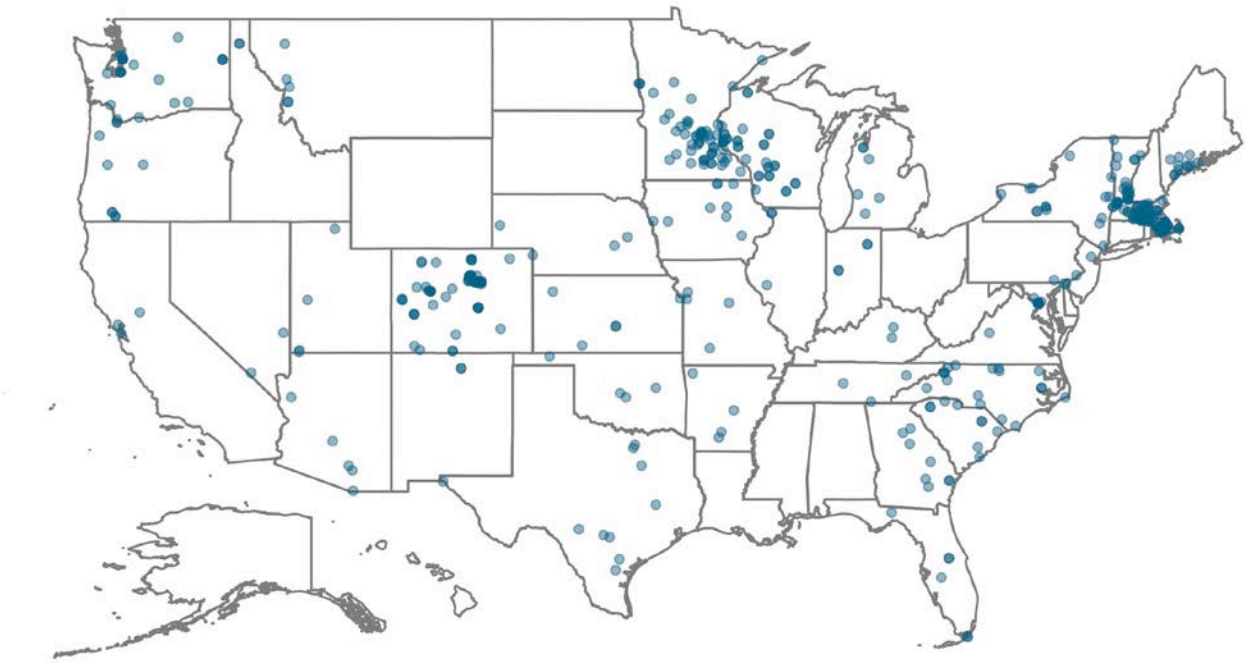

Figure 34. Active community solar projects as of end of 2017

[11] A publicly available version of the community solar project list is available at https://data nrel.gov/submissions/95 ("Community Solar Project Database," NREL).

9.2.1 The Effects of Community Solar Programs

About 70% of community solar projects operate in states with programs to support community solar, such as virtual net metering or group billing. Virtual net metering allows net metering credits to accrue from off-site systems to remotely located customers. These programs increase customer incentives to adopt community solar and may facilitate customer acquisition. Nonetheless, roughly 30% of community solar projects operate in states without such programs. Similarly, the majority of future community solar capacity is expected to be deployed in six states with community solar programs: California, Colorado, Maryland, Massachusetts, Minnesota, and New York (Figure 35), based on projections from Honeyman, Shiao, and Krulewitz (2017). In this section, we briefly explore these community solar programs and how they continue to drive the community solar market.

Figure 35. Current and projected community solar capacity in six leading states

Data sources: Honeyman, Shiao, and Krulewitz 2017; O'Shaughnessy et al. 2018

New York

In 2015, as part of the state's Reforming the Energy Vision program, the New York Public Service Commission implemented a community distributed generation program that allows virtual net metering. Community solar projects are also eligible for financial incentives through the state's NY-Sun program. As a result of these programs, New York is projected to deploy more community solar than any other state in the coming years: Honeyman, Shiao, and Krulewitz (2017) project that more than 500 MW of capacity could be deployed in New York alone from 2018 to 2021. As of July 2018, 18 community solar projects were completed and an additional 312 projects were in the pipeline (NYSERDA 2018).

Massachusetts

The Massachusetts community solar market is driven by the state's virtual net metering program as well as a historically strong SREC market. In early 2017, community solar accounted for about one-third of the SREC queue (Honeyman, Shiao, and Krulewitz 2017). Beginning in 2018, Massachusetts transitioned from its existing SREC program to a new Solar Massachusetts Renewable Target (SMART) program. Subscriber compensation is projected to be lower under

the SMART program, however several developers state that the new program provides enough certainty to support further market growth (Trabish 2017).

Minnesota

Minnesota's community solar market is supported by state-level legislation and financial incentives offered by Xcel Energy, the state's largest utility. These measures were, at first, largely ineffective at enabling projects to come online, due to various regulatory delays, but the Minnesota community solar market finally rose in 2017, with more than 50 projects being implemented (Hannah 2017). Beginning in 2018, all new community solar projects are required to compensate subscribers according to a value of solar tariff rather than the traditional retail rate (Gleckner 2016). The switch to the value of solar tariff—which is lower than the retail rate—has slowed the Minnesota community solar market. The project pipeline shrunk from a peak of over 1,400 MW in late 2015 to under 600 MW in late 2017 (Hannah 2017). Most of the projected Minnesota market in Figure 35 represents projects in the pipeline that were grandfathered into the previous retail rate compensation method. Honeyman, Shiao, and Krulewitz (2017) project a weaker Minnesota community solar market beyond 2019 as developers adjust to the value of solar tariff.

Colorado

Colorado's community solar market is supported by the state's Solar Gardens program and the associated financial incentives offered by Xcel Energy, the state's largest utility. The financial incentives provided by Xcel Energy's Solar*Rewards Community program have allowed community solar developers to offer attractive rates to subscribers. In return, Xcel Energy owns the RECs and uses them toward RPS compliance, which is similar to other state community solar programs. The Solar*Rewards Community program is projected to support more than 100 MW of community solar deployment from 2017 to 2019 (Honeyman, Shiao, and Krulewitz 2017).

California

California's community solar market is driven by state legislation requiring the state's investor-owned utilities to procure up to 600 MW of community solar by 2019. The California program is unique in that the utilities are required to retire RECs on behalf of subscribers, though only one investor-owned utility (PG&E) has implemented this design to date, to our knowledge. This requirement also poses a challenge in providing customer cost savings given that the value of RECs cannot be used to reduce subscription rates. California community solar subscribers also bear other charges, such as exit fees,[12] that undermine the economics of community solar subscriptions (Trabish 2017). While customers in other major state markets generally save money by subscribing to community solar, California community solar customers pay a premium over standard utility rates (Honeyman, Shiao, and Krulewitz 2017). Due primarily to this challenge, Honeyman, Shiao, and Krulewitz (2017) project that the investor-owned utilities will fall well short of the 2019 target of 600 MW.

[12] In regulated electricity markets, utilities make long-term investments on behalf of retail electricity customers. When customers "exit" utility service (e.g., to join community solar), the utilities continue to bear these long-term costs but now have fewer customers from which to recoup the costs. To avoid inter-customer cost shifting, exit fees are levied to compensate investor-owned utilities for sunk investments made on behalf of existing customers.

Maryland

In 2015, Maryland passed legislation calling for a 193-MW community solar pilot program. Honeyman, Shiao, and Krulewitz (2017) project that Maryland will deploy 159 MW of this target between 2017 and 2021. The projected shortfall is due to relatively low SREC prices, which fell in 2016 as PV output began to exceed requirements to meet the state RPS. Maryland subsequently increased RPS targets in 2017, which could eventually increase SREC prices and support community solar development. The first community solar project under the Maryland pilot was interconnected in March 2018.

9.2.2 Community Solar Green Power Products

Most community solar projects to date do not qualify as green power programs given that subscribers do not own the RECs. Community solar programs could be restructured as green power programs in at least four ways (Table 8). The most straightforward model is to retire the project RECs on behalf of the subscribers. Alternatively, community solar program administrators could allow customers to choose whether to purchase the RECs, whether through an opt-out or opt-in model. In some cases, the value of the community solar RECs may be too high to justify retiring the RECs on behalf of subscribers, especially in states with active SREC markets. In these cases, community solar program administrators could sell the community solar RECs but buy lower-cost "replacement" RECs to retire on behalf of their subscribers. The replacement REC model would allow community solar subscribers to make a green power claim, even if that claim is not based on local solar.

