The Growth in COMMUNITY CHOICE AGGREGATION

Impacts to California's GRID

NEXT 10

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The UCLA Luskin Center for Innovation appreciates the contributions of the aforementioned individuals. This paper, however, does not necessarily reflect their views nor is an endorsement of its findings. Any errors are those of the authors.

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I.

Executive Summary

AS California continues to transition its power mix toward more renewable energy sources, Community Choice Aggregators (CCAs) have emerged as a powerful player to achieve a clean energy future. CCAs allow cities and/or counties to aggregate the electrical loads of their residents, businesses, and municipal facilities to purchase energy on their behalf. Each CCA is administered with the mission to provide an alternative electricity service to the local investor-owned utility (IOU) and to reflect its community's preferences for energy procurement and local energy programs.

While CCAs are relatively new in California, they are rapidly growing in number. If current trends continue, they may serve a majority of IOUs' power customers within the next ten years and by doing so would likely transform the retail electricity sector across California. One transformative change that comes with the proliferation of CCAs is the rapid increase in renewable energy on the grid. This will increase the challenges that California already face to manage system-wide reliability. Due to the local and public nature of these entities, CCAs are well-positioned to address some of these grid challenges through local energy programs, and to coordinate more closely with customers.

Part of a series of briefs analyzing issues affecting the future of California's grid, this brief investigates trends in the growth of CCAs and their associated power mixes and local programs. The purpose of this brief is to analyze how CCAs have and may affect California's electricity grid, and help policymakers identify strategies to help optimize grid performance as more CCAs launch in the state.

Key takeaways include:

- **CCAs are relatively new, but on the rise**
  - » The cumulative share of CCA load in California is currently about 10 percent of the total state electricity consumption and should rise to 16 percent by 2020.
  - » Since the launch of the first CCA in 2010 (MCE), the number of CCAs launching per year has increased significantly. There were nine operational CCAs by the end of 2017 and at least eight new CCAs are expected to launch in 2018.
  - » This rapid growth is changing how market shares are distributed. In 2010, investor-owned utilities (IOUs) had 78 percent of the statewide market share but that share reduced to 70 percent in 2017. IOU market share is expected to continue decreasing to 64 percent by the end of 2018 and to approximately 57 percent in 2020.
- **CCAs are increasing renewables on the grid**
  - » The rise of CCAs has had both direct and indirect positive effects on overall renewable energy consumed in California, leading the state to meet its 2030 RPS targets approximately ten years in advance.
  - » Their direct effect has been to offer electricity to communities with renewable energy content ranging from 37 percent to 100 percent, and with a state-wide average of 52 percent in 2017.
  - » Because IOUs hold a large number of long-term renewable energy contracts but are losing customers to CCAs, the ratio of renewable energy per customer is thereby increased. As a result, CCAs are indirectly causing the share of IOUs' renewable energy to rise. In 2017, IOUs reported to produce between 32 percent and 44 percent of their electricity from renewable energies, and estimate that number to exceed 50 percent by 2020.
  - » Based on the California Public Utilities Commission's (CPUC) estimation that 85 percent of the state's load could depart IOUs for CCAs, direct access and distributed generation by 2030, the authors of this brief estimate that Pacific Gas & Electric (PG&E), Southern California Edison (SCE) and San Diego Gas & Electric (SDG&E) will have an average of 67 percent of renewable energy in their portfolio by 2025.
- **CCAs are cost-competitive but face challenges as new entities**
  - » CCA customer rates are currently lower than their incumbent IOU rates, ranging from -0.1 percent to -2.1 percent lower.
  - » When CCAs launch, they suffer from a lack of credit score and track record while needing power instantaneously and at a low price in order to keep customer retention as high as possible. As an example, MCE launched in 2010 but only became the first CCA to obtain a credit rating in 2018.
  - » The direct consequence of this is that CCAs in California are currently heavily relying on short-term contracts, which reduces long-term visibility for statewide energy procurement and capacity planning.

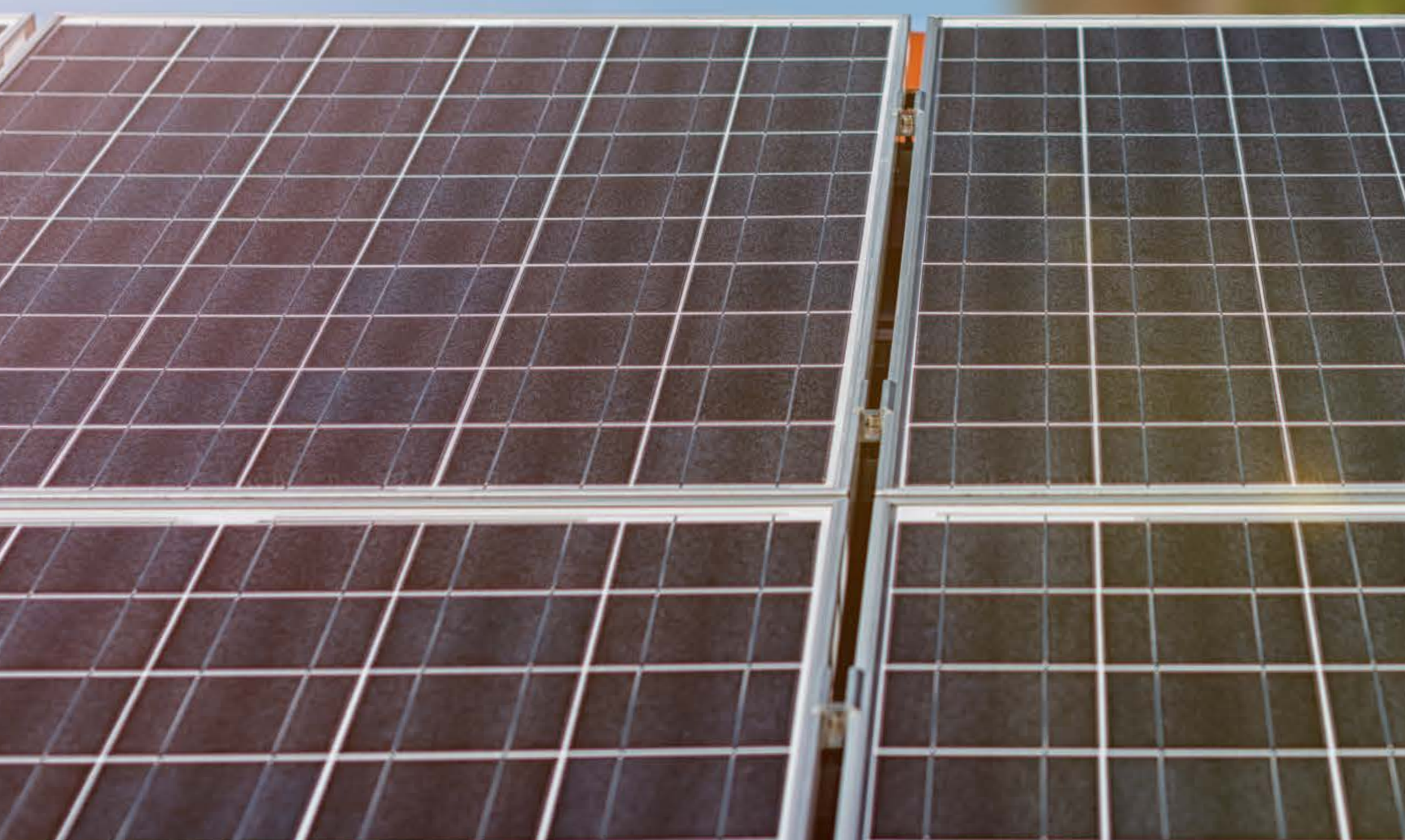
- **While the future development of CCAs remains uncertain, grid impacts thus far have been minimal**
    - » Because CCAs deliver electricity to existing customers that were previously served by IOUs, their impact on the transmission grid has been minimal to date.
    - » CCAs' focus thus far on biomass, geothermal and out-of-state wind means that they are not exacerbating some of the grid challenges associated with solar energy.
    - » Some CCAs rely more on out-of-state renewable energy generation than IOUs, and are therefore dependent on transmission lines, contributing to congestion costs. While CCAs will likely continue to grow in number, to date the average amount of out-of-state power purchased by CCAs does not greatly affect the grid.
- **The local and public nature of CCAs well positions them to implement energy programs that will provide grid benefits**
    - » Existing CCAs have developed innovative and tailored local programs that benefit the grid as well as their customers. Several types of their local programs, such as local energy generation, energy efficiency, storage and demand response, can provide grid benefits by reducing the need to import energy through long-distance transmission lines especially during peak times.
    - » For example, MCE and Sonoma Clean Power's total Feed-in Tariff installations have the capacity to produce 5,000 MWh per year and 9,300 MWh per year, respectively. The authors of this brief estimate that altogether, these two programs could generate a total of $1.3 million in avoided system-wide costs by increasing the amount of distributed generation on the grid.
    - » Compared to the IOUs, all CCAs' provide higher compensation rates to net energy metering (NEM) customers for the net surplus solar energy generated. These rates can be more than three times higher than the IOUs.
    - » MCE's multi-family energy efficiency program is more cost-effective than the comparable PG&E's program.

While this brief's analysis finds that CCAs have had a minimal impact on the transmission grid to date, looking forward, CCAs' greatest impact on the grid will come from their direct and indirect push for more renewable energy. As CCAs drive greater renewable energy investments, it is important that state regulators ensure that customers' energy needs are met affordably and reliably. This brief is intended to explore these trends to help inform decisions that will direct the future benefits that CCAs may provide for both customers and the grid.

II.

Introduction and Analysis Overview

COMMUNITIES across California are forming Community Choice Aggregators (CCAs) at a surprisingly rapid rate. CCAs allow cities and/or counties to aggregate the electrical loads of their residents, businesses, and municipal facilities to purchase energy on their behalf. Each CCA is administered with the mission to provide an alternative electricity service to the local investor-owned utility and to reflect its community's preferences when it comes to energy procurement and local energy programs.



Much of the grid in California is managed by the California Independent System Operator (CAISO) as well as investor owned utilities (IOUs). CAISO manages the wholesale power market as well as the flow of electricity on the grid with the goal of supporting a competitive energy market and comprehensive infrastructure planning efforts. The IOUs manage their own transmission and distribution systems that deliver electricity to their own customers, CCA customers and Direct Access customers. This brief offers a preliminary assessment of CCAs' possible adverse impacts and benefits on California's grid, as well as a snapshot of a rapidly changing retail electricity landscape.

CCAs Are Changing the Landscape of Retail Electricity

How might the rise of CCAs impact how California's grid is managed? The following chapter ("Community Choice Aggregation and its Impact on the Californian Electricity Sector") describes how CCAs are beginning to change the landscape of retail electricity in California. The analysis shows that CCAs have grown rapidly since 2011, with over half of them starting within the last two years. If cirrent growth trends continue, they may serve a majority of California's power consumers within the next ten years. These trends suggest that CCAs will likely transform the retail electricity sector across California unless policies emerge that impede their financial viability or growth.

Some observers have voiced concerns that simply in creasing the number of participants in the electricity market might raise challenges for grid management. However, the spatial distribution of customers is not currently changing as a result of communities forming CCAs. So while other possible grid stressors and regulatory issues may emerge from the rise of CCAs, merely partitioning consumers into smaller service territories will not, by itself change the location or size of the load that is managed by grid operators.

Assessing Grid Impacts

Given the likely future scale of transformation within the retail electricity sector, in the chapter "CCAs and Their Grid Impact" the authors evaluate several issues that may impact grid management. Some observers have worried about how well the grid will accommodate rising levels of intermittent renewable energy. The authors therefore begin this investigation with an examination of the differences in the percentage of renewable energy procured by both CCAs and IOUs. This analysis finds that the rise of CCAs has had both direct and indirect positive effects on overall renewable energy consumed in California. Their direct effect has been to offer electricity to communities with renewable energy content ranging from 37 percent to 100 percent, with a current state-wide average of 52 percent.

What has been more surprising is the indirect impact that the emergence of CCAs has had on the percentage of renewable energy supplied by IOUs. While in 2017, IOUs reported offering electricity with renewable energy content between 32 percent and 44 percent, they estimate that by 2020 they will offer electricity with renewable energy content that exceeds 50 percent. This increase is in large part because IOUs continue to hold a large number of long-term renewable energy contracts but are losing customers to CCAs, thereby increasing the ratio of renewable energy per customer.

Given this growth in renewable energy content of electricity sold to both CCAs and IOUs, the authors further explore concerns related to grid managers' responsibility to match the supply of energy with demand. One commonly cited concern about the grid is how cost effectively grid managers will accommodate the supply variability and uncertainty associated with solar and wind energy. A second grid concern, more related to solar, is the potential periodic over supply, also referred to as the duck curve, which raises the prospect of curtailments and negative prices.