Table 8. Potential Community Solar Green Power Models

Model	Description
Community solar green power	Community-solar generated RECs are retired on behalf of subscribers.
Opt-out community solar green power	Community-solar generated RECs are retired on behalf of subscribers by default, but subscribers have the option to sell their RECs to obtain a lower rate.
Opt-in community solar green power	Subscribers do not own the RECs by default but have the option to opt-in to a higher rate with the associated RECs.
Community solar with replacement RECs	Community-solar generated RECs are used for RPS compliance, but program administrator purchases and retires other RECs on behalf of the subscribers.

To our knowledge, only four community solar green power programs are active:

- MCE (formerly Marin Clean Energy) is a CCA serving Marin County, Napa County, unincorporated Contra Costa County, and other cities in the region. MCE offers CCA customers the opportunity to subscribe to shares from a 1-MW community solar facility in Novato, CA. MCE (2018) estimates that in 2017, about 160 CCA customers bought about 600 MWh of green power through the Local Sol program.

- Pacific Gas & Electric (PG&E) began offering the Solar Choice community solar product in 2016. Solar Choice subscribers may choose to purchase the equivalent of 50% or 100% of their annual energy use. PG&E uses program revenues to deploy community solar projects in its service territory as needed to match demand. Under state legislation, PG&E and all other California investor-owned utilities are required to retire RECs on behalf of the subscribers. The PG&E Solar Choice program sold about 34,000 MWh of green power in 2017 (PG&E 2018).
- Rocky Mountain Power's (RMP's) Subscriber Solar product allows customers to subscribe to shares of a 20-MW community solar project near Holden, Utah. Subscribers sign on for up to a 20-year term with a fixed solar rate. The program was fully subscribed as of the end of 2017, and RMP is looking for potential sites to expand the program. RMP voluntarily retires all RECs on behalf of subscribers. The Subscriber Solar program sold about 43,000 MWh of green power in 2017.[13]
- The Sacramento Municipal Utility District (SMUD) has offered community solar through the SolarShares program since 2008. Like other community solar programs, SMUD initially used the SolarShares RECs for RPS compliance purposes and passed the value of the RECs through to subscribers as a cost savings measure. In 2017, SMUD amended the SolarShares program so that all RECs are retired on behalf of subscribers. The SolarShares program sold about 25,000 MWh of green power in 2017. For more information about the program, see Text Box 1 (page 41).

An unknown number of community solar programs allow customers to opt in to buy their RECs. For instance, the Revision Energy Community Solar Farm in Maine sells RECs to improve project economics but allows interested customers to buy back their portion of RECs (Revision Energy 2018). Our community solar estimates do not include green power sales through opt-in models such as Revision Energy's. Assuming customer participation rates in opt-in community solar REC purchases are similar to participation rates in other opt-in programs (e.g., utility green pricing), green power sales through such opt-in programs are likely small relative to sales through the four community solar programs described above.

[13] Utah has a voluntary renewable energy goal rather than a binding RPS. The renewable energy goal is not factored out of the green power sales estimate.

10 Expanding Electricity Product Choice: Opportunities and Challenges for Green Power Markets

U.S. retail electricity customers have access to more electricity choices than ever. The proliferation of electricity product choice is mostly a positive development for green power markets and for customers seeking green power. The expansion of electricity product offerings has contributed to recent growth in the voluntary green power market. PPAs and CCAs alone have added around 30 million MWh of green power sales per year. However, the expansion of electricity products also poses challenges to green power markets. New products may generate customer confusion that could, in some cases, reduce green power demand. In this section, we summarize how the expansion of electricity product choices creates opportunities and challenges for green power markets. We limit our discussion to five products: utility basic service,[14] utility green pricing, competitive suppliers, CCAs, and community solar. And, the focus of this section is on residential and small commercial customers, which are arguably less informed about electricity products and more susceptible to confusion during product choice. We exclude utility renewable contracts, unbundled RECs, and PPAs because these products are generally used by large sophisticated green power buyers that are arguably less susceptible to product confusion.

For the purposes of this section, we categorize retail electricity products into two subtypes. *Default power products* refer to products that offer an electricity portfolio that complies with but does not significantly exceed an RPS. *Green power products* refer to the products summarized in this report where RECs are retired on behalf of customers in excess of RPS. Most retail electricity products include variants of both types. For instance, some competitive suppliers offer green power while others offer default power. Most utility basic service represents default power, however this may change as utilities begin to voluntarily procure renewable energy in excess of state RPS (see Section 10.1).

Demand for green power increases whenever customers switch from a default to a green power product. The expansion of retail electricity products may increase demand for green power by increasing the number of pathways for default-to-green power switching. Figure 36 illustrates this concept. Each connecting line represents a default-to-green power switch that would increase demand for green power. The number of pathways increase as retail electricity product choice increases. In recent years, customer switches from basic utility service to CCAs have been the most impactful in terms of effects on green power demand. Some community solar programs have begun retiring RECs on behalf of subscribers (see Section 9.2.2), opening up switches to community solar as a default-to-green power pathway.

[14] Utility basic service refers to the default electricity package offered to utility customers.

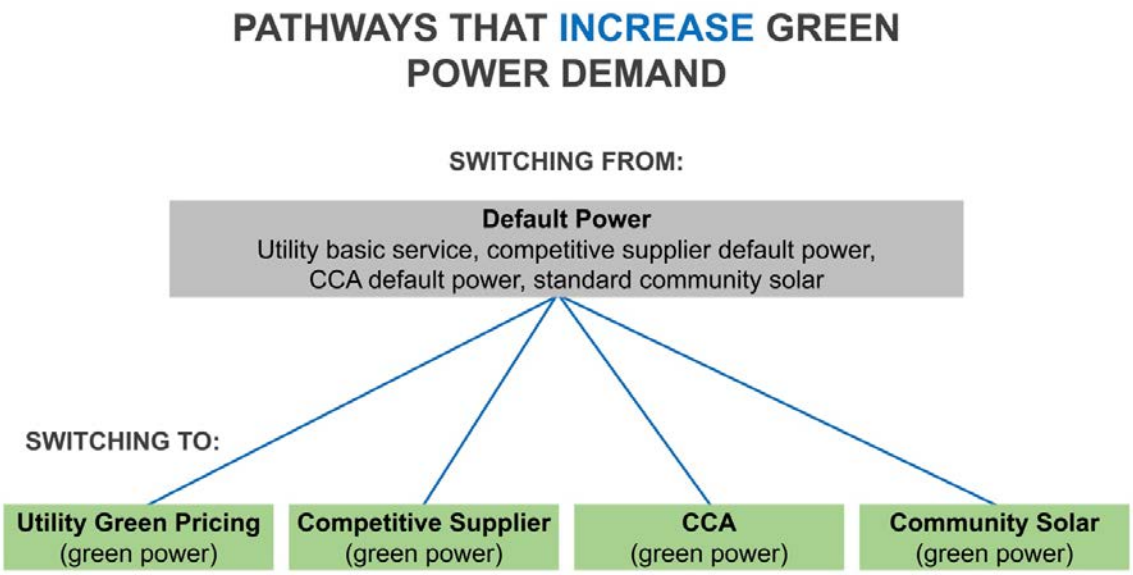

Figure 36. Customer product switching pathways that increase green power demand

Demand for green power decreases whenever a customer switches from a green power to a default power product. Figure 37 illustrates the pathways for green-to-default power switching. The expansion of retail electricity product choice increases the number of ways that customers can switch from green to default power.