This brief analyzes and compares the types of renewable energy that CCAs and IOUs have purchased and discusses grid planning efforts in light of California's aggressive goals towards renewable energy. The authors find that currently these possible grid impacts do not warrant serious concern for several reasons. First, compared to IOUs, CCAs have purchased a surprising amount of wind power relative to solar. Second, although several CCAs are responsible for developing new wind and solar, CCAs sign the majority of their energy contracts with pre-existing solar and wind plants that are already connected to the grid.[1] Third, grid managers have been planning for many years to accommodate the growth in solar production that California's aggressive state policies will require. So even as CCAs purchase more renewable power in the future, the grid should be ready to accommodate it, and these new generators will have to be reviewed and approved before being interconnected to the grid. Moreover, the authors expect CCAs to focus more on local sources of energy and demand side measures as they mature, relieving stress on the grid.

As the location of CCAs' power generation sources changes, there are possible concerns over how that could affect transmission and congestion costs. This analysis compares the percentage of out-of-state power that CCAs and IOUS are currently purchasing which relies on long-distance transmission lines. Compared to IOUs, some CCAs purchase less renewable energy from out-of-state while others purchase more. Although the number of CCAs is likely to rapidly change, to date the average amount of out of state power purchased by CCAs does not differ greatly from the overall amount of power purchased by IOUs. CAISO's long-term transmission planning efforts are also discussed.

Finally, this analysis considers how grid managers' ability to plan for periods of extremely high electricity demand may be affected. The California Public Utilities Commission (CPUC) requires both CCAs and IOUs to comply with resource adequacy requirements. The reliability of resource adequacy planning may depend upon short versus long-term power planning. Compared to IOUs, the authors find that CCAs rely much more on short-term renewable energy contracts. Whether this pattern will persist over time is unclear. The CPUC recently noted a 15 percentage point decrease in year ahead capacity requirements under contract compared to 2014, proportionally. The CPUC also noted a surge in the amount of load serving entities unable to procure local resource adequacy. Although no CCAs requested waivers, this may be a short-term phenomenon associated with the start-up of 15 CCAs commencing between 2017 and 2018. As CCAs mature, they seek to acquire longer term contracts and are in fact required to do so for their renewable energy contracts by a recent state law. More research is needed on resource adequacy, particularly on the long-term effect of short-term contracting.

Possible Benefits of CCAs for Grid Management

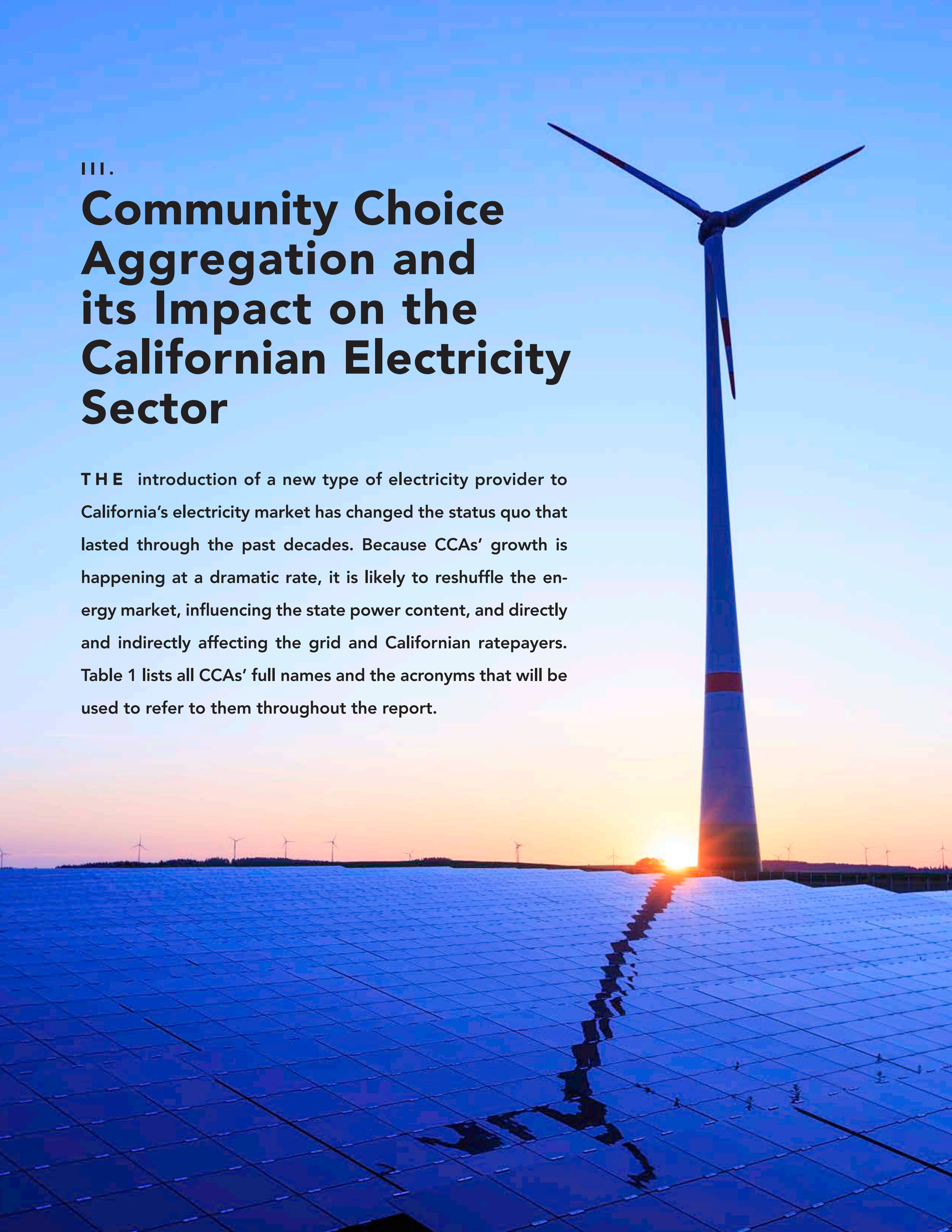
The performance and cost effectiveness of grid management improves when a load serving entity can structurally reduce peak electricity load and shave or shift the peak customer demand for electricity. For these reasons, if the growth in CCAs leads to an increase in the performance of energy efficiency and demand response programs, they could significantly benefit grid performance and reduce operational costs. For similar reasons, if CCAs are more able than IOUs to spur the growth of controllable distributed energy resources such as battery storage, smart charging of electric vehicles, and smart grids, they could benefit the grid. Finally, the selective and strategic localized development of local solar and related renewables may also prove beneficial.

In "CCAs' Alternative Solutions to Alleviate Grid Stress" the authors assess the presence of programs started by CCAs that focus on hard-to-reach customers and provide additional energy efficiency savings on top of IOUs' programs, in order to help alleviate stress on the grid. CCAs are currently providing their Net Energy Metering (NEM) customers with compensation rates that are twice or three times higher than their incumbent IOUs. Although still very early in their implementation process, some CCAs have articulated goals to advance local storage, demand response,

1 CCA energy procurement data compiled by Matt Freedman at The Utility Reform Network.

electric vehicles rate design, and the implementation of microgrids.

Our review reveals that some CCAs have been proven very innovative in tailoring programs specifically to their communities' preferences. They can do this because CCAs have considerable freedom to utilize their rate-setting authority to finance these programs, and sometimes even leverage private sector investments through partnerships with local businesses. In contrast, IOUs provide other benefits like economies of scale but are usually not intimately familiar with any given community they serve, given their larger service territories, and require analyses and approval by the CPUC prior to adopting similar innovations.



III.

Community Choice Aggregation and its Impact on the Californian Electricity Sector

THE introduction of a new type of electricity provider to California's electricity market has changed the status quo that lasted through the past decades. Because CCAs' growth is happening at a dramatic rate, it is likely to reshuffle the energy market, influencing the state power content, and directly and indirectly affecting the grid and Californian ratepayers. Table 1 lists all CCAs' full names and the acronyms that will be used to refer to them throughout the report.

TABLE 1 List of CCAs' Full Names and Acronyms

Acronym	Full Name	Acronym	Full Name
MCE	Marin Clean Energy	CPA	Clean Power Alliance of Southern California
SCP	Sonoma Clean Power	SJP	San Jacinto Power
LCE	Lancaster Choice Energy	MBCP	Monterey Bay Community Power
CPSF	Clean Power San Francisco	RMEA	Rancho Mirage Energy Authority
PCE	Peninsula Clean Energy	SBCCA	Solana Beach Community Choice Aggregation
RCEA	Redwood Coast Energy Authority	EBCE	East Bay Community Energy
AVCE	Apple Valley Choice Energy	VCE	Valley Choice Energy
SVCE	Silicon Valley Clean Energy	KCCP	King City Community Power
PRIME	Pico Rivera Municipal Energy	SJCE	San Jose Clean Energy
PIO	Pioneer Community Energy	DCE	Desert Community Energy

The Proliferation of CCAs

The current popularity of CCAs is illustrated by Figure 1 below, which presents the launch dates and cumulative load growth of this new type of electricity provider. Since 2010, the number of CCAs launching per year has increased exponentially. There were nine operational CCAs by the end of 2017 and at least nine new CCAs are expected to launch in 2018.

This rapid growth is changing how market shares are distributed between IOUs and other electricity providers, also called load serving entities (LSEs). As illustrated by the pie charts below, IOUs had 78 percent of the statewide market share in 2010. As a result of the proliferation of CCAs, IOUs' statewide market share reduced to 70 percent in 2017 and is expected to continue decreasing to 64 percent in 2018 and to approximately 57 percent in 2020.[2]

IOUs still provide the transmission and delivery of electricity to CCA customers, while CCAs only take over the energy procurement for these customers. This loss in market share will change IOUs' current business model, likely shifting their focus to more of a transmission and delivery agency. As detailed further later in this brief, the shuffle of market share has not radically changed the energy procurement business model so far. In order to open up the electricity market to new entrants, the legislature constrained IOUs to divest their power plants and use third-party electricity generators the same way CCAs currently do for their customers. Publicly Owned Utilities (POUs) are not affected by this growth as CCAs can only launch in IOU territory. CCAs and POUs are both public entities. However, POUs own their transmission and distribution grid, whereas CCAs use the IOUs'.

With an increasing amount of market share, CCAs' energy procurement decisions are likely to become more important at the state level and more likely to impact the grid. The following section looks at the impact of a greater number of market participants on the grid.

2 See Figure 2.

FIG 1 CCA Load Growth Over Time[3]

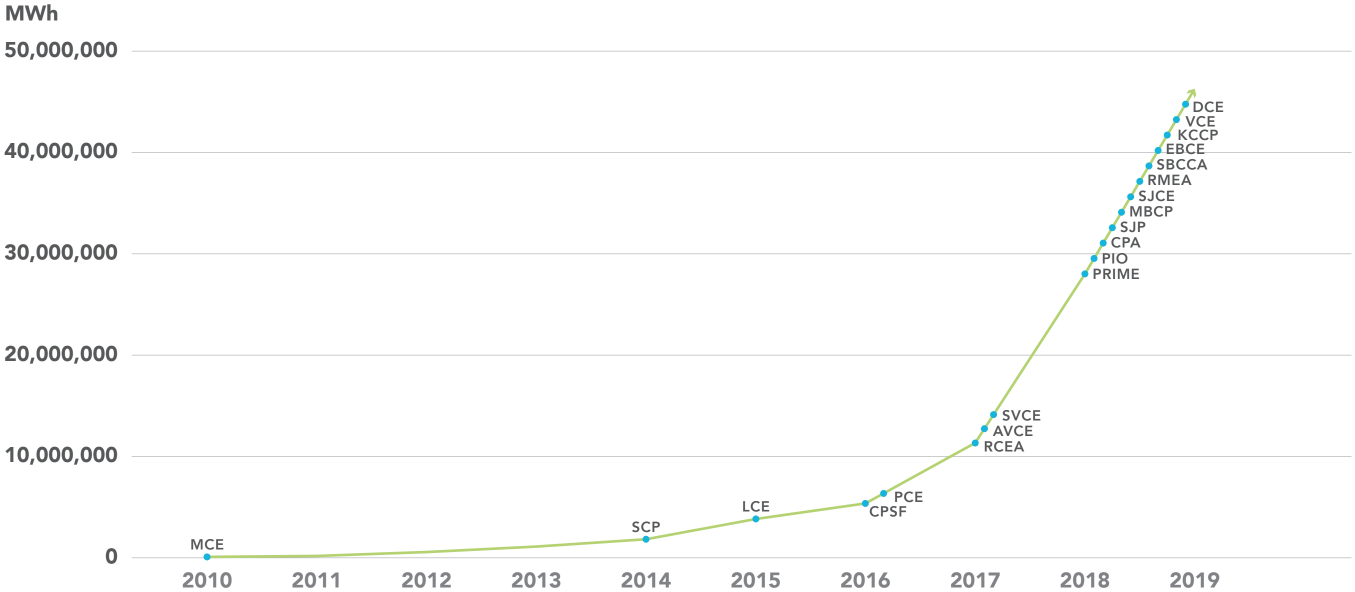
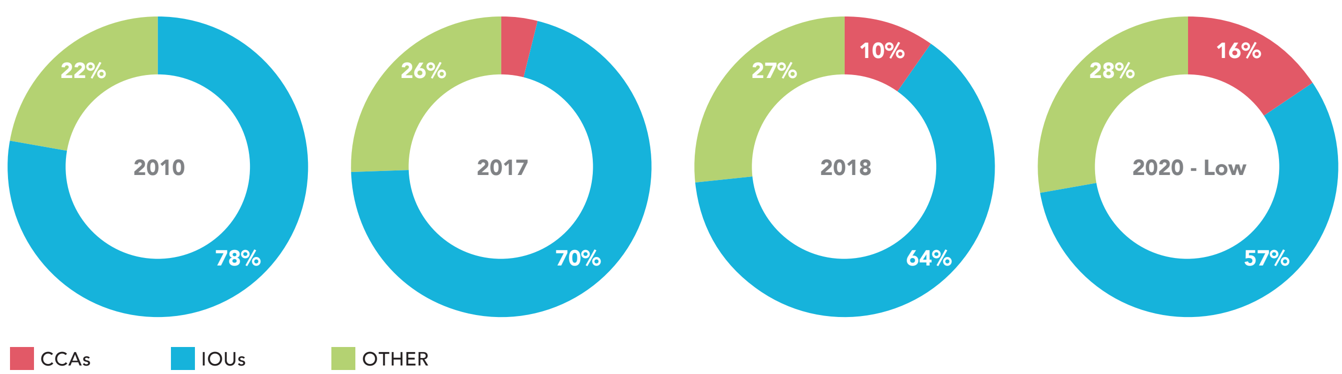


FIG 2 Market Share by Load Serving Entity Type[4]



3 CCA annual load data from each CCA's respective implementation plan. Launch dates from each entity's respective website.