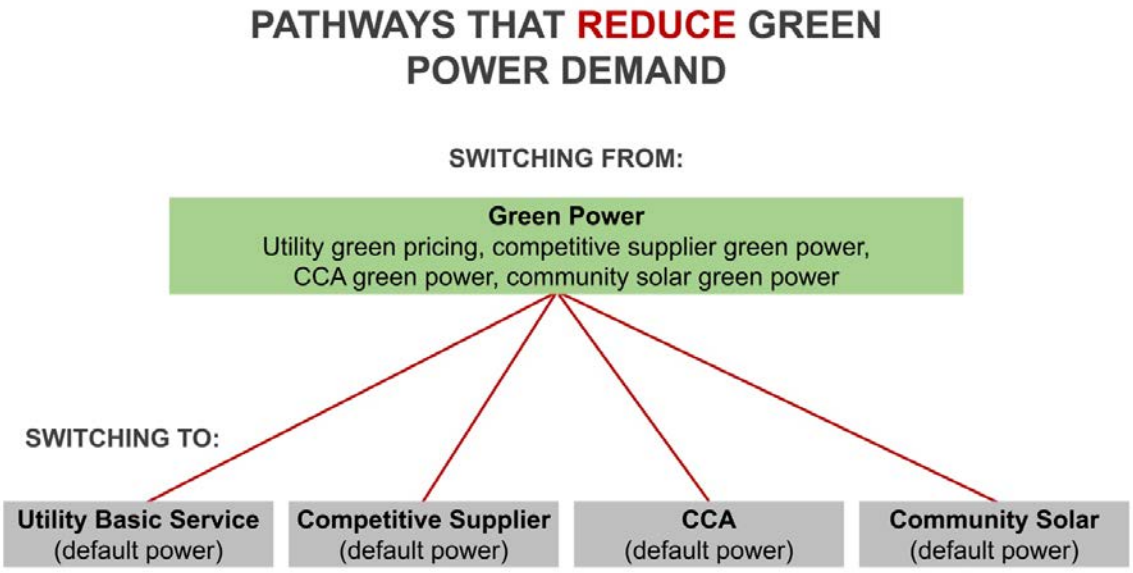

Figure 37. Customer product switching pathways that decrease green power demand

Retail electricity customers are generally unaware of their renewable energy options (Rogers 2011) and may not fully understand the implications of switching between products that do and do not back their electricity use with RECs. Given limited customer awareness, the expansion of green power product offerings could result in customer confusion. To illustrate, suppose a customer procures green power through a utility green pricing program. Then suppose the customer subscribes to a new community solar project serving her area. The customer may assume the community solar project provides a similar green power product as utility green pricing and may choose to discontinue her participation in utility green pricing. However, if the community solar developer does not retire RECs on behalf of the customers—consistent with most community solar projects—the customer no longer has a legal claim to be using green power.

The community solar example illustrates that potentially misleading product perceptions may affect customer choices. The perceptions may be misleading in the sense that most sales through most electricity products represent default rather than green power, particularly for community solar and competitive suppliers (Figure 38). Products that are perceived to offer green power may draw customers away from green power products like utility green pricing (see case study in Text Box 1).

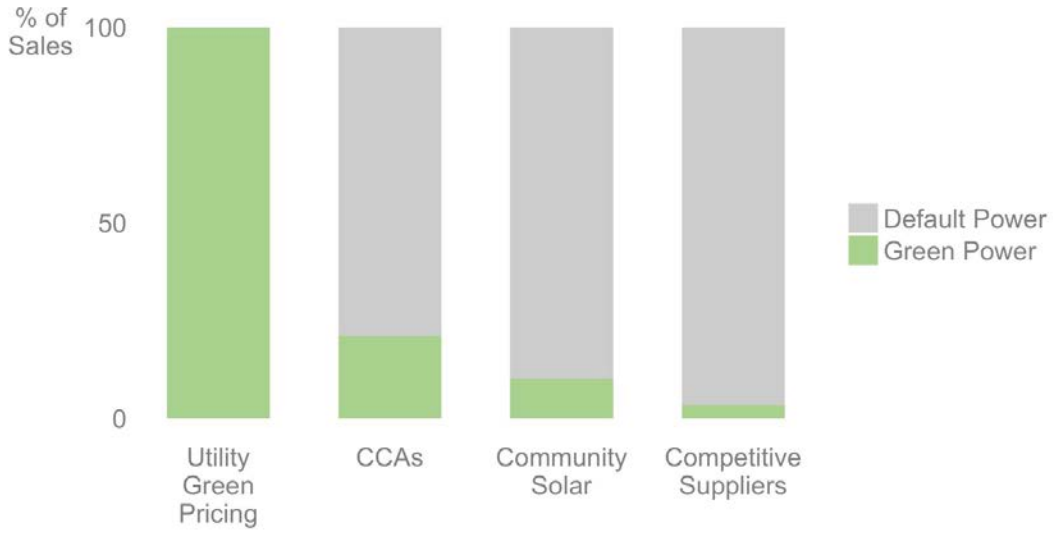

Figure 38. Green power share of total sales by electricity product

To date, the expansion of retail electricity products has increased green power demand, particularly through default-to-green power shifts in CCAs. There is no evidence that the expansion of new green power products has reduced green power demand at any significant scale. However, most CCAs and community solar programs do not offer green power, increasing the risk of inadvertent green-to-default power switching. There are at least two ways to mitigate the potentially adverse effects of customer confusion on green power markets. First, regulators and utilities could increase product transparency through informational resources. For instance, Xcel Energy clearly states that community solar subscribers cannot claim to use solar energy (Xcel Energy 2017). Similarly, the Minnesota Commerce Department advises subscribers to study whether their community solar contract includes RECs, which they state represent the "legal rights to the environmental benefits" of solar energy (MN 2018). Second, more electricity

products could be designed to offer green power by default (see example in Text Box 1), or at least provide customers the option to procure green power. We discuss several ways that community solar programs could offer green power in Section 9.2.2.

Text Box 1. The SMUD SolarShares Program: A Case Study of the Opportunities and Challenges of Expanding Electricity Product Choice

The SMUD SolarShares program provides an illustrative case study of the potential opportunities and challenges of expanding product choice. Since 2007, SMUD has offered community solar to residential customers through the program. Under the initial SolarShares structure, SMUD used the community solar RECs for RPS compliance. SMUD also administers Greenergy, one of the largest utility green pricing programs in the country.

After expanding SolarShares to large commercial customers, SMUD saw that some large commercial Greenergy customers were also interested in SolarShares. Indeed, many customers participated in both programs. One concern was that some Greenergy customers saw SolarShares as a substitute for green pricing, even though RECs were used for RPS compliance rather than retired on behalf of subscribers. As the SolarShares program expanded, SMUD foresaw the possibility that some green pricing customers could switch from Greenergy to SolarShares. And, if this occurred, expanding the SolarShares program would result in reduced green power sales in SMUD's service territory, all else being equal.

In an effort to be transparent with participants and provide an authentic renewable program, SMUD amended its SolarShares program in 2017 so that the community solar RECs are retired on behalf of subscribers. As a result, the SolarShares program is now one of the largest green power community solar programs in the country. Furthermore, the expansion of SolarShares will only increase green power sales in SMUD's service territory, even if the program draws some customers out of the Greenergy green pricing program.

Information based on an interview with Wade Hughes, SMUD

Above-RPS Utility Basic Service as a Green Power Product

In the discussion above, we state that most utility basic service represents default power. However, as renewable energy costs decline, utilities are increasingly procuring renewable energy beyond levels required by state RPS. For instance, California's investor-owned utilities are on track to meet 2030 RPS targets by 2020 (Gattaciecca, Trumbull, and DeShazo 2018). Xcel Energy, which serves customers in eight different states, expects to source about 40% of its energy through wind by 2022, surpassing RPS requirements in multiple states well ahead of schedule (Xcel Energy 2018). MidAmerican Energy in Iowa currently delivers an electricity portfolio with about 50% renewable energy (MidAmerican 2018) far exceeding the state's RPS. Above-RPS renewable energy content in utility electricity portfolios adds further complexity to electricity choice and the quantification of voluntary green power.

The rise of above-RPS utility renewable energy procurement raises questions about the role of utility basic service in voluntary green power markets. Under our definition of green power as renewable electricity voluntarily purchased by retail electricity customers, we do not treat above-RPS utility renewable energy sales as green power, under the rationale that retail electricity customers have not "voluntarily" procured renewable electricity. However, expanding electricity choice weakens this rationale and provides an argument for reconsidering how we define green power.

There may be some rationale for including utility basic service options with above-RPS renewable energy as green power, if the utility retires the RECs for its ratepayers. In restructured markets and in jurisdictions with CCAs, utility basic service is in fact a customer choice—though many customers may be unaware of the choice. If the utility provides more renewable energy than local competitive suppliers or the local CCA *and* a customer chooses to remain with the utility in order to buy more renewable energy, one could argue the customer has voluntarily procured renewable electricity through their decision to continue with utility basic service. As long as utilities retire above-RPS RECs on behalf of their ratepaying customers, there should be no potential for double claims to the renewable electricity. Indeed, from this perspective, it is unclear how green power claims based on above-RPS utility basic service differ from green power claims based on above-RPS competitive supplier or CCA service. From a research perspective, customers that procure green power by choosing to buy basic service are nearly impossible to identify, which raises difficult questions about how utility basic service green power could be quantified. The potential impacts of above-RPS utility renewable energy sales on green power markets are an area for further consideration and research.

11 Conclusions and Observations

We estimate that about 5.5 million customers procured about 112 million MWh of voluntary green power in 2017. And, the U.S. voluntary green power market continues to grow steadily: we estimate sales increased by about 27% from 2016 to 2017. Green power sales increased for all seven green power products summarized in this report. Key trends by product include:

- **Utility green pricing:** Growth in sales continued to be driven by a few large programs, while sales remained stable in most programs. Utility green pricing programs are procuring more solar. Solar's share of green pricing sales increased from about 2% in 2013 to 14% in 2017 among the top 10 largest programs, and from less than 1% in 2013 to 6% in 2017 among the remaining green pricing programs.
- **Utility renewable contracts:** Sales increased by 17% from 2016 to 2017. Fourteen utilities now offer utility green tariff programs, and bilateral contracts have been signed in six states. New utility green tariff contracts were signed in 2017 in New Mexico and Nevada.
- **Competitive suppliers:** Sales increased by 0.9 million MWh (12%) from 2016 to 2017, primarily due to increases in sales by the largest competitive suppliers of green power.
- **Unbundled RECs:** Unbundled RECs continue to account for about half (46%) of the voluntary green power market in terms of sales. The number of customers procuring unbundled RECs continued to increase, perhaps reflecting marketing efforts to residential and small commercial customers.
- **CCAs:** Sales increased by 2.3 million MWh (73%) in California, Massachusetts, New York, and Ohio but declined by 1.5 million MWh (29%) in Illinois from 2016 to 2017, resulting in a net year-over-year increase of about 0.8 million MWh (10%). The ongoing expansion of green power CCAs in California, Massachusetts, and New York was likely to drive further growth in CCA green power sales in future years.
- **PPAs:** Green power sales through PPAs more than doubled from 2016 to 2017, accounting for nearly half of the total increase in U.S. voluntary green power sales. The significant increase was due primarily to PPA contracts that were signed in 2015 and came online for the first time in 2017.
- **Community solar:** Three large utility-administered programs and one CCA-administered community solar program now retire RECs on behalf of subscribers, and they generated about 4.7 million MWh of green power in 2017. However, the vast majority of community solar projects do not retire RECs on behalf of subscribers; these additional projects generated about 62.3 million MWh of solar output in 2017.

The ongoing growth of the U.S. voluntary green power market is driven primarily by (1) increased sales of existing products, especially unbundled renewable energy certificates—which grew by 32 million MWh from 2010 to 2017—but also by (2) the expansion of new products such as CCAs and PPAs—which together grew by 29 million MWh from 2010 to 2017. As these new products expand, there is the potential for customer confusion and for customers to misunderstand the impact of their purchases. Measures to increase product transparency, particularly for new products such as CCAs and community solar, could help customers better understand the impact of their purchasing decisions.

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Appendix. State-by-State Data Tables

This appendix provides state-level estimates of green power participation (Table A-1) and generation (Table A-2). These state-level estimates are approximations based on the best available data and should be treated as such.

Table A-1. Green Power Customers by State

State	Utility Green Pricing	Utility Contracts	Competitive Suppliers	Unbundled RECs	CCAs	PPAs	Community Solar	Total
AK	173	0	0	14	0	0	0	**187**
AL	7,808	0	0	239	0	0	0	**8,047**
AR	0	0	0	54	0	1	0	**55**
AZ	9,946	0	0	482	0	1	0	**10,429**
CA	124,991	0	1,003	21,530	1,238,840	131	2,029	**1,388,524**
CO	60,732	0	0	9,283	0	0	0	**70,015**
CT	0	0	35,476	1,102	0	0	0	**36,578**
DC	0	0	10,223	644	0	0	0	**10,867**
DE	343	0	4,647	172	0	0	0	**5,162**
FL	2,964	0	0	497	0	10	0	**3,471**
GA	17,091	1	0	783	0	5	0	**17,880**
HI	0	0	0	35	0	7	0	**42**
IA	5,178	2	0	1,045	0	0	0	**6,225**
ID	29,726	0	0	729	0	0	2,680	**33,135**
IL	4,181	0	138,936	5,834	463,000	6	0	**611,957**
IN	11,631	0	0	1,469	0	1	0	**13,101**
KS	1,433	0	0	3,899	0	5	0	**5,337**
KY	5,653	0	0	345	0	0	0	**5,998**
LA	0	0	0	109	0	0	0	**109**
MA	7,457	0	96,107	4,452	860,712	2	0	**968,730**
MD	0	0	59,994	3,188	0	3	0	**63,185**

State	Utility Green Pricing	Utility Contracts	Competitive Suppliers	Unbundled RECs	CCAs	PPAs	Community Solar	Total
ME	0	0	18,906	134	0	1	0	**19,041**
MI	18,806	0	38	7,650	0	0	0	**26,494**
MN	63,409	0	0	9,719	0	2	0	**73,130**
MO	6,765	0	0	1,066	0	0	0	**7,831**
MS	133	0	0	37	0	1	0	**171**
MT	1,707	0	0	86	0	0	0	**1,793**
NC	10,012	3	0	674	0	13	0	**10,702**
ND	621	0	0	14	0	1	0	**636**
NE	1,391	1	0	26	0	1	0	**1,419**
NH	0	0	11,118	526	0	0	0	**11,644**
NJ	0	0	70,602	879	0	2	0	**71,483**
NM	3,588	0	0	266	0	0	0	**3,854**
NV	3,412	4	0	75	0	0	0	**3,491**
NY	24,462	0	229,274	15,246	64,002	4	0	**332,988**
OH	2,966	0	84,460	5,713	99,698	2	0	**192,839**
OK	3,342	1	0	56	0	9	0	**3,408**
OR	214,499	0	3	47,310	0	1	0	**261,813**
PA	0	0	198,131	2,853	0	1	0	**200,985**
RI	4,803	0	13,435	153	0	0	0	**18,391**
SC	7,192	0	0	766	0	1	0	**7,959**
SD	439	0	0	13	0	0	0	**452**
TN	10,287	1	0	1,704	0	4	0	**11,996**
TX	21,432	0	718,148	5,301	0	47	0	**744,928**
UT	25,591	0	0	9,404	0	4	0	**34,999**
VA	28,912	2	67	6,060	0	4	0	**35,045**

State	Utility Green Pricing	Utility Contracts	Competitive Suppliers	Unbundled RECs	CCAs	PPAs	Community Solar	Total
VT	3,357	0	0	20	0	0	0	**3,377**
WA	85,996	0	1	13,118	0	0	0	**99,115**
WI	26,886	0	0	6,132	0	0	0	**33,018**
WV	0	0	0	53	0	2	0	**55**
WY	25,686	0	0	1,040	0	1	0	**26,727**

Table A-2. Estimated Green Power Production (MWh) by State of Origin[a]