4 Source: figure created by the UCLA Luskin Center for Innovation. The estimation of the 'low' scenario of CCA load in 2020 is based on the assumption that no new CCAs launch after 2018. CCAs' load data was retrieved from each entity's most recent implementation plan. IOUs' load data was obtained from the California Energy Commission (2018) "Mid Case Revised Demand Forecast". The "other" category represents the difference between the California Energy Commission's statewide load estimation and the IOU and CCA loads.

An Increasing Number of Market Participants

The increasing number of operational CCAs is fragmenting the territory that was originally served by only three IOUs. This means that the same amount of load will be served by a greater number of energy procurement entities. This raises the question of how the divorce between an energy procurement role and an infrastructure management role could impact the grid.

Even if IOUs own most of the wires in California, the actual scheduling and balancing of electricity demand and supply is done in an open and transparent market provided by CAISO. Because CCAs serve existing customers, they do not modify how and where the load demand has to be served. Consequently, from a grid manager's perspective, CCAs only increase the number of market participants that have to schedule and balance the same load the same way as other LSEs.

How is the market fragmentation reflecting on market risk? Are more market players benefiting ratepayers as they diversify risks across California and reduce the financial consequences of one big entity's failure? Or does the risk of failure per entity increase as these new energy procurement entities are smaller than the existing IOUs? As presented in Table 2, the absolute number of CCAs still remains small compared to the total number of 77 other LSEs currently operating in California. If a CCA fails, it is very likely that the load would be served by the incumbent IOU or another CCA. The failure of a small LSE like a CCA is likely to have a financial impact on their customers, but also likely to have a smaller impact on the grid than the failure of one of the three major IOUs would today. A future research project could conduct stress tests on each market participant in order to understand the robustness of bigger LSEs versus smaller LSEs in case of market price shock or other disruptive events. Another next research step could be to learn from CCAs in other states that have been in existence longer. For example, a CCA in Massachusetts went "dormant" due to a capacity cost increase, resulting in higher rates than its incumbent IOU.[5]

TABLE 2 CEC Categorization of Each Type of LSE in California[6]

Type of Load Serving Entity	Number
Investor Owned Utilities (IOUs)	6
Publicly Owned Utilities (POUs)	46
Electric Service Providers (ESPs)	21
Rural Electric Cooperatives	4
Community Choice Aggregators (CCAs)	13

Pushing for Greater Customer Choice and Renewable Energy

CCAs have introduced customer choice to electricity consumers in two ways. First, customers living in an area served by a CCA can now choose between at least two service providers. Second, each existing CCA often offers two electricity products: a default product (historically greener than the IOUs' default product) and a 100 percent renewable energy product.[7] Figure 3 compares the power content of the default products offered by operational CCAs, as of 2017. As a comparison, PG&E and SCE respectively had 33 percent and 32 percent of their electricity generated from renewable energy in 2017.[8]

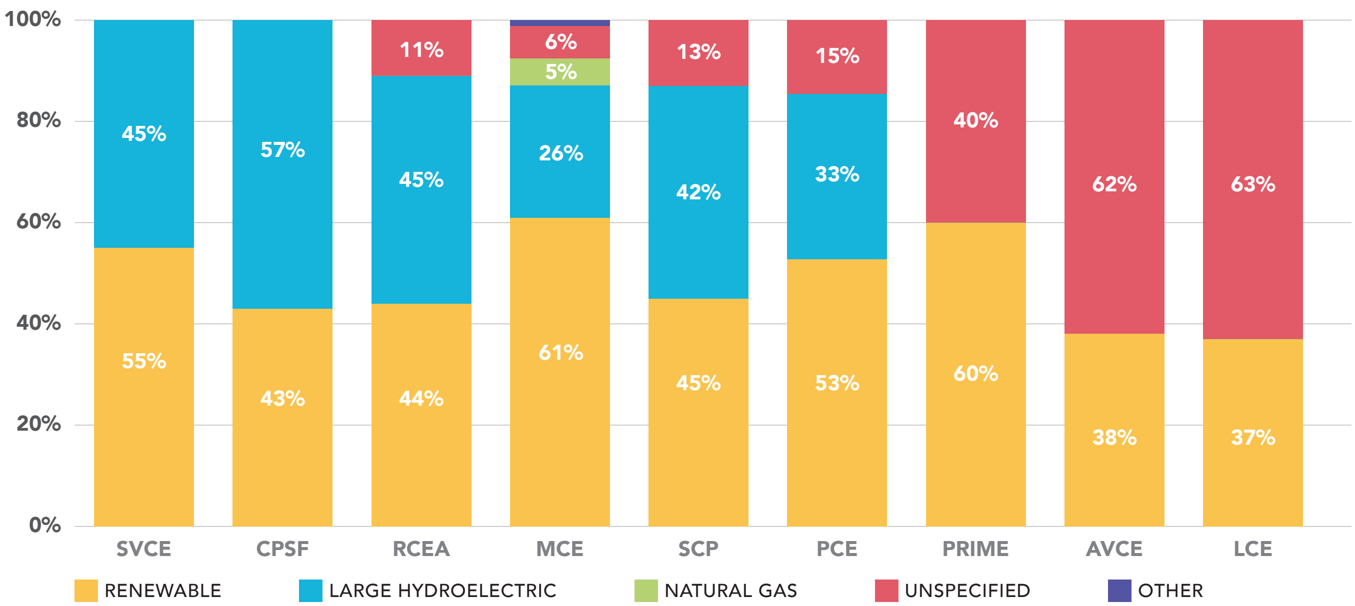
5 LEAN Energy U.S. (2018). *Massachusetts.*

6 California Energy Commission (2018). *Electric Load-Serving Entities (LSEs) in California.* Note that not all LSEs in California are under the CAISO balancing authority.

7 For further information, see the UCLA Luskin Center for Innovation's report *The Promises and Challenges of CCAs in California.* It is also important to note that more recently, we have noticed that new CCAs are slightly diverging from this trend. Monterey Bay Community Power, a central coast CCA, is now offering one renewable energy product but with two different rate options. Also, Pioneer Community Energy, the Placer County CCA, is offering only one product, which may be more reflective of the community's preferences. There is no limitation to the number of electricity products CCAs can offer their customers.

8 Estimated based on publicly available California Energy Commission 2017 power source disclosure program data.

FIG 3 Renewable Content of Default Products Offered by CCAs as of 2017[9]



This push for greater customer choice and greener electricity had a positive impact on IOUs: after the first CCA launched in 2010 and introduced multiple rate options, all three IOUs filed for a "Green Tariff Shared Renewables" program in 2012, which was approved by the CPUC in 2015.[10] In their application, PG&E cited demand for a greener option from "customers, as well as governmental and public leaders in PG&E's service area."[11] Additionally, CCAs provide support to the state's climate change legislation. The impacts of voluntary over compliance with California's Renewables Portfolio Standard (RPS) on the grid are discussed further in the next chapter.

Keeping Rates Competitive

In order to keep a high customer retention rate, CCAs aim to provide cheaper rates than their incumbent utilities. This is achieved mainly due to lower energy prices today, and also due to CCAs' use of different types of power contracts and power sources, as explained further in "CCAs and Their Grid Impact."[12] Figure 4 shows how much cheaper CCA rates were compared to their incumbent IOU in 2017. It is important to note that rates depend on market forces and regulatory decisions that are still pending.[13] This competitive price advantage has played a role in CCAs' popularity, giving momentum to their proliferation.

9 Renewable energy content estimated based on publicly available California Energy Commission 2017 power source disclosure program data for default options.

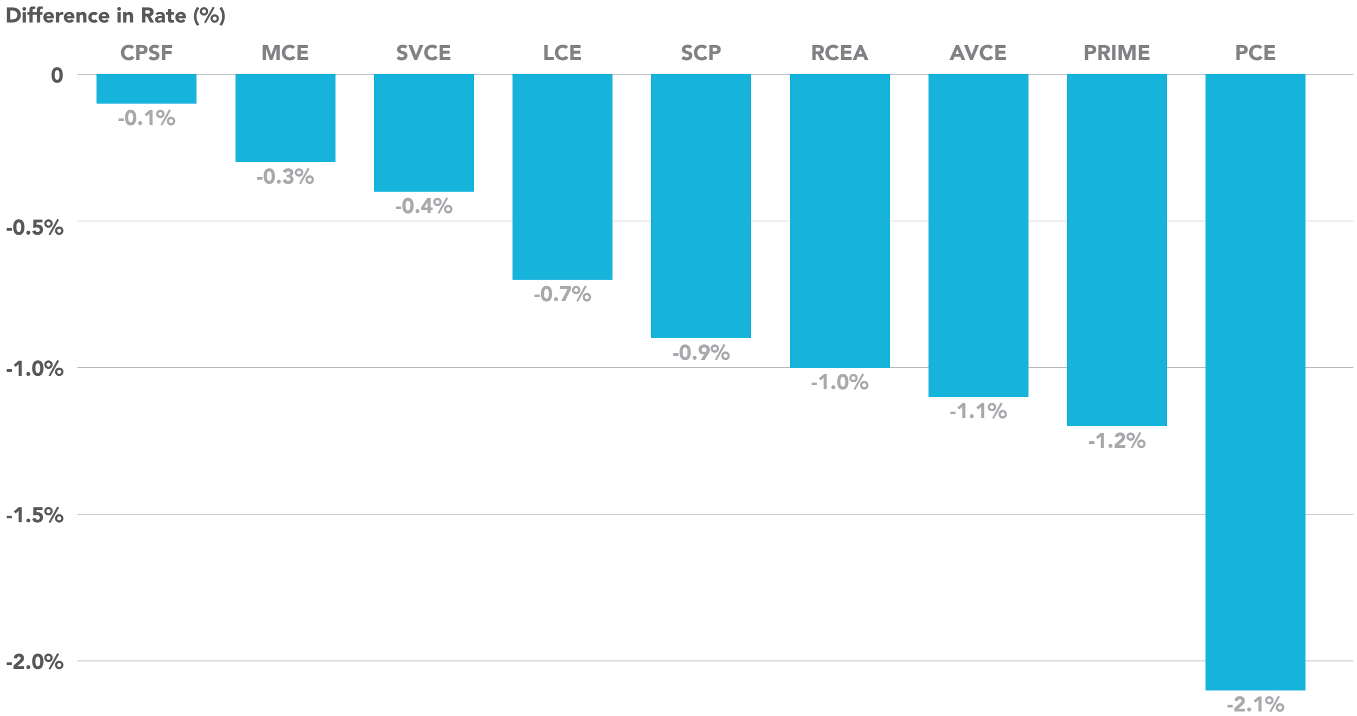
10 California Public Utilities Commission (2015). D15-01-051. *Decision Approving Green Tariff Shared Renewables Program for San Diego Gas & Electric Company, Pacific Gas and Electric Company, and Southern California Edison Company Pursuant to Senate Bill 43.*

11 California Public Utilities Commission (2012). A12-04-020. *Application of Pacific Gas and Electric Company (U 39 E) to Establish a Green Option Tariff.*

12 These reasons are further developed in the UCLA Luskin Center for Innovation report *The Promises and Challenges of CCAs in California.*

13 California Public Utilities Commission (2018). R. 17-06-026. *Power Charge Indifference Adjustment.*

FIG 4 2017 CCA Rate Comparison to Affiliate IOU[14]



14 This comparison focused exclusively on residential rates (E-1 for PG&E and Domestic for SCE). Rates from each entity's most recent IOU-CCA Joint Rate Comparisons.