State	Utility Green Pricing	Utility Contracts	Competitive Suppliers	Unbundled RECs	CCAs	PPAs	Community Solar	Total
AK	813	0	0	37,394	0	0	0	38,207
AL	110,829	0	0	90,590	0	0	0	201,419
AR	0	0	0	182,553	0	27,200	0	209,753
AZ	209,734	0	0	72,886	32,654	54,141	0	369,415
CA	596,194	0	12,776	485,232	1,566,794	2,290,502	36,996	4,988,494
CO	405,253	0	0	437,650	293,886	0	0	1,136,789
CT	0	0	43,557	0	490	0	0	44,047
DC	0	0	449,311	0	0	0	0	449,311
DE	54,153	0	92,171	0	0	0	0	146,324
FL	13,908	0	0	1,051,183	0	22,245	0	1,087,336
GA	209,665	111,033	0	698,733	0	53,714	0	1,073,145
HI	0	0	0	0	0	256,922	0	256,922
IA	61,896	1,661,100	52,304	1,970,807	523,031	0	0	4,269,138
ID	905,518	0	0	1,216,976	65,308	0	43,418	2,231,220
IL	130,466	0	1,692,230	525,130	1,394,749	893,609	0	4,636,184
IN	26,725	0	0	3,011	174,344	0	0	204,080
KS	6,723	0	0	4,257,380	0	1,581,381	0	5,845,484
KY	104,641	0	0	19,527	0	0	0	124,168
LA	0	0	0	63,200	0	0	0	63,200
MA	26,636	0	144,700	118	153,704	10,044	0	335,202
MD	0	0	336,826	0	592,768	10,929	0	940,523
ME	0	0	1,282	0	72,454	69,248	0	142,984
MI	125,762	0	48,763	126,558	0	0	0	301,083
MN	341,141	0	0	616,297	139,475	18,291	0	1,115,204
MO	74,774	0	0	99,297	139,475	0	0	313,546
MS	79,027	0	0	6,408	0	0	0	85,435
MT	171,145	0	0	37,248	13,062	0	0	221,455

State	Utility Green Pricing	Utility Contracts	Competitive Suppliers	Unbundled RECs	CCAs	PPAs	Community Solar	Total
NC	170,906	188,288	0	329,582	0	452,584	0	1,141,360
ND	37,011	0	0	1,928,584	139,475	5,186	0	2,110,256
NE	40,624	118,260	0	2,124,820	0	21,150	0	2,304,854
NH	0	0	3,741	1,963	34,936	0	0	40,640
NJ	0	0	108,870	272	0	21,550	0	130,692
NM	179,788	0	0	1,031,884	0	0	0	1,211,672
NV	179,079	234,535	0	151,949	9,796	0	0	575,359
NY	103,050	0	838,933	9,369	25,835	15,796	0	992,983
OH	66,461	0	160,563	350	174,344	549,998	0	951,716
OK	15,679	163,987	0	13,110,962	0	3,955,166	0	17,245,794
OR	865,813	0	0	601,577	65,308	131,242	0	1,663,940
PA	0	0	458,859	92,180	152,496	67,575	0	771,110
RI	21,799	0	35	0	34,936	0	0	56,770
SC	33,745	0	0	212,638	0	4,601	0	250,984
SD	36,158	0	0	1,191,466	34,869	0	0	1,262,493
TN	79,027	17,608	0	33,885	0	23,694	0	154,214
TX	898,543	0	13,549,454	15,902,710	1,642,005	10,441,515	0	42,434,227
UT	525,712	0	0	845,101	6,531	10,820	0	1,388,164
VA	124,487	293,285	0	21,377	0	137,532	0	576,681
VT	16,235	0	0	0	21,563	0	0	37,798
WA	1,037,122	0	0	513,918	1,044,929	0	0	2,595,969
WI	237,227	0	106,208	128,079	69,737	0	0	541,251
WV	0	0	32,556	7,387	34,869	137,182	0	211,994
WY	526,531	0	0	530,839	32,654	6,789	0	1,096,813

[a] Sums across totals and states do not add to total green power sales because about 1.2 million MWh of green power is sourced from Canada

Exhibit JAL-12

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BOUNDLESS ENERGY™

Legal Department

American Electric Power
1 Riverside Plaza
Columbus, OH 43215-2373
AEP.com

December 13, 2017

Asim Z. Haque
Chairman, Public Utilities Commission of Ohio
Public Utilities Commission of Ohio
180 East Broad Street
Columbus Ohio 43215-3793

Re: *In the Matter of Ohio Power Company's Generation Transition Docket,* Case No. 17-882-EL-UNC

Steven T. Nourse
Chief Ohio Regulatory Counsel
(614) 716-1608 (P)
(614) 716-2014 (F)
stnourse@aep.com

Dear Chairman Haque:

On behalf of Ohio Power Company (AEP Ohio), I am submitting the enclosed report entitled "Ohio Renewable Energy Manufacturing & Company Establishment Analysis" conducted by Navigant Consulting, Inc. Submittal of this report fulfills Paragraph III.D.12.e of the Joint Stipulation and Recommendation in Case Nos. 14-1693-EL-RDR and 14-1694-EL-AAM (PPA Rider Stipulation). The report will also be referenced in the Company's 2018 annual update filing, but the Company wanted to submit it now since it is already completed.

Thank you for your attention to this matter.

Respectfully Submitted,

//s/ Steven T. Nourse

cc: Parties of Record

NAVIGANT

Ohio Renewable Energy Manufacturing & Company Establishment Analysis

Prepared for:
AEP Ohio

AEP OHIO
An AEP Company

FINAL

Submitted by:
Navigant Consulting, Inc.
1375 Walnut St. #100
Boulder, CO 80302

303.728.2500
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December 13, 2017

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DISCLAIMER

This report was prepared by Navigant Consulting, Inc. (Navigant) for AEP Ohio. The work presented in this report represents Navigant's professional judgment based on the information available at the time this report was prepared. Navigant is not responsible for the reader's use of, or reliance upon, the report, nor any decisions based on the report. NAVIGANT MAKES NO REPRESENTATIONS OR WARRANTIES, EXPRESSED OR IMPLIED. Readers of the report are advised that they assume all liabilities incurred by them, or third parties, as a result of their reliance on the report, or the data, information, findings and opinions contained in the report.

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EXECUTIVE SUMMARY

BACKGROUND

In PPA Stipulation Section III.D.12. e., the Public Utilities Commission of Ohio (PUCO) directed AEP Ohio to "perform an analysis about how to bring or encourage companies to establish renewable energy companies with headquarters and manufacturing plants in Ohio and how to transition the current power plant workforce to such job opportunities."[1] AEP Ohio retained Navigant, an independent third party, to conduct this analysis. Navigant completed six tasks with the goal of providing actionable strategies for achieving the goals outlined in the stipulation.

Table E-1. Task Goals

Project Task	Task Goal
1. Initiate Project	Confirm project goals and define communication plans.
2. Develop Company Motivators	Catalog the reasons why renewable energy companies locate where they do and rank them in order of importance.
3. Define State Strategies	Characterize the different strategies used by states and discuss their relative success.
4. Assess in Ohio	Establish a baseline number and type of renewable energy companies already in Ohio.
5. Map Career Transitions	Define pathways for existing conventional power plant workers to move into the renewable energy industry as jobs decline in conventional power plants.
6. Develop Recommendations & Findings	Develop high-impact, feasible options for the state of Ohio to encourage renewable energy companies and manufacturers to set up headquarters in Ohio.

This report details the research and findings of Navigant's analysis and provides a roadmap for encouraging renewable energy companies to establish in or locate to Ohio while also providing pathways for power plant workers to transition into these opportunities.

RENEWABLE ENERGY COMPANY MOTIVATORS

Navigant began this study by determining the factors that drive renewable energy development and services companies and manufacturers to locate headquarters or manufacturing facilities in a certain area. Navigant developed a six-category framework that significantly affect different operational factors and ultimately influence locational decisions, ranking these locational motivators for both renewable companies focused on development and services and manufacturers. These factors serve as levers for states to pull to drive regional renewable energy company growth.

[1]Public Utilities Commission of Ohio, Opinion and Order, Case No. 14-1693-EL-RDR and Case No. 14-1694-EL-AAM, PPA Stipulation Section III.D.12.e.

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Figure E-1. Renewable Energy Company & Manufacturer Locational Motivators

STATE STRATEGIES

Navigant characterized strategies used by states to target companies and manufacturers and discussed each strategies' relative success. This analysis resulted in four overarching themes.

Figure E-2. State Strategies Framework

Based on our analysis, Navigant focused on incentives and policy and created a scoring system to assess wind and solar strategies by state and determine whether there was a correlation between these strategies and the number of solar and wind jobs per state. From this analysis, the team verified that policies, such as RPS, Net Metering, third-party PPAs, and financial incentives, in addition to solar resource availability and high electric rates, play a large role in driving solar jobs at the state level. Meanwhile policies and financial incentives play a less significant role in the growth of wind jobs, due in large part to the types of wind jobs available.