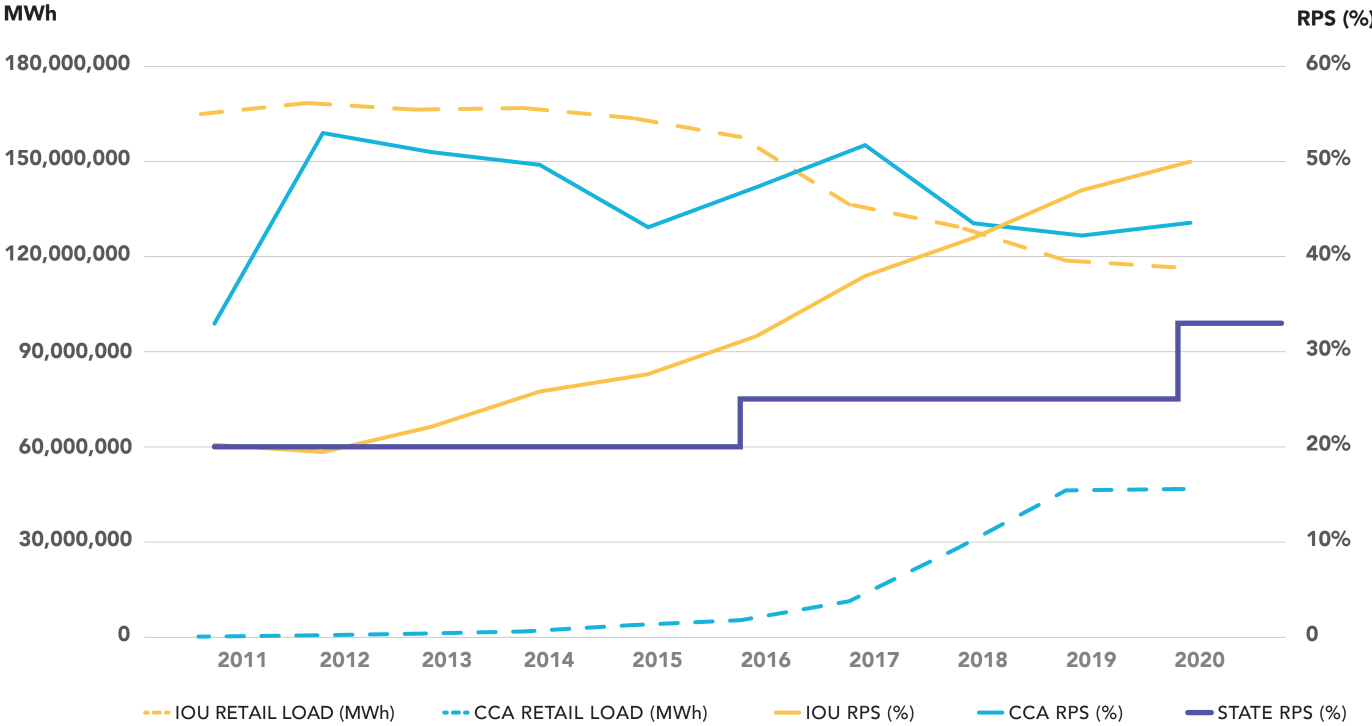
IV.

CCAs and Their Grid Impact

THE electrical grid is composed of transmission and distribution lines. Transmission refers to the long distance high voltage lines that move electricity from far away large-scale power plants to substations. Substations allow the electricity to flow through to the distribution network, which delivers electricity to where it is consumed. Consequently, the nature and the location of the power used to generate electricity has an important influence on the overall grid.

Because CCAs have the ability to choose the location and the type of energy sources they use for electricity generation, it raises several questions. How can the proliferation of CCAs and their emphasis on renewable energy impact the grid? Are CCAs' energy procurement strategies any different from other LSEs in California, and how could this affect the grid?

FIG 5 Historical Percentage of Renewable Energy by Load Serving Entity[16]



Note: it is important to mention that the proliferation of CCAs is not the only reason for RPS over compliance. As an example, until June 2018, SDG&E did not have any operational CCAs in its territory but has the highest share of RPS of all IOUs with 43% in 2016 versus 33% and 28% for PG&E and SCE, respectively.[17]

Pushing for More Renewables: Meeting RPS Targets Ten Years Ahead of Schedule

As part of its climate change efforts, California has set ambitious goals to sell 33 percent and 50 percent of electricity from renewable energy sources, in 2020 and 2030 respectively. Today, partly due to the proliferation of CCAs, California is on track to meet its 2030 RPS target of 50 percent ten years in advance.[15]

In 2017, CCAs had a weighted average of 52 percent renewable energy in their portfolio (refer to the previous chapter for further details). But also, their proliferation has resulted in substantial load departure from PG&E and SCE, increasing de facto the utilities' relative RPS share over a smaller customer base. Consequently, the CPUC is now expecting the three main IOUs to collectively have over 50 percent RPS in 2020.

15 California Public Utilities Commission (2018). *California Renewables Portfolio Standard (RPS).*

16 Source: IOU load data from the California Public Utilities Commission 2016 Preliminary RPS Compliance Reports. IOU RPS eligible power content percentages from the California Public Utilities Commission (2017) *Renewables Portfolio Standard Annual Report.* CCA load data from each CCA's most recent respective implementation plan. CCA historical RPS eligible power content estimated based on load data and historical power content labels. Future CCA RPS eligible procurement estimated from power content and load projections from their respective implementation plans, integrated resource plans, and established targets when possible. If not, we assume that CCAs will not decrease the share of renewables in their portfolio between 2018 and 2020 and that CCAs will be in compliance with RPS mandates. This assumes a 'low' scenario in which no new CCAs launch after 2018.

17 California Public Utilities Commission (2018). *California Renewables Portfolio Standard (RPS)*

FIG 6 RPS Eligible Procurement (MWh)[18]

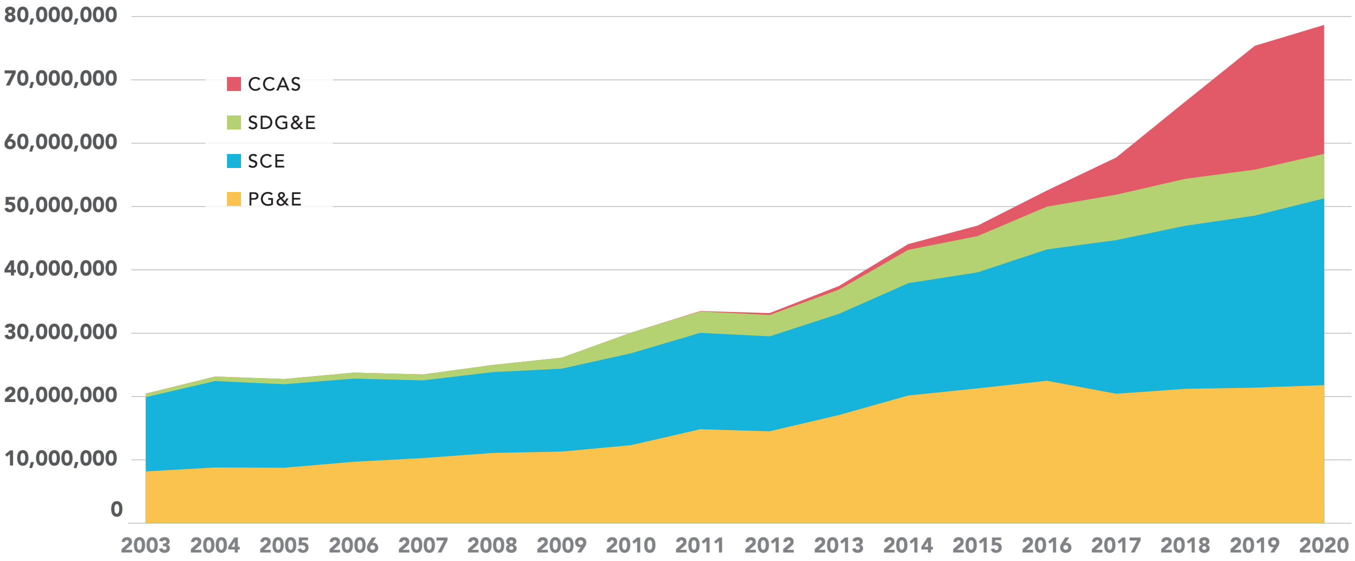


Figure 5 illustrates the correlation between the proliferation of CCAs, resulting in departing load from IOUs, with the growing percentage share of renewable energy in IOUs' portfolio.

Figure 6 shows the annual amount of renewable energy under contract in each of the three main IOUs' portfolios, as reported in their annual RPS compliance reports submitted to the CPUC. The figure also illustrates an estimation of CCAs' contribution to the California power content. Based on this data, CCAs are expected to potentially add an extra 20 TWh in 2020, resulting in a 35 percent increase of green electricity within IOUs' territory.[17]

Looking forward, the proliferation of CCAs is likely to amplify this overall RPS over compliance. Based on the estimation that 85 percent of the load could depart IOUs for CCAs, direct access and distributed generation by 2030,[19] the authors estimate that PG&E, SCE and SDG&E will have an average of 67 percent of renewable energy in their portfolio by 2025, including 56 percent of the total annual load met with wind and solar.[20] If all existing and future CCAs maintain a high level of renewable energy in their portfolios as they currently do, their proliferation is likely to also impact California's power content in the coming years.

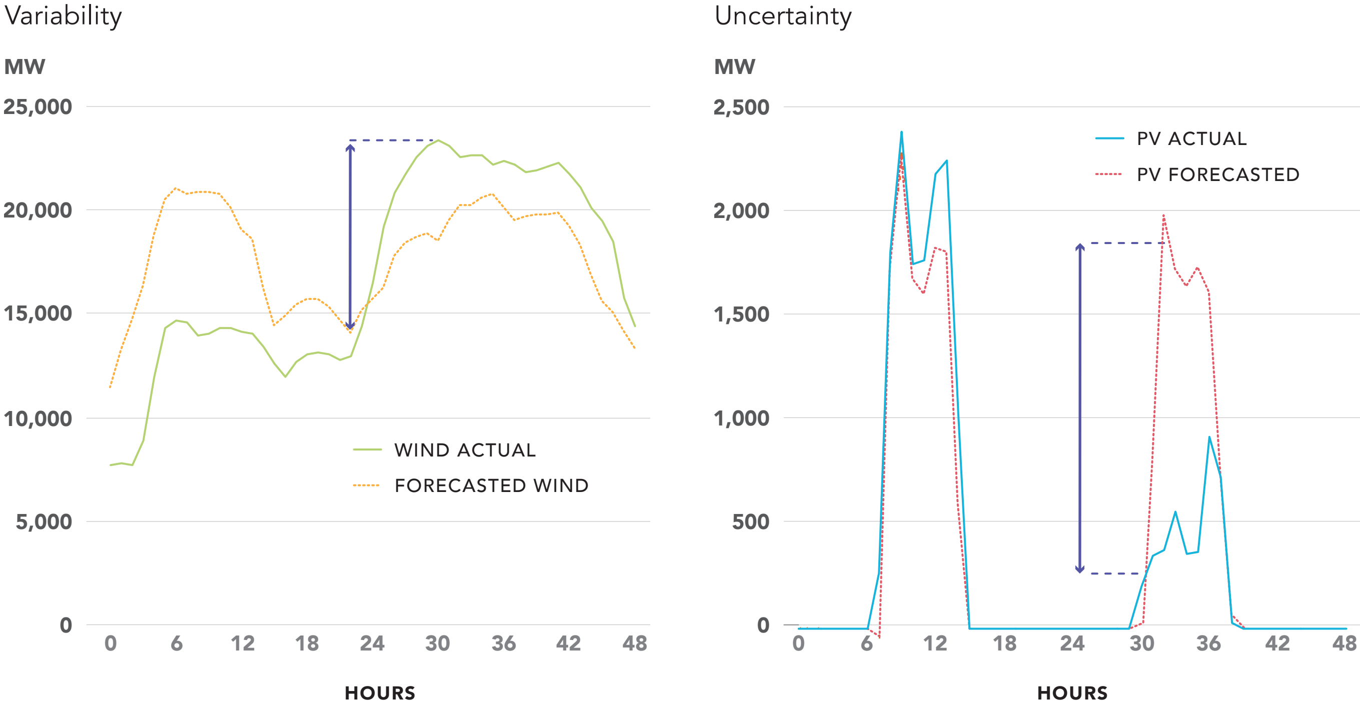
Given current grid infrastructure, what important technical and economic challenges will the grid face as a result of the speed at which these changes happen?

18 Source: IOU RPS eligible procurement from the California Public Utilities Commission 2016 Preliminary RPS Compliance Reports. CCA RPS eligible procurement estimated by the UCLA Luskin Center for Innovation from power content and load projections from their respective implementation plans. Future power content based on integrated resource plans and established targets when possible. If not, we assume that CCAs will not decrease the share of renewables in their portfolio between 2018 and 2020 and that CCAs will be in compliance with RPS mandates. This assumes a 'low' scenario in which no new CCAs launch after 2018.

19 California Public Utilities Commission (2017). Staff White Paper. *Consumer and Retail Choice, the Role of the Utility, and an Evolving Regulatory Framework*. "The CPUC estimates that 85% of the load could depart IOUs in the mid 2020s. We also make the assumption that no other RPS eligible contracts are added to IOUs portfolio"

20 Estimated based on California Public Utilities Commission 2018 *w* "RPS Executed Projects: Public Data" and the assumption that there will be a steady decrease in IOUs' load until 2030, when it is expected that 85% of IOUs' load will have departed.

FIG 7 Example of the Variability of a Wind Plant and the Uncertainty of a Solar Plant[21]



Managing High Renewable Energy Penetration

Historically, electricity was mostly generated from large hydro, nuclear and natural gas power plants, the latter of which could be turned on as needed throughout the day, to handle the variable nature of the load demand. Califor-rnia policies and the proliferation of CCAs could further increase the amount of wind and solar energy production, adding supply-side challenges to grid stability. In this section, the authors present the challenges and solutions of high renewable energy penetration, and why CCAs' energy procurement strategies do not currently impact the grid.

Variability and Uncertainty of Solar and Wind Energy Sources

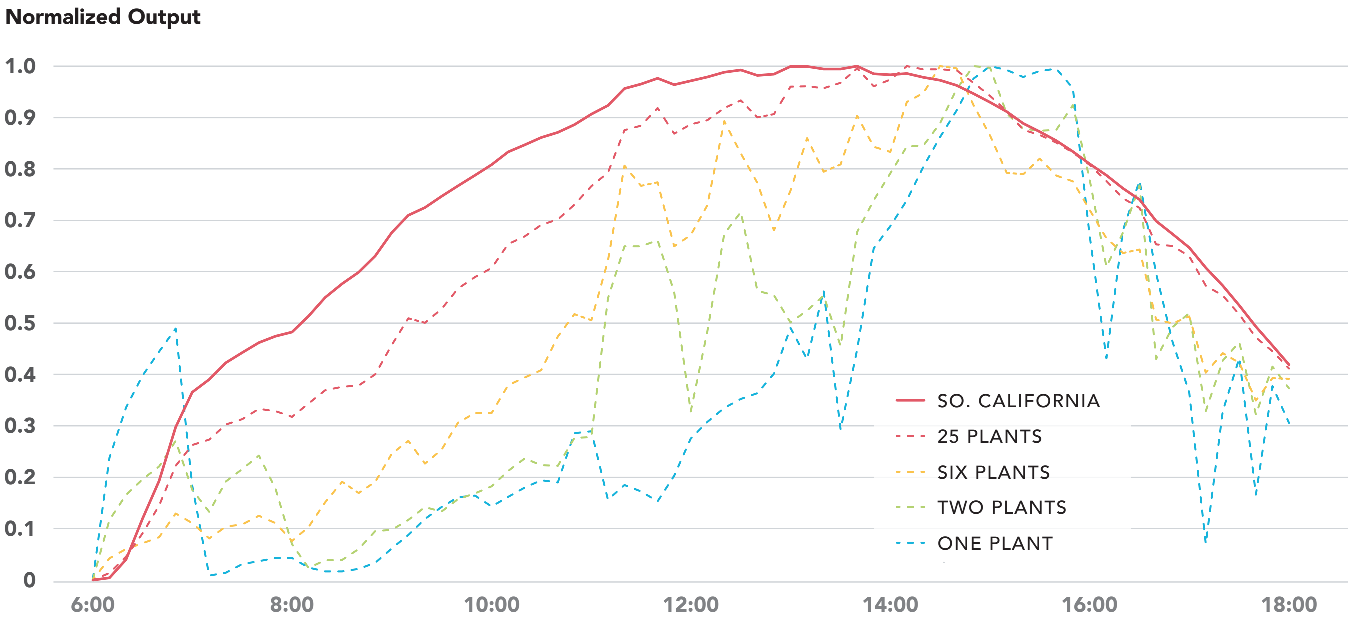
In part because there is currently no substantial storage capacity in California, electricity needs to be consumed at the same time that it is produced. High renewable energy penetration proportionally decreases the amount of dispatchable energy on the grid, while wind and solar increase variability and uncertainty, as illustrated in the figure above. As an example moving clouds can result in rapid changes in solar energy generation.

Today, this power fluctuation creates voltage fluctuation and stability challenges on the transmission grid that require fossil-fueled power plants to turn on and off more frequently. A study by the National Renewable Energy Laboratory found that up to 33 percent of wind and solar energy penetration increases annual cycling costs by $35–$157 million in the West, but also displaces annual fuel costs by approximately $7 billion.[22] A recent study details the technical challenges and

21 National Renewable Energy Laboratory (2013). *Impacts of Variability and Uncertainty in Solar Photovoltaic Generation at Multiple Timescales.*

22 National Renewable Energy Laboratory (2013). *The Western Wind and Solar Integration Study Phase 2.*

FIG 8 Variance in Power Output Fluctuation for Increasing Aggregation of PV in Southern California for a Partly Cloudy Day[23]



solutions to maintain the balance between load and generation with high wind and solar integration.[24] To use the same example, the impact of cloud coverage can actually be reduced with large geographic diversity among solar generators, so they are not all impacted at the same time by moving clouds.[25] The figure below shows the normalisation of solar power output for one, two, six, 25 solar plants, and all Southern California solar generation. The larger the geographic distribution, the less the power fluctuation.

Over Supply Issues and Economic Impacts

As more solar generation capacity is added, California is constantly breaking new records. On March 4, 2018 for the first time California produced 49.95 percent of its electricity from solar. On May 27th, 2018, California broke another record and produced 53.7 percent of its electricity from solar.[26] While this is great news for California climate and clean energy goals, it also highlights the need to address two major challenges that come with high solar energy penetration: ramping up energy production to meet evening demand when the sun sets, and dealing with over supply.

Over supply exacerbates an issue colloquially known as the 'duck curve.' Solar energy generation does not coincide when energy generation is most needed during the day. Around the same time when solar stops generating after the sun sets, there is a spike in electricity demand when people come home from work and turn on lights, appliances, and air conditioning systems. With more solar, this causes a greater need for the rapid ramping of other sources of electricity generation (often natural gas) to meet this need. Strategies to address these ramping needs are discussed more in the next chapter.

23 National Renewable Energy Laboratory (2013). The Western Wind and Solar Integration Study Phase 2.

24 National Renewable Energy Laboratory (2017). *Integrating high levels of variable renewable energy into electric power systems.*

25 National Renewable Energy Laboratory (2013). *Integrating Variable Renewable Energy: Challenges and Solutions.*

26 California Independent System Operator (2018).

TABLE 3 Percent Renewable Energy from Each Source in 2017[27]

	PG&E	MCE	SCP	CPSF	PCE	RCEA	SVCE	SCE	LCE	AVCE	PRIME
Renewable	33%	61%	45%	43%	53%	44%	55%	32%	37%	38%	60%
Solar	13%	9%	11%	3%	7%	5%	10%	13%	8%	20%	0%
Wind	8%	27%	23%	40%	24%	24%	36%	10%	22%	12%	17%
Biomass & Biowaste	4%	6%	0%	0%	7%	11%	6%	0%	0%	6%	0%
Geothermal	5%	10%	11%	0%	6%	5%	1%	8%	0%	0%	11%
Eligible hydroelectric	3%	9%	0%	0%	9%	0%	2%	1%	7%	0%	33%
Large Hydroelectric	18%	26%	42%	57%	33%	45%	45%	8%	0%	0%	0%

*Table note: The highlighted columns represent the two main IOUs affiliated with the corresponding CCAs. These IOUs are Pacific Gas & Electric (PG&E) and Southern California Edison (SCE).

Over supply often happens in spring, when California experiences larger hydropower production due to warming weather and melting snow, but when the sunny days are not hot enough to trigger a large increase in air conditioning load across the state. This results in two economic effects: curtailment and, very often, negative wholesale electricity prices. By pushing for more renewable energy, CCAs contribute to these two economic effects. Professor Lucas Davis of the University of California, Berkeley estimated that more than 130 hours in California experienced negative wholesale electricity prices in 2017, due to the combination of hydro and solar over supply.[28] This number could grow, as solar energy becomes an even larger part of the California power mix.

CCAs' Current Power Content: Toward Less Variable Renewable Energy?

As illustrated in Table 3, CCAs and IOUs produce their electricity from different types of renewable energy sources. CCAs have relied more on wind than solar. Wind is a good complement of solar as it produces electricity even when the sun does not shine, as illustrated in Figure 7.

Table 3 also shows that some CCAs have generated part of their electricity from geothermal and biomass. Geothermal allows for a constant electricity production, also called baseload, which takes some of the variability challenges off the grid. Biomass is currently mostly used as baseload, but could be used as a dispatchable energy source at times when electricity is needed the most. These sources are in fact valued by the state legislature, as seen with Assembly Bill 2208 which, if passed, could mandate that a percentage of RPS requirements is met with geothermal and biomass.

It is hard to draw conclusions and make projections based on current CCAs' portfolios, as they are different from each other and also new entities. There is currently limited information on future CCAs' power content. The only statement that can be made today is that their current energy procurement strategies are not impacting the grid nor amplifying the consequences of solar over generation. Looking forward, CCAs could amplify these impacts if they focus on large utility-scale solar power plants. However, CCAs have expressed goals of focusing more on local sources and distributed energy resource development, including generation, which would help alleviate some of the stress on the transmission grid, as detailed further in the "CCAs' Alternative Solutions to Alleviate Grid Stress" section.

27 Power content estimated based on publicly available California Energy Commission 2017 power source disclosure program data for each entity's default product.

28 Energy Institute at Haas – Pr. L. Davis (2018). Energy Institute blog: *Is Solar Really the Reason for Negative Electricity Prices?*

Transmission and Congestion Issues

Most of the time, renewable energy power plants are built at locations that ensure the highest capacity factor, where the natural resource is the most available, and not necessarily where the load demand is located. Consequently, increasing the share of renewable energy in California's portfolio through new large utility-scale plants could lead to greater use of long distance transmission lines, which comes with energy losses, and congestion issues.[29] In some cases, this could even necessitate the construction of new transmission lines, which are reported to cost between one and three million dollars per mile and take years to build.[30]

This raises the question whether CCAs' proliferation and strong focus on renewable energy could exacerbate these issues.

Current Locations of CCAs' Power Generation

Figure 9 illustrates how the current locations of CCAs' major power purchase agreements (PPAs) are spread out across the state. While some CCAs focus on local power plants, other CCAs source their energy from all across the state. It is, however, important to note that most new CCAs contract with existing power plants, which are already connected and were previously generating and delivering electricity to the grid (see the "CCAs' Power Contracts and Resource Adequacy" section for greater details). By procuring electricity from existing generators, CCAs are unlikely to impact the grid as they do not alter the current status quo. However, a recent database compiled by Matt Freedman shows that the older the CCA, the larger the share of power comes from newly built power plants. For example, MCE has approximately 35 percent and SCP has 22 percent of their energy coming from new generators. The reason why is further explain in the following section. It is also important to note that when LSEs sign contracts for the construction of new power plants, the siting and interconnections are done strategically with the help of both IOU and CAISO engagement, in order to prevent the aggravation of grid issues.

Finally, CAISO's 2017-2018 Transmission Plan "outlines the proposed design and construction of transmission networks for the next decade, identified 17 new transmission projects at a combined cost of nearly $271.3 million. The plan also recommends the cancellation of 18 transmission projects and revisions of 21 other projects in Pacific Gas & Electric (PG&E) area and two in the San Diego Gas & Electric area, avoiding an estimated $2.6 billion in future costs. The changes were mainly due to changes in local area load forecasts, and strongly influenced by energy efficiency programs and increasing levels of residential, rooftop solar generation."[31]

Consequently, if CCAs emphasize local sources of energy, energy efficiency and other local energy programs, they could accentuate this trend and avoid further transmission grid upgrades or other costly constructions (see the next chapter for further information on CCAs' local programs).