ASSESS OHIO

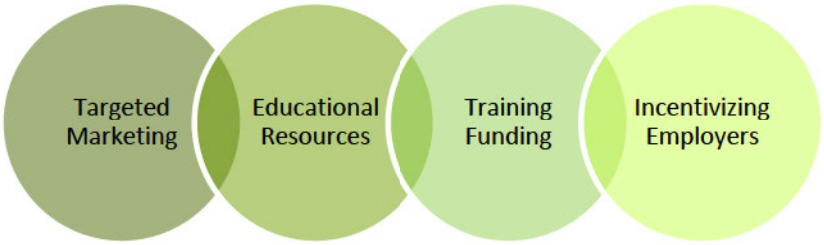
Navigant assessed the current state of jobs and companies in Ohio, aimed at establishing a baseline for the renewable energy companies in Ohio and helping Navigant target its findings and recommendations to allow for sustained renewable energy company and job growth. Our analysis found that many companies of different sizes and types are currently operating in Ohio.

MAP CAREER TRANSITION

Navigant examined strategies for the state of Ohio to facilitate employee transition to renewable energy opportunities as they arise. Based on the research and resources available, Navigant developed a pathway for transitioning from a conventional power plant career to a renewable energy career. Navigant

identified four strategies that key stakeholders can enact. The strategies are intended to work in conjunction, utilizing different levers for helping conventional power plant workers transition.

Figure E-3. Strategies for Facilitating Career Transition



FINDINGS & RECOMMENDATIONS

Navigant developed four guiding principles for implementing strategies to grow a localized renewable energy market, increasing the number of companies and jobs within the state. The guiding principles were: market stability, consistent programs, workforce preparation, and research and development. Using these principles, Navigant developed five actionable recommendations for the state and local governments to implement to drive renewable energy company and job growth. Table E-2 lists the recommendations.

Table E-2. Study Recommendations

Number	Recommendation
1	Publish multi-year state renewable energy procurement plan, led by the state or a state-wide body.
2	Expand JobsOhio to include: • Renewable energy education platform providing career transition resources. • Concierge service to answer renewable energy questions.
3	Remove permitting barriers.
4	Invest in Research & Development.
5	Continue to invest in roads and infrastructure.

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1. INTRODUCTION

1.1 STUDY BACKGROUND

In PPA Stipulation Section III.D.12. e., the PUCO directed AEP Ohio to "perform an analysis about how to bring or encourage companies to establish renewable energy companies with headquarters and manufacturing plants in Ohio and how to transition the current power plant workforce to such job opportunities."[2] AEP Ohio retained Navigant, an independent third party, to conduct this analysis.

This report lays out the findings from the study, providing an in-depth overview of why renewable energy companies establish in specific locations, strategies for attracting these companies, and how different stakeholders can participate in the transitioning of conventional power plant workers to renewable energy opportunities. Ultimately, the analysis serves as a roadmap for encouraging renewable energy companies, particularly in the wind and solar industry, to establish in Ohio and for training and connecting workers to renewable energy opportunities as they arise.

1.2 STUDY GOALS

To provide actionable recommendations, Navigant created a list of questions to guide the analysis. The questions centered on renewable energy company motivators, existing strategies for encouraging regional renewable energy development (and therefore driving regional company location), and pathways for transitioning conventional power plant workers to renewable energy careers. The list below provides these questions.

- What are the factors that drive companies to locate headquarters or manufacturing facilities?
- What strategies do other states use to encourage companies to locate in their state?
- What renewable energy companies currently have headquarters or manufacturing in Ohio?
- And what attracted these companies to locate operations in Ohio or to leave Ohio?
- How can the current power plant workforce transition to work in the renewable energy industry?
- What actions should Ohio take to encourage renewable energy companies to set up headquarters in Ohio?

Based on these questions, Navigant developed a framework of six tasks to explore and answer the questions outlined above, ultimately providing actionable strategies for AEP Ohio and the state of Ohio. Table 1-1 below provides an overview of Navigant's framework.

Table 1-1. Task Goals

Project Task	Task Goal
1. Initiate Project	Confirm project goals and define communication plans.
2. Develop Company Motivators	Catalog the reasons why renewable energy companies locate where they do and rank them in order of importance.

[2] Public Utilities Commission of Ohio, Opinion and Order, Case No. 14-1693-EL-RDR and Case No. 14-1694-EL-AAM, PPA Stipulation Section III.D.12.e.

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3.	Define State Strategies	Characterize the different strategies used by states and discuss their relative success.
4.	Assess Ohio	Establish a baseline number and type of renewable energy companies already in Ohio.
5.	Map Career Transitions	Define pathways for existing conventional power plant workers to move into the renewable energy industry as jobs decline in conventional power plants.
6.	Develop Recommendations & Findings	Develop high-impact, feasible options for the state of Ohio to encourage renewable energy companies and manufacturers to set up headquarters in Ohio.

1.3 REPORT ORGANIZATION

Navigant organized the report to align to the study goals and tasks:

- **Section 2: Company Motivators** – Research and resulting framework for why companies locate where they do.
- **Section 3: State Strategies** – Outline and relative success rank of state strategies for encouraging regional growth or renewable energy companies.
- **Section 4: Assess Ohio** – Definition of solar and wind value chains and map of solar and wind companies located in Ohio.
- **Section 5: Map Career Transitions** – Pathway and strategies to help existing power plant workers transition to the renewable energy industry.
- **Section 6: Findings & Recommendations** – Actionable strategies for the state of Ohio to consider increasing the development of renewable energy companies in the State.

The report includes 2 appendices, which provide additional information:

- Case study key takeaways from renewable energy companies on locational decision-making and stakeholder recommendations.
- Resources for transitioning conventional power plant workers to renewable energy jobs, mentioned in Section 5, Renewable Energy Career Transitioning.

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2. COMPANY MOTIVATORS

Navigant began this study by determining the factors that drive renewable energy development and services companies and manufacturers to locate headquarters or manufacturing facilities in a certain area, ranking these locational motivators. Navigant gained an understanding of locational motivators and how they align to various state strategies for the regional development of renewable energy manufacturers and companies. The findings ultimately resulted in valuable insight into how renewable energy companies may react to proposed strategies. Figure 2-1 illustrates the overarching locational motivators Navigant identified. This section explains the approach and key resources and provides details on the findings.

Figure 2-1. Renewable Energy Company & Manufacturer Locational Motivators

Source: Navigant 2017

2.1 APPROACH

Navigant used a four-step approach to identify, prioritize, and validate the top locational motivators for renewable energy companies and manufacturers. The steps include: conducting general research, brainstorming the initial list of drivers, prioritizing the drivers, and validating the prioritization through additional primary and secondary research. The first step involved examining national and global studies related to regional development as well as measures of "competitiveness" that influence market growth in a specific region. This step yielded a comprehensive catalog of drivers that influence companies and/or manufacturers picking one location over another. Navigant then translated this catalog into overarching categories, leveraging the team's expertise in renewable energy and past Navigant studies. Following the finalization of the locational motivator categories, the team created a qualitative prioritization framework based on renewable energy industry specific studies validating the prioritization through industry interviews and additional market research. The list below details the key sources used throughout the process.

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- U.S. Government National Network for Manufacturing Innovation Report[3]
- World Economic Forum Studies[4]
- National Renewable Energy Laboratory (NREL) Studies[5,6]
- Deloitte's Global Manufacturing Competitiveness Index[7]
- Company Case Studies[8]
- Recent News Articles[9, 10,11]

2.2 FRAMEWORK

Navigant created a framework of locational motivators for renewable energy companies and manufacturers. The framework consists of six categories that significantly affect different operational factors and ultimately influence locational decisions. These factors serve as levers to pull to drive regional renewable energy company growth. Table 2-1 details the locational motivators framework for renewable energy companies and manufacturers.