Out-of-State Renewable Energy Purchases

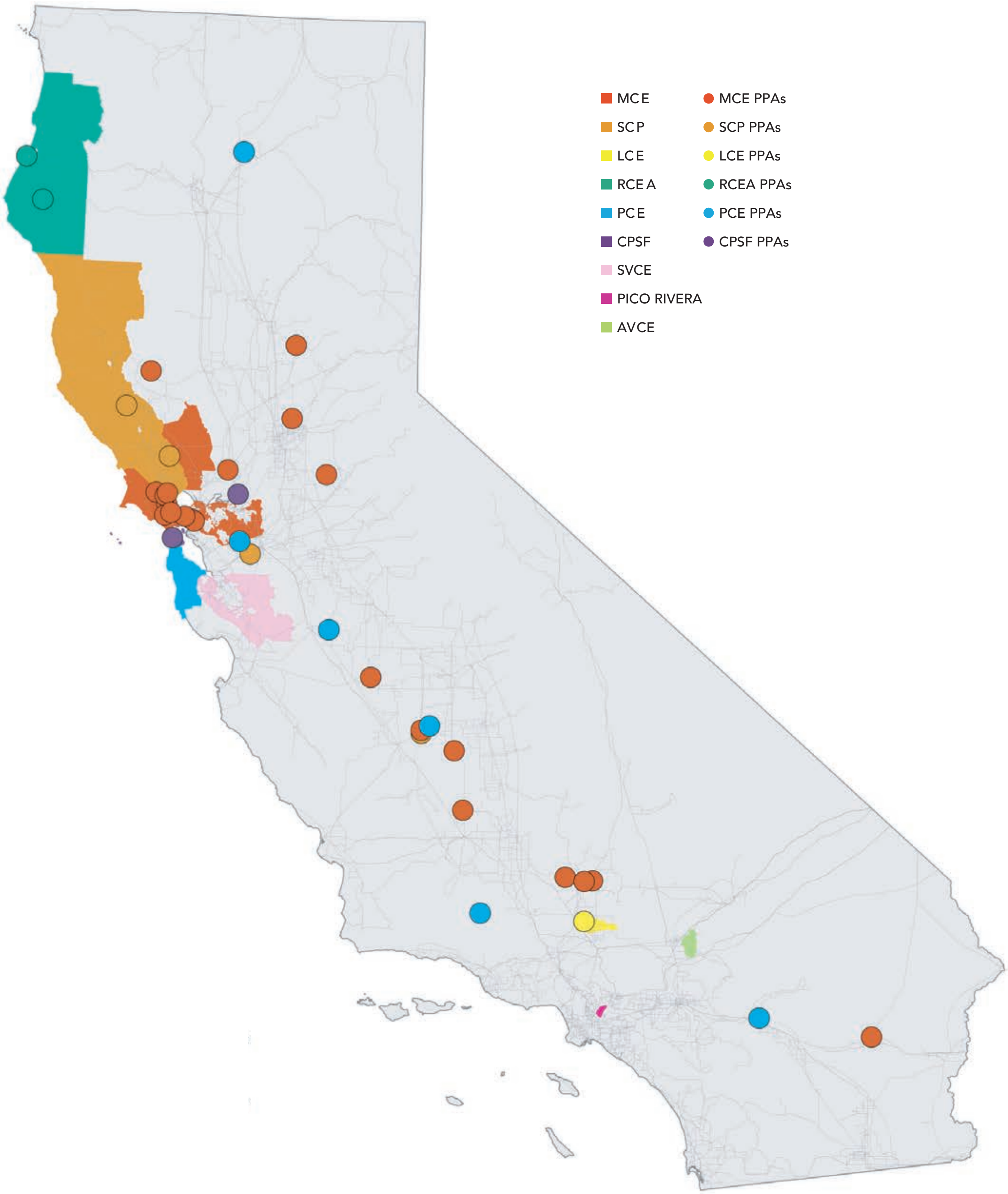
Table 4 compares the share of renewable energy that comes from out of state for the most established CCAs and their incumbent utilities. It can be seen that some CCAs rely more on out-of-state renewable energy generation than PG&E and SCE, revealing the dependence on transmission lines, and a contribution to congestion costs, similar to other LSEs. Although the number of CCAs is likely to rapidly change, to date the average amount of out of state power purchased by CCAs does not greatly impact the overall amount

29 California Energy Commission (2011). *California Transmission Congestion Assessment:* "a transmission line or path is said to be congested when its transfer capability is insufficient to accommodate all needed power transfers and unscheduled power flows"

30 Mason, T., Curry, T., Wilson, D. Western Electricity Coordinating Council (2012). *Capital Costs for Transmission and Substations: Recommendations for WECC Transmission Expansion Planning.*

31 California Independent System Operator (2018). News Release. *Board Approves 2017-18 Transmission Plan, CRR Rule Changes Plan Calls for Canceling, Modifying Projects to Avoid $2.6 Billion in Costs.*

FIG 9 Location of CCAs' Renewable Energy Power Purchase Agreements[32]



32 PPAs from each CCAs IRP when available or by email with staff.

TABLE 4 Location of Procurred Energy by CCA in 2017[35]

	PG&E	MCE	SCP	CPSF	PCE	SVCE	SCE	LCE
Out of State (as % of renewable energy purchases)	30%	23%	47%	0%	33%	38%	18%	78%

of out-of-state power purchased by Californian LSEs all together, and is thus unlikely to impact the grid. It would be interesting to model how far this trend could continue before having a significant impact on the overall state electricity imports and the grid, as the majority of the top congested path are inter-state.[33]

Should the state choose to enter into a regional grid with the West, it is uncertain how out-of-state power purchases would change.[34] Moreover, CCAs' import of out-of-state wind energy could be beneficial for California as it could help with some of the solar energy integration challenges. The following section develops further how CCAs' energy procurement decisions are mainly driven by cost and readily available sources of energy, as most have only recently launched.

CCAs' Power Contracts and Resource Adequacy

Power Purchasing Agreements: Long-Term versus Short-Term

When CCAs launch, they need power instantaneously for their customers at a low price in order to keep customer retention as high as possible. This means that CCAs cannot rely on long-term contracts right at the beginning as they would then need to wait for the construction of new power plants, which often takes several years. Moreover, new CCAs lack credit scores and track records, which are obstacles for long-term contracts and power plant construction. In fact, MCE, which launched eight years ago, was the first CCA to obtain a credit rating, and it only happened in 2018. The direct consequence of this is that currently, CCAs in California are heavily relying on ready-to-be-executed short-term contracts to procure electricity for their customers. The table below shows the percentage of long-term versus short-term RPS contracts for CCAs and the three main IOUs. It can be seen that the oldest CCAs often have greater amounts of long-term RPS contracts than the newer CCAs, and they drastically increase the share of long-term RPS contracts in the coming years.

33 California Energy Commission (2011). *California Transmission Congestion Assessment.*

34 To learn more about grid regionalization, see Next 10's accompanying brief at http://www.next10.org/regional-grid

35 Source: CCA data compiled by Matt Freedman at The Utility Reform Network. IOU data from California Public Utilities Commission (2018). *Reports and Data.* RPS Executed Projects: Public Data.

TABLE 5 Percent of RPS Eligible Contracts That Are Long Term[36]

	PG&E	SCE	SDG&E	MCE	SCP	LCE	CPSF	PCE	RCEA	SVCE	PRIME	AVCE
2017	99%	99%	97%	25%	32%	14%	0.04%	0.01%	0%	0%	0%	0%
2018	98%	98%	97%	45%	56%	16%	0.06%	0.01%	0%	0%	0%	0%
2019	98%	98%	98%	66%	54%	21%	0.09%	43%	0%	0%	0%	0%
2020	98%	98%	98%	80%	55%	100%	0.15%	46%	0%	0%	0%	0%

Table note: Long-term contracts are defined as energy contracts signed for a period equal to or longer than ten years.

Because both market operators and energy providers need long-term visibility, it is important that all LSEs be required to have a portion of their energy procurement secured through long-term contracts. Senate Bill 350 mandates that "beginning January 1, 2021, at least 65 percent of the procurement a retail seller counts toward the RPS requirements… shall be from its contracts of 10 years or more."[37] Even though this bill does not apply to non-RPS eligible contracts, there are currently discussions between the CPUC and CCAs regarding long-term contracting obligations. CCAs argue that the CPUC cannot obligate them to enter into long-term contracts.[38] The resource adequacy requirement ensures that all LSEs have enough capacity under contract to ensure short- to mid-term grid reliability. Moreover, as CCAs mature, they are likely to be presented with more opportunities to sign long-term energy contracts, and endorse their fair share of responsibilities when it comes to long-term grid reliability. More research on the long-term effect of short-term contracting is needed.

Resource Adequacy

CCAs, like other LSEs, are subject to resource adequacy (RA) requirements. According to the CPUC, "the resource adequacy program has two goals: first, it provides sufficient resources to the California Independent System Operator to ensure the safe and reliable operation of the grid in real time. Second, it is designed to provide appropriate incentives for the siting and construction of new resources needed for reliability in the future."[39]

There are three types of resource adequacy:[40]

- **system resource adequacy:** obligates LSEs to procure capacity sufficient to meet 115 percent of their peak demand;
- **local resource adequacy:** requires LSEs to procure local capacity in "areas with transmission limitations."[41] Every year CAISO develops a "Local Capacity Technical Analysis" that identifies the minimum local resource capacity for each area;
- **flexible resource adequacy requirements:** CAISO's annual Flexible Capacity Study defines and quantifies the resources needed to manage grid reliability during the largest three-hour continuous ramp in each month.

These three types of RA requirements are in place to ensure that all LSEs have the right amount and type of resources available to constantly meet their load demand, while addressing intermittency and ramping challenges resulting from higher penetrations of renewable energy, maintaining grid stability and reliability, and decreasing the need for long distance transmission lines.

36 Data from the California Public Utilities Commission 2016 Preliminary RPS Compliance Reports.

37 SB-350 Clean Energy and Pollution Reduction Act of 2015.

38 Gridworks and the Energy Foundation (2018). *Community Choice Aggregation and California's Clean Energy Future.*

39 California Public Utilities Commission (2018). *Resource Adequacy*

40 California Public Utilities Commission (2017). *2016 Resource Adequacy Report*

41 California Public Utilities Commission (2018). *Integrated Resource Plan and Long Term Procurement Plan (IRP-LTPP).*

A recent CPUC report identified a few recent issues related to RA that could make long-term grid reliability more challenging if no further action is taken.[42] For system RA, the analysis highlights a 15 percentage point decrease in forward procurement, in the proportion of system capacity requirements that are under contract one year before the compliance month. This shows a substantial decrease in one-year RA capacity that is likely "tied to uncertainty caused by recent growth of out-of-market procurement and the expansion of CCAs."[43] For local RA, the analysis highlights for the first time a strong surge in the number of LSEs unable to procure adequate local RA, with a local deficiency of 270 MW. However, according to CalCCA, no CCAs requested local resource adequacy waivers in 2017.[44]

The decrease in forward procurement for this specific year could be explained by the fact that four new CCAs launched in 2017 and eight new CCAs launched in 2018. Some of these new entities launched after the month of April, which is the cutoff month for participating in the year-ahead RA process. Consequently, if these issues are correlated with the launch of new CCAs, they should disappear over time as the vast majority of CCAs will have launched and be able to participate in the RA process.

As CCAs grow, they will represent a larger share of the load. This means that the state electricity sector as well as the future of the grid will rely more and more on CCAs' energy procurement decisions. This is why it is very important to ensure the correct long-term planning of resources and energy procurement in California. Even though CAISO is going to be a key stakeholder in this role, it nevertheless raises some questions regarding the efficacy and the cost-effectiveness of fragmented versus centralized energy procurement models.

An example underscoring the potential need for more coordination is highlighted in a Gridworks' discussion paper. Gridworks uses the designation of the Calpine Metcalf plant as a "Reliability Must-Run" (RMR) unit by CAISO to illustrate that even though LSEs in the San Francisco Bay Area procured enough resources to meet their own local RA requirements, a 500 MW natural gas plant was still needed to meet the local needs in the San Jose area. This resulted in many LSEs' customers double paying for RA, including this expensive RMR contract. Gridworks concludes saying that "no one is individually responsible for making sure that strategically-located plants are procured, and LSEs may not even know there is a need in a particular place until after the fact."[45]

Could a greater collaboration between CAISO, IOUs, CCAs and the CPUC help to prevent these kinds of issue in the future? Would the centralization of CCAs' energy procurement facilitate a more efficient and cost-effective RA process? It is important to ensure that local preferences are reflected without increasing the overall cost of meeting the state's goals.

42 California Public Utilities Commission (2018). *Current Trends in California's Resource Adequacy Program*

43 Ibid. page 42

44 Trabish, H. Utility Dive (2018). *California regulators see signs of a new energy crisis — can they prevent it?* Quote from Beth Vaughan.

45 Gridworks and the Energy Foundation (2018). *Community Choice Aggregation and California's Clean Energy Future.*

V.

CCAs’ Alternative Solutions to Alleviate Grid Stress

CCAS tend to offer their customers innovative and tailored programs that suit their communities’ preferences and interests.

Several of these types of local programs, sometimes known as distributed energy resources, can provide a multitude of grid benefits.[46] Distributed energy resources include, but are not limited to, energy efficiency, distributed generation, storage, demand response, electric vehicles, and other local energy programs that can relieve some of the stress on the transmission grid.[47]

TABLE 6 Energy Efficiency Cost Effectiveness Comparison – 2018 Multi Family Programs

Program Name	Budget	Gross kWh	$/kWh
MCE - Multi Family	$676,437	462,981	$1.46
PGE - California New Homes Multifamily	$1,460,826	176,850	$8.26
PGE - Multifamily	$6,779,725	2,113,918	$3.21

Source: CEDARS California Energy Data and Reporting System (2018).

Traditionally, electricity is supplied to meet demand, however with higher variable renewable energy penetration, there are increasing needs to have a flexible load demand as well. Distributed energy resources can help by changing where, when, and how customers demand electricity to better adapt to the variability of electricity generation coming from wind and solar. The local and public nature of CCAs well positions them to implement these local programs that alleviate stress on the grid.

This chapter presents examples of the local energy programs that CCAs have developed and their most prominent benefits for the transmission grid. This chapter also discusses the challenges of shifting some of the stress from the transmission grid to the distribution network.

CCAs' Energy Efficiency Efforts: Complementary Programs and Hard to Reach Customers

Energy efficiency programs reduce the need to generate electricity, which results in cheaper electricity bills, and many benefits associated with load demand reduction such as the deferral of transmission investment and congestion costs. CCA customers are able to participate in the IOU's energy efficiency programs. In addition, CCAs have the option to administer their own energy efficiency programs. Until this year MCE was the only CCA to do so.[48] LCE is now taking the same path. When a CCA administers energy efficiency programs, they are funded through the public goods charge collected by the CPUC and must meet certain criteria, including: the programs are not already offered by the IOU or focus on "hard-to-reach" markets such as multi-family residential and small commercial.[49]

Because energy efficiency programs are important for the grid and the energy sector in California, the authors have compared the cost effectiveness of MCE's and PG&E's programs. This analysis focuses on a comparison of a similar type of program dedicated to hard-to-reach customers: multi-family residents.

46 To learn more about distributed energy resources and their impacts on the California grid, see Next 10's accompanying brief at http://www.next10.org/grid-der

47 Federal Energy Regulatory Commission (2018). *Distributed Energy Resources Technical Considerations for the Bulk Power System.*

48 MCE (2017). *2018 Integrated Resource Plan.* MCE's EE programs helped to save a cumulative 3,190 MWh

49 California Public Utilities Commission (2013). R.09-11-014. *Energy Efficiency Policy Manual Version 5.0 for Post-2012 Programs*

TABLE 7 NEM Compensation Rates[51]

	PG&E	MCE	SCP	CPSF	PCE	RCEA	PIO	MBCP	SCE	AVCE	LCE	PRIME	RMEA
Compensation Rate (per kWh)	2.8¢	7.8¢	7.7¢	8.9¢	7.8¢	8.1¢	3¢	6.1¢	3.1¢	6¢	6¢	6¢	6¢

Table 6 illustrates how MCE's multi-family program is more cost effective than PG&E's.

Other CCAs are exploring new energy efficiency programs without becoming public goods charge fund administrators. For example, RCEA plans to use revenues from their CCA to supplement IOU energy efficiency efforts. Some CCAs, like PCE, are considering working with other existing administrators of energy efficiency programs, like the Bay Area Regional Energy Network (BayREN) through the San Mateo County Office of Sustainability. Additionally, SCP also offers residents a "DIY Energy Savings Toolkit" that they can check out from local libraries, which offer tools and supplies to help residents save energy.[50]

Generating Energy Closer to Where It Is Consumed

Distributed Energy Generation

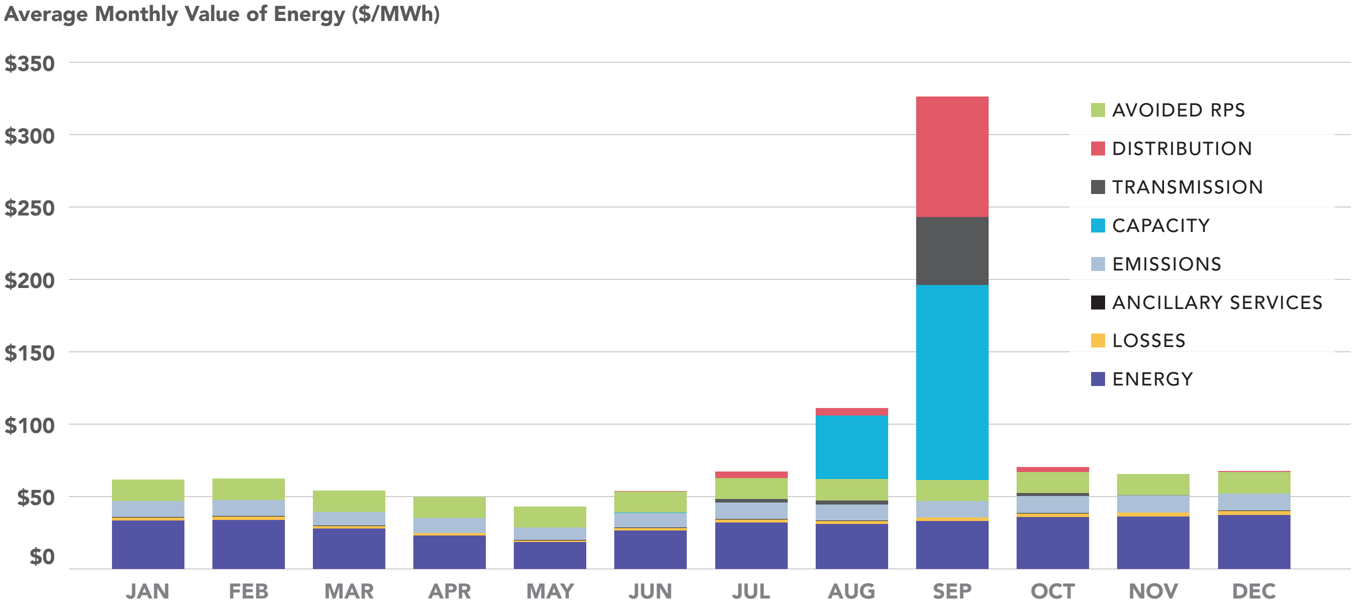
Distributed generation (DG) refers to energy generation facilities that are located closer to where the energy is used. This can include local generators, which only utilize the local distribution grid (instead of the long distance transmission lines) or behind-the-meter generators, where the energy is typically used on site. In some cases, the energy can flow back out to the distribution grid to be used by other consumers nearby. DG can help communities to improve their system resiliency by decreasing their dependence on the transmission grid and their exposure to potential blackouts. DG also helps to alleviate some of the variability and congestion issues of the transmission grid and to decrease energy losses.

Due to their local nature, CCAs are well positioned to develop and implement programs that would support the increased penetration of DG in their communities. CCAs have three different ways of doing so: (1) Net Energy Metering programs, (2) Feed-in Tariffs, and (3) integrating DG in their energy procurement strategy by building new local generators.

50 Sonoma Clean Power's Website (2018). *Do-It-Yourself Energy & Water Savings Toolkits.*

51 Source: CEDARS California Energy Data and Reporting Systems. *Programs.*

FIG 10 Avoided Costs Estimated by E3 Model for Climate Zone 2 of PG&E's Territory[52]



Net Metering with Greater Incentives for Residential Solar Producers

Net Energy Metering (NEM) allows customers to offset their energy consumption through the energy they generate with their rooftop solar installations. These customers are compensated for any energy they generate in excess of their consumption. When a CCA launches, all existing NEM customers are typically rolled into the CCA's NEM program. Most CCAs' NEM capacity therefore existed prior to its launch. However, all existing CCAs currently offer much higher compensation rates for net surplus energy generated than their affiliate IOU, as illustrated in Table 7. CCAs' higher NEM compensation policies could be utilized to incentivize other local energy programs as well.

Provide More Accessible NEM Programs for Multi-Dwelling Property Owners

In addition to higher NEM incentives, CCAs can implement other programs to increase the development of local renewable energy among other customer categories than single-family homeowners. For example, SCP has two programs called NetGreen Aggregation and Virtual NetGreen. The first program allows customers to use solar production from one site to offset electricity usage at multiple sites. The second program allows multiple tenants at the same residence to all have a share of a solar generation installation on top of their multi-dwelling building.[53]

PG&E has also offered these types of programs to its customers in the past. Future research could examine how CCAs can leverage their local nature in favor of hard-to-reach customers.

52 Climate zone 2 covers the majority of MCE, SCP, and RCEA territory.

53 Sonoma Clean Power (2018). *NetGreen*.

Feed-in Tariff Programs

MCE and SCP both offer Feed-in Tariff (FIT) programs, which enable small scale solar to be generated and sold independently of energy consumption. MCE currently has 3.2 MW under contract and SCP has 5.99 MW. These two programs have been used as examples here in order to illustrate the avoided costs that come with distributed generation. Using the System Advisor Model (SAM) developed by the National Renewable Energy Laboratory, the authors estimate that the MCE and SCP's total FIT installations have the capacity to produce 5,000 MWh per year and 9,300 MWh per year, respectively. Using the Avoided Cost Calculator recommended by the CPUC and developed by E3,[54] the authors estimate that altogether, these two programs could generate a total of $1.3 million in avoided costs. The figure below illustrates the cost categories taken into account by the E3 model. A more detailed version of this estimation is available in Appendix A. The state legislature is currently considering Senate Bill 692, which could further increase the cost benefits of local energy generation through programs like FIT. This bill would revise the transmission charge so it only applies to electricity that uses the transmission grid.

Other Distributed Energy Resources that Reduce Ramping Needs

Storage

Energy storage is an essential tool for greater renewable energy penetration, both on the transmission grid and on the distribution network. Storage provides a number of important benefits and greatly improves the value of distributed generation, as solar peak production does not always coincide with peak load demand. These benefits are wide ranging and include frequency regulation, voltage support, congestion relief, and transmission and distribution grid upgrade deferral.[55]

All CCAs are required to procure storage capacity equivalent to one percent of their 2020 peak load by 2024.[56] As an example, MCE currently has 1.34 MW of storage (0.13% of 2018 peak load) and RCEA has plans to develop 2 MW (1.5% of 2018 peak load). As storage gets increasingly cheaper, CCAs can invest in this underutilized resource that can help the grid by reducing ramping needs and intermittency resulting from renewable energy generation. Furthermore, the state could see additional legislative support, such as the proposed Senate Bill 700, which could help to accelerate the spread of storage by providing rebates.

Demand Response

Demand response provides an opportunity for consumers to play a significant role in the operation of the transmission grid by reducing or shifting their electricity usage during peak periods. It is an important program that helps to manage and increase load demand flexibility as well as helps smooth the ramp-up in energy generation during sunset. SCP has a new demand response program called "GridSavvy." This program

54 California Public Utilities Commission (2018). *Cost-effectiveness.*

55 Rocky Mountain Institute (2015). *The Economics of Battery Energy Storage: How Multi-Use, Customer-Sited Batteries Deliver the Most Services and Value to Customers and the Grid.*

56 AB 2514 (Skinner) and California Public Utilities Commission (2012) *Rulemaking R. 10-12-007* and (2013) *Decision D.13-10-040.*

gives customers a $5 monthly incentive for allowing SCP to use their smart devices to respond to changes in the grid to better match supply and demand.[57] These smart devices include smart thermostats, smart plugs, smart appliances and smart electric vehicle chargers, explored more in the section below.

Peak Pricing

In 2019, all electricity customers will automatically be enrolled by default into time of use (TOU) rates. TOU rates use price signals to encourage customers to consume electricity during off-peak hours. CCAs, with their rate-setting authority, are empowered with the option to modify IOUs' TOU rates. As an example, a CCA could offer a more aggressive option where customers would be paying even more during peak hours but less during off-peak hours. This ideally could help to further shift peak load demand and reduce ramping needs, subsequently reducing stress on the grid.

Electric Vehicles

With a target of five million zero-emission vehicles on the road by 2030, California can expect the transportation sector to have significant impacts on the electricity sector and the grid. This could be even further expanded Assembly Bill 1745 passes, requiring all new registered cars to be electric after 2040. With planning, electric vehicles (EVs) could be used to solve several grid issues. The right policies and rate designs could prevent EVs from amplifying the duck curve and even could alleviate the problem of oversupply during off-peak hours. Smart EV chargers can also be viewed as a resource, or virtual pow er plant, that can decide when to charge a car depending on market conditions, similar to how demand response works. Finally, some electric car companies are even look ing at bidirectional charging technology that allows the car to also provide electricity where it is plugged in.[58]

For example, LCE has supported another local agency, the Antelope Valley Transit Authority, with their public bus electrification project.[59] Additionally, SCP has supported electric vehicles in two ways. Last year, this CCA offered rebates on electric vehicles, on top of discounted prices from local dealerships and they offered free smart electric vehicle chargers in collaboration with the company eMotorWerks. These smart chargers, known as JuiceNet chargers, can vary the charge to respond to changes in the grid and provide customers incentives for participating. These are also examples of how CCAs can partner with private companies to deliver their customers with greater financial value.

Microgrids

Other emerging projects to improve grid resiliency include developing microgrids. Microgrids allow for sections of the grid to generate and consume all electricity onsite, so they can operate independently and be disconnected from the main grid if necessary. Microgrids alleviate some of the stress on the grid because they can totally island a community.

For example, RCEA's territory has unique geographic challenges when it comes to transmission, as it is located more than 100 miles west of the main transmission corridors in a relatively rural location. This can make upgrading transmission capacity challenging and costly. Consequently, RCEA has established local energy independence as one of its top priorities, where the CCA, supported by PG&E, focuses on other local energy programs, including microgrids. In the coming years, RCEA and the CEC EPIC program are helping to fund a microgrid within Humboldt County in collaboration with PG&E and the Schatz Energy Research Center at Humboldt State University. RCEA will own and operate the multi-customer microgrid, which will include 2 MW wholesale solar photovoltaic (PV), 250 kW NEM PV, and 2 MW of storage.

57 Sonoma Clean Power's Website (2018). *Get a Smart Charger and Join GridSavvy!*

58 To learn more about electric vehicles and their impacts on the California grid, see Next 10's accompanying brief at http://www.next10.org/grid-ev

59 Antelope Valley Transit Authority (2018). *Business Plan*

Limitations to High Penetration of Distrbuted Generation

In the event more CCAs launch and focus on local energy programs, the distribution grid will become more important and could require some upgrades.[60] SCE estimates that the maximum hosting capacity for distributed generation is approximately 15 percent of the total substation's load. Above this threshold, new renewable energy generation would become challenging to manage and could require costly upgrades to the distribution network. For example, because it proportionally requires a lot more power variability to impact the statewide transmission grid than the distribution network, solar energy comes with even more important challenges for the local grid, including power fluctuation voltage regulation, grid stability, and power quality.[61]

Consequently, if distributed generation becomes a more important part of California's power content, the state may see the creation of distribution system operators to ensure the correct balancing and scheduling of operation at the local level. Higher levels of distributed energy resource penetration could therefore likely require higher standard of siting, data collection, and communication to balance and schedule the distribution grid. For example, a study examined how German distribution system operators feasibly integrated up to 56 percent renewable capacity on some parts of its low-voltage grid.[62] While upgrades have been needed, including replacing transformers, the study found that "the planning and operation of low-voltage grids did not fundamentally change with the growing share of PV. Classic grid expansion measures are typically used and advanced technologies are gradually introduced."[63]

The Economics of Local Programs

How CCAs Finance Local Programs

CCAs can utilize their rate-setting authority to earn enough revenues so that part of the net margin can be invested directly in local energy programs or a rate stabilization fund. So far, most existing CCAs have allocated a small portion of their annual budget toward local programs. As illustrated in Table 8, there is great variation in the amount of investment in local programs using revenues. Small amounts of direct investment can be partially explained by the fact that CCAs are very new entities, and in order to keep retention rates high, they need to remain cost competitive compared to their incumbent utilities when they launch.

Investments in local energy programs should be made strategically to keep customers' energy bills low and insulate them against market volatility. These programs should also aim to minimize grid impacts so that both transmission and distribution grid upgrades are deferred. Given the mission of CCAs, they are likely to invest any potential financial surplus coming from the activity of energy procurement back into their community, whether it is in the form of rebates for customers or innovative solutions to decarbonize. For example, PRIME's biggest pitch to customers last summer emphasized "the mixture of new programs and services with innovative infrastructure investments, such as microgrid and virtual power plants, that truly impact customer's bottom line."

The soon-to-launch MBCP instituted an innovative way to increase money for local energy programs. They offer a 100 percent GHG-free electricity product that is 3 percent cheaper that PG&E. They also offer their customers the option to "reinvest their rebate." Customers enrolled in this second program would pay

60 In order to better understand the effect of distributed energy resources on the distribution network, we discussed with Nanpeng Yu, from the Smart City Innovation Laboratory at UC Riverside, assistant professor, and currently focusing on these issues.

61 Based on a discussion with Hamidreza Nazaripouya, research assistant professor at UC Riverside: some of the power quality issues can come from voltage sags, rise, flicker, and frequency fluctuations.

62 B. Bayer et al. (2017). *The German Experience with Integrating Photovoltaic Systems into the Low-voltage Grids.*

63 Ibid.

TABLE 8 Energy Programs Budget Comparison[64]

	MCE	SCP	LCE	CPSF	PCE	SVCE	RCEA	AVCE	PRIME
Local Programs, Rebates, and Incentives Spending	$255,000	$6,000,000	$68,015	$0.00	$250,000	$4,780,000	$957,897	$3,000	$0.00
Spending per MWh	$0.06	$0.38	$0.11	$0.00	$0.08	$1.73	$1.62	$0.01	$0.00

the same rate as PG&E allowing MBCP to invest the 3 percent difference in local energy projects.

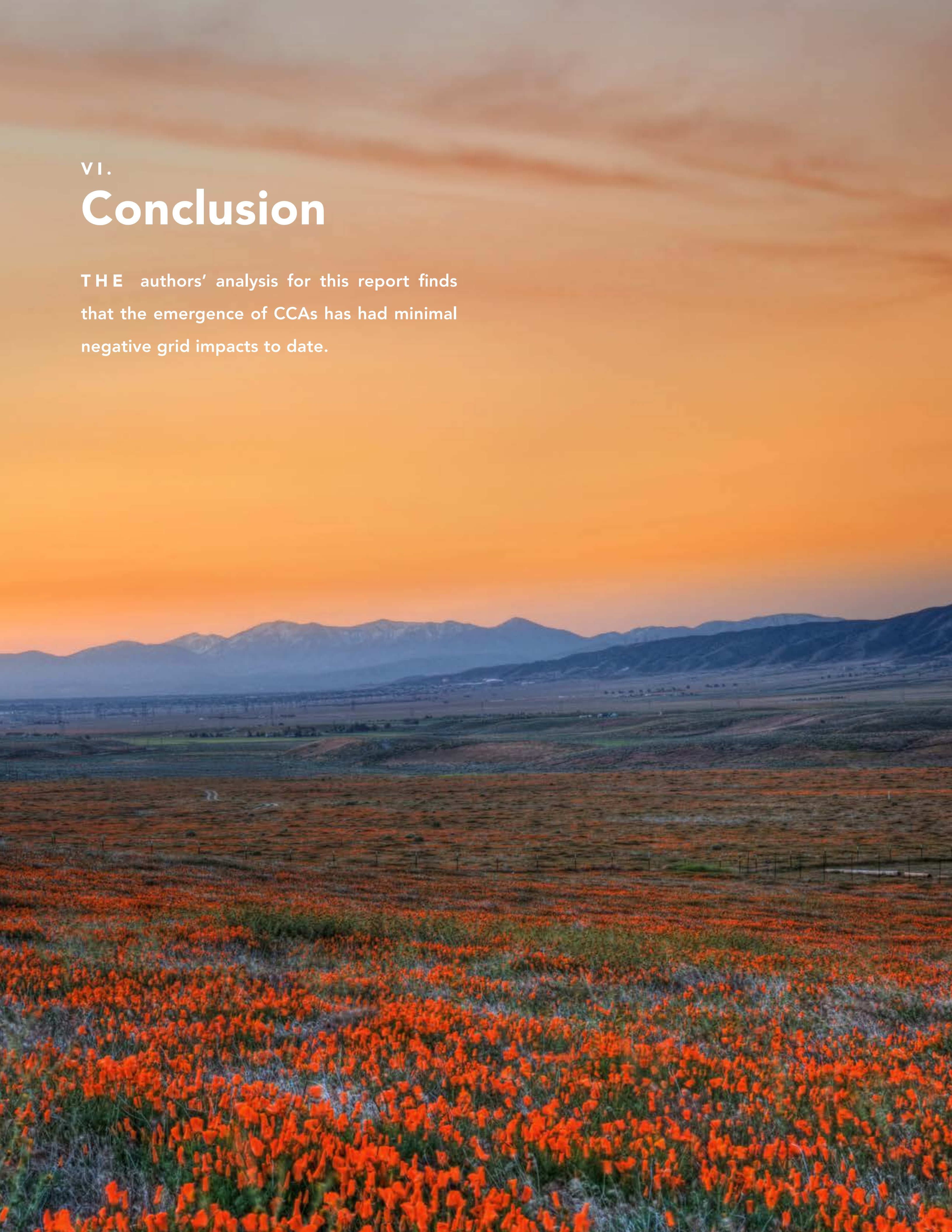
Some CCAs have also partnered with other public agencies or private companies, leveraging at its maximum external funding and incentives for decarbonizing their communities. For example, as described earlier, SCP worked with local car dealerships to reduce the cost of an electric vehicle, on top of rebates offered by SCP.

CCAs also have the opportunity to invest in distributed energy resources as part of their energy planning and procurement strategies. This comes with two benefits: it utilizes the largest portion of revenues received by the CCAs (energy procurement represents approximately 90% of total sales), and it reduces energy need and costs, but also future regulatory requirements such as resource adequacy.

How Local Programs Help CCAs to Meet Resource Adequacy Requirements

As system resource adequacy is calculated based on LSE's peak demand, local energy programs that reduce demand can help to reduce a LSE's resource adequacy obligations. Additionally, some resources like storage and demand response could have the ability to ramp up quickly to meet large and sudden increases in demand, which could be potentially utilized to meet flexible resource adequacy requirements (see the "CCAs' Power Contracts and Resource Adequacy" section for further information on resource adequacy.

64 Source: each CCA's fiscal year 2017-2018 budget or implementation plan.



VI.

Conclusion

THE authors' analysis for this report finds that the emergence of CCAs has had minimal negative grid impacts to date.

CCAs are still relatively new entities that currently represent a cumulative share of the load not exceeding 10 percent of the total state electricity consumption. CCAs deliver electricity to existing customers that were previously served by IOUs. This means that their impact on the transmission grid has been minimal to date. Looking forward, CCAs' greatest impact on the grid comes from their direct and indirect push for more renewable energy. However, recent studies have suggested that high renewable energy penetration is less of a technical challenge than an economic problem, which can be solved with a combination of several existing solutions. Moreover, the authors of this analysis found that CCAs have so far focused more on wind and non-variable renewable energy sources, which do not exacerbate the grid issues identified in this report.

When CCAs launch, they need cheap and ready-to-be-used contracts to serve their customers, while suffering from a lack of credit score and track record. This has forced some CCAs to heavily rely on 1) out-of-state energy generation and 2) short-term contracts. The first increases transmission needs and congestion issues while the latter decreases planning capacity and long-term grid reliability. The authors believe that more research is needed in this field, but this trend should diminish as CCAs mature and focus more on local sources of energy. Moreover, if CCAs manage to produce a substantial amount of energy locally, this would defer further investment in transmission infrastructure.

In fact, CCAs' smaller size, public and local nature represent a strong asset to implement local energy programs, which may help reduce or shift energy consumption, and thus alleviate stress on the transmission grid. Preliminary evidence from existing CCAs suggests that they may be better positioned to provide programs to hard-to-reach customers. CCAs have also shown a desire to pilot and implement innovative local energy programs, tailored to their community's preferences and best interests. A focus on local energy program expansion provides a potential opportunity for CCAs to bring benefits to the transmission grid and support the state's goals of decarbonization.

The recent launch of CCAs and the wide diversity among them makes it hard to draw general conclusions and predict future trends, and this may become increasingly true as more CCAs launch across the state. There is therefore a need for future research to examine the impacts of these shifting trends, especially related to short-term and out-of-state contracts. While not an issue currently, these trends, amplified by the continued proliferation of CCAs, could worsen inter-state congestion and complicate planning and long-term grid reliability.

VII.

Appendix

1. Estimation of electricity generation of all of MCE's and SCP's FIT installation, for one year, based on the System Advisor Model (SAM) developed by the National Renewable Energy Laboratory (NREL).

FIG 11 Electricity generation from all Sonoma Clean Power's FIT installations

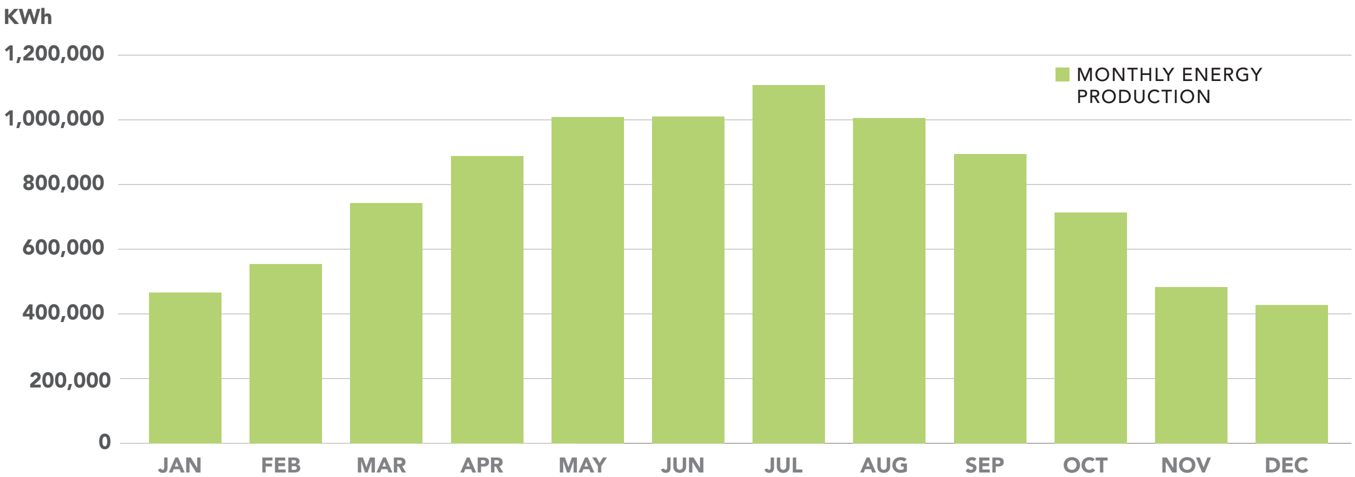