"Moved locations because we wanted to make this into a real business. To make an impact, we needed to be close to a large population."
– Dovetail Wind & Solar

[3] President's Council of Advisors on Science and Technology, Accelerating US Advanced Manufacturing, October 2014, https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/amp20_report_final.pdf
[4] World Economic Forum, The Future of Manufacturing: Opportunities Drive Economic Growth, 2012, http://www3.weforum.org/docs/WEF_MOB_FutureManufacturing_Report_2012.pdf
[5] NREL, Manufacturing Conditions in the Global Wind Industry, https://www.nrel.gov/docs/fy14osti/60063.pdf..
[6] NREL, Carbon Fiber Manufacturing Facility Siting, https://www.nrel.gov/docs/fy17osti/66875.pdf .
[7] Deloitte, 2016 Global Manufacturing Competitiveness Index, 2016, https://www2.deloitte.com/global/en/pages/manufacturing/articles/global-manufacturing-competitiveness-index.html.
[8] See Appendix A for details.
[9] The Journal News, "Start-up Business for Water-Power Technology to Open in Hamilton", December 2013, http://www.journal-news.com/news/start-business-for-water-power-technology-open-hamilton/GSCQ3bLbOzaTrRGLDscYHM/
[10] Toledo Blade, "Toledo Area Could Get Another Solar Plant with 600 Jobs", 2010, http://www.toledoblade.com/local/2010/10/15/Toledo-area-could-get-another-solar-plant-with-600-jobs.html
[11] Smart Energy Decisions, "Renewable Energy Access Lures Facebook to Ohio", August 18, 2017, https://www.smartenergydecisions.com/blog/2017/08/18/renewable-energy-access-lures-facebook-to-ohio?contact_id=59160&inf_contact_key=f87cf785d4ce3888273549c39b9591175051586c7ca7f86891a0a3ada8f79751

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Table 2-1. Renewable Energy Company & Manufacturer Locational Motivators Framework

Motivators	Description	Examples
Renewable Energy Market 	The Renewable Energy Market encompasses the localized climate for building renewables, including policy, permitting, and financial factors. These factors can help reduce long term business and financial risks as well as improve the ease of project development.	• Project economics, including electric rates, renewable energy resource availability, and inexpensive land • Policy, including Renewable Portfolio Standards (RPS), Net Energy Metering (NEM), and Solar Renewable Energy Credits (RECs) • Supportive permitting and financing
Supportive Schemes 	Supportive Schemes include incentives for developing a renewable energy product. These schemes can tip the scales in favor of a location if they reduce costs or provide long-term advantages, such as low-cost, innovative R&D opportunities.	• Investment in Research & Development (R&D) • Equipment / manufacturing incentives • Grants
Workforce 	Workforce incorporates various labor aspects, including worker preparedness, access to training or educational resources, and cost of labor.	• Education and training program accessibility • Specialized knowledge via universities • Inexpensive labor
Logistics 	Logistics encompass ease of access to a stable product or end-user market via transportation corridors or proximity.	• Infrastructure / distribution access • Proximity to stable market
Operating Expenses 	Operating expenses include the cost of doing business in a location.	• Inexpensive land • Electric rates • Facility rents • State and local taxes
Supply Chain 	Supply chain includes the entire product value chain.	• Supplier market

Source: Navigant 2017

2.3 PRIORITIZATION

Using the framework described, Navigant investigated renewable energy-specific studies, recent company relocations, and firsthand case studies to prioritize each category. Navigant created two separate lists, one for general renewable energy companies and one for manufacturers of wind and

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"We knew within a fifteen-mile radius where we wanted to be… which is very close to the I-70/75 highway crossroads." – Energy Optimizers, USA

solar products, due to differing needs for these businesses. For example, manufacturers need to be located near transportation corridors to move products from different factories for assembly or installation. Meanwhile, renewable energy developers or service firms may prioritize a location near an end-user market to sell their product. The prioritized lists in Table 2-2 represent the most influential drivers in renewable energy company and manufacturer decision-making. This list provides a pathway for determining actionable strategies to entice companies to locate in a certain area.

Table 2-2. Renewable Energy Company and Manufacturer Prioritized Locational Motivators

Rank	Company Locational Motivators	Manufacturer Locational Motivators
1	Renewable Energy Market	Workforce
2	Supportive Schemes	Logistics
3	Workforce	Supply Chain
4	Logistics	Operating Expenses
5	Supply Chain	Supportive Schemes
6	Operating Expenses	Renewable Energy Market

Source: Navigant 2017

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3. STATE STRATEGIES

Navigant characterized strategies used by states to target companies and manufacturers and discussed each strategies' relative success. Task 3 leverages the findings from Task 2 to identify specific and actionable levers for sustained renewable energy company and job growth with the aim of understanding possible high-value strategies. Given that many states and counties have been targeting renewable energy companies and jobs for the last 10 to 15 years, Navigant focused on gaining an understanding of how these strategies have influenced the number of renewable energy jobs and companies to-date.

This analysis resulted in four overarching themes defined in Figure 3-1. The following section provides additional details about the approach for developing this framework and the success of these strategies.

Figure 3-1. State Strategies Framework

Source: Navigant 2017

3.1 APPROACH

Navigant conducted a three-phase approach which involved researching existing literature, identifying strategies, and evaluating each strategies' success. The process began with conducting a literature search incorporating case study details, trade industry information, current initiatives, and information from the Database of State Incentives for Renewables and Efficiency (DSIRE).[12] Like the locational driver analysis, the research yielded a catalog of strategies employed by states to draw renewable energy companies and jobs to their state. Due to the volume of strategies, Navigant grouped these findings by similarity to get an overview of the types of strategies available. Finally, the team evaluated the success of each of the strategies by assigning scores to them at the state level. These scores were then compared against the number of wind and solar jobs in that respective state to test the legitimacy of the scoring. The entire analysis leveraged the sources in the list below.

- NREL Studies[13]
- The Solar Foundation, SolSmart Initiative Funded by the Department of Energy (DOE)[14]
- Database of State Incentives for Renewables & Efficiency (DSIRE)[15]

[12] NC Clean Energy Technology Center, Database of State Incentives for Renewables and Efficiency (DSIRE), http://www.dsireusa.org/.
[13] NREL, The Role of State Policy in Renewable Energy Development, July 2009, https://www.nrel.gov/docs/fy09osti/45971.pdf .
[14] The Solar Foundation, SolSmart Initiative, https://www.thesolarfoundation.org/policy-research/solsmart/ .
[15] NC Clean Energy Technology Center, Database of State Incentives for Renewables & Efficiency, http://www.dsireusa.org/.

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- The Solar Foundation 2016 Solar Job Census[16]
- American Wind Energy Association State Fact Sheets[17]
- Existing Navigant Studies[18]
- Energy Information Administration, Electric Rates[19]

3.2 FRAMEWORK

Navigant's approach resulted in a four-category framework of strategies employed by states to incentivize companies and manufacturers to locate in and ultimately bring jobs to their state. This framework aims to explain strategies currently used, providing an overview of possibilities for the state of Ohio. Table 3-1 outlines the framework created.

Table 3-1. State Strategies Framework

Strategies	Description	Examples
Incentives 	Incentive strategies encompass any method of reducing the cost of doing business.	• Tax credits • Rebates • Subsidies • Performance-based incentives • Grants • Loans • Employment Incentives
Policy 	Policy strategies include regulations that increase market certainty, reducing the risk and improving the ease of doing business within the state.	• Renewable Portfolio Standards (RPS) • Net Metering (NEM) • Renewable Energy Credits (RECS) • Green tariffs • Community development zones • Preferred or required local sourcing

[16] The Solar Foundation, Solar Job Census 2016, https://www.thesolarfoundation.org/national/.
[17] American Wind Energy Association, US Wind Energy State Facts, https://www.awea.org/resources/statefactsheets.aspx?itemnumber=890&navItemNumber=5067.
[18] Navigant, Washington State Clean Energy Leadership Plan for the Washington Clean Energy Leadership Council, http://www.efsec.wa.gov/Whistling%20Ridge/Adjudication/Intervenor's%20pre-filed%20testimony/Ex%2034-05,%20CELC%20extract.pdf.
[19] Energy Information Administration, Table 5.6.A. Average Price of Electricity to Ultimate Customers by End-Use Sector, by State, July 2017 and 2016, July 2017, https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_6_a

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Market Awareness 	Market awareness strategies encompass building a market for renewable energy by educating consumers, providing opportunities for projects (e.g. through project aggregation), and any other strategies that encourage end-users to partake in the industry.	• Market awareness education • Choices for customers (market access) • Local organizations/co-ops for project aggregation, policy lobbying, and market education
Company Support 	Customer support strategies include methods for supporting prospective renewable energy companies/employers. These strategies include funding as well as general assistance.	• Workforce training • Incentives for industry development • Employee search assistance • Property search assistance • Funding demonstration projects • Focus on building research, technology transfer, and university capabilities

Source: Navigant 2017

3.3 STRATEGY EVALUATION

"RPS policies continue to play a central role in supporting RE growth." - NREL

With the framework defined, Navigant focused on evaluating the success of the policy and incentive strategies, stemming from two recent reports from the National Renewable Energy Laboratory (NREL) and the Lawrence Berkeley National Laboratory (LBNL), industry-leading renewable energy research organizations. LBNL recently published its 2017 Annual Status Report of US Renewable Portfolio Standards, which included an analysis of the historical impacts of RPS on renewables development, concluding that "roughly half of all growth in US renewable electricity (RE) generation and capacity since 2000 is associated with state RPS requirements."[20] Likewise a 2014 report from NREL came to a similar conclusion, finding that "niche incentives, only when layered on top of high quality market access policies, can support distributed generation penetration in target markets."[21] In short, the two reports support the idea that policies and incentives are the main drivers for renewable energy market growth, which in turn spurs renewable energy job growth.

Given this information, Navigant created a scoring system to assess wind and solar strategies by state and determine whether there was a correlation between these strategies and the number of solar and wind jobs per state. The solar scoring accounted for RPS, NEM, Solar Renewable Energy Credits (SRECs), third party PPAs, the number of financial incentives available as well as non-policy market factors, such as electric rates and solar resource availability. The wind scoring included RPS, the number of financial incentives, electric rates, and wind resource availability. Table 3-2 shows the scoring framework for all policies and incentives assessed.

[20] Lawrence Berkeley National Laboratory (LBNL), US Renewables Portfolio Standards: 2017 Annual Status Report Abstract, https://emp.lbl.gov/publications/us-renewables-portfolio-standards-0.
[21] National Renewable Energy Laboratory (NREL), "Are Incentives the Thing?", December 2014, https://www.nrel.gov/docs/fy15osti/63059.pdf.

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Table 3-2. State Strategy Scoring Framework

Categories	Scoring
RPS*	RPS Standards – 4 RPS Goals – 2 No RPS – 0
Net Metering**	Net Metering – 2 Other Rules – 1 No Net Metering – 0
SRECs**	SRECs – 2 SRECs Eligible – 1 No SRECs – 0
Third Party PPAs	Third party PPAs – 1 No Third party PPAs – 0 Status Unclear – 0
Financial Incentives	Many state incentives – 2 Some state incentives – 1 Few state incentives – 0
Electric Rates*	High Rates – 4 Medium Rates – 2 Low Rates – 0
Wind & Solar* Resources	High Resource – 4 Medium Resource – 2 Little Resource – 0

Source: Navigant 2017

**Navigant applied extra weight to these categories given influence on wind or solar developments.*

*** Only used in solar scoring framework*

Navigant chose to add additional weights to RPS, electric rates, and wind and solar resource availability due to their significant influence on renewable energy development. For example, ample sunshine or wind resources reduce business risk while high electric rates improve the financials of developing these resources. Figure 3-2 shows the scoring calculations to assess state strategies for both wind and solar.

Figure 3-2. State Strategy Scoring Calculations

Solar Strategy Score **=** *RPS + Net Metering + SRECs + Third Party PPAs + Financial Incentives + Electric Rates + Solar Resources*

Wind Strategy Score = *RPS + Financial Incentives + Electric Rates + Wind Resources*

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3.3.1 Solar

The calculations resulted in a ranking of states according to their strategy score. To determine the success of these strategies, Navigant compared the rankings to the number of solar jobs in each state.[22] The table below shows the 10 states with the most jobs per capita and their associated Navigant strategy rank.

Table 3-3. Top 10 Solar Job States vs. Navigant Strategy Rank

Top 10 Solar Job States[23]	State	State Solar Jobs per Capita[24]	Navigant Strategy Framework State Rank[25]
1	California	100,050	1
2	Massachusetts	14,582	5
3	Texas	9,396	15
4	Nevada	8,371	13
5	Florida	8,260	28
6	New York	8,135	15
7	Arizona	7,310	5
8	North Carolina	7,112	5
9	New Jersey	6,056	4
10	Colorado	6,004	3

See footnotes for sources.

As shown above, nine of the top ten solar jobs states land within the top fifteen of Navigant's ranking. The only exception is Florida, which has a particularly strong solar resource and therefore, high number of jobs, despite having fewer policies and financial incentives than its peers. This reinforces the idea that policies and incentives drive market and job growth in the solar industry. In Figure 3-3, Navigant plotted the rankings against the number of jobs per capita per state for the entire country to demonstrate the correlation.

State-level and national policies drive a large portion of business model decisions, particularly related to the location of regional offices and manufacturing. - First Solar

[22] Navigant extracted state jobs data from The Solar Foundation, The 2016 Solar Job Census, https://www.thesolarfoundation.org/national/.
[23] Ibid.
[24] Ibid.
[25] Navigant analysis.

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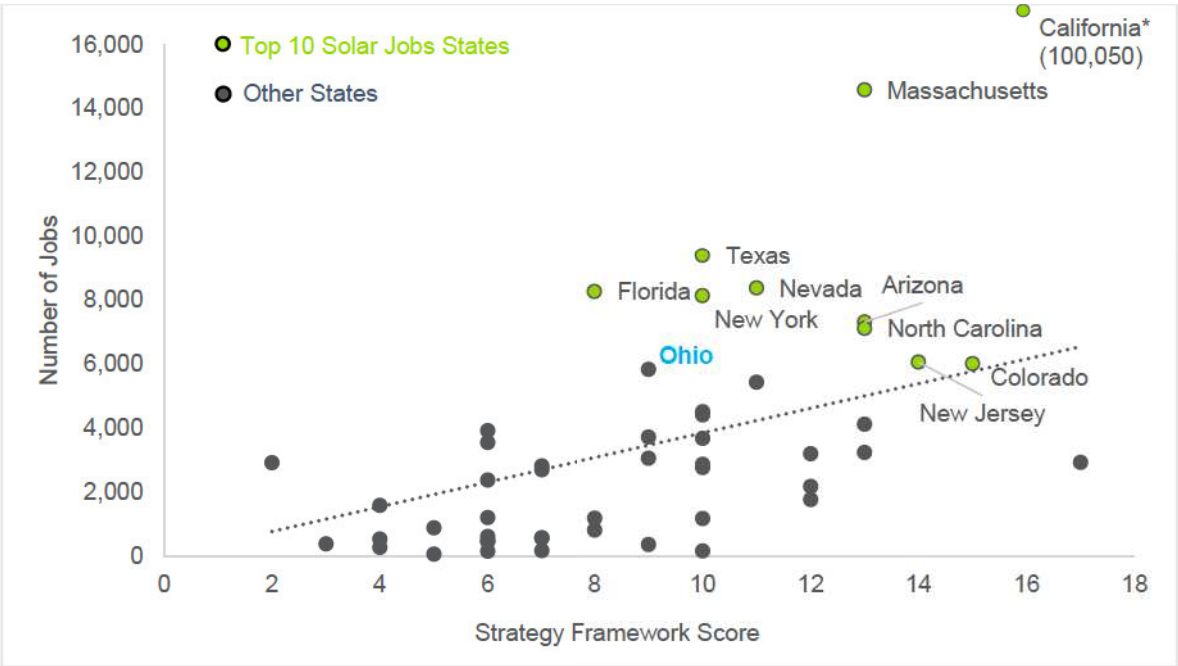
Figure 3-3. Solar Jobs per Capita vs. Solar Strategies



Source: Navigant 2017

**Navigant removed California from the scatter plot and added separately due to the magnitude of jobs in California.*

The plot shows that strong policies and incentives, high electric rates, and a robust solar resource correlates with a high number of solar jobs.

3.3.2 Wind

Similar to the solar analysis, Navigant compared the wind strategy score against the number of wind jobs per state. The table below shows the results of this comparison.

Table 3-4. Top 10 Wind Job States vs. Navigant Strategy Rank

Top 10 Wind Job States[26]	State	State Wind Jobs[27]	Navigant Strategy Framework State Rank[28]
1	Colorado	4,144	15
2	Texas	2,979	15
3	Iowa	1,929	15
4	Ohio	1,626	11
5	Illinois	1,482	15

[26] American Wind Energy Association, Economic Development Impact of Wind Projects prepared by Navigant.
[27] Ibid.
[28] Navigant analysis.

Summary: Testimony Direct Testimony of Jonathan A. Lesser, Ph.D on Behalf of the Office of the Ohio Consumers Counsel - Public Version - Part 2 of 3 electronically filed by Ms. Deb J. Bingham on behalf of Willis, Maureen R Mrs.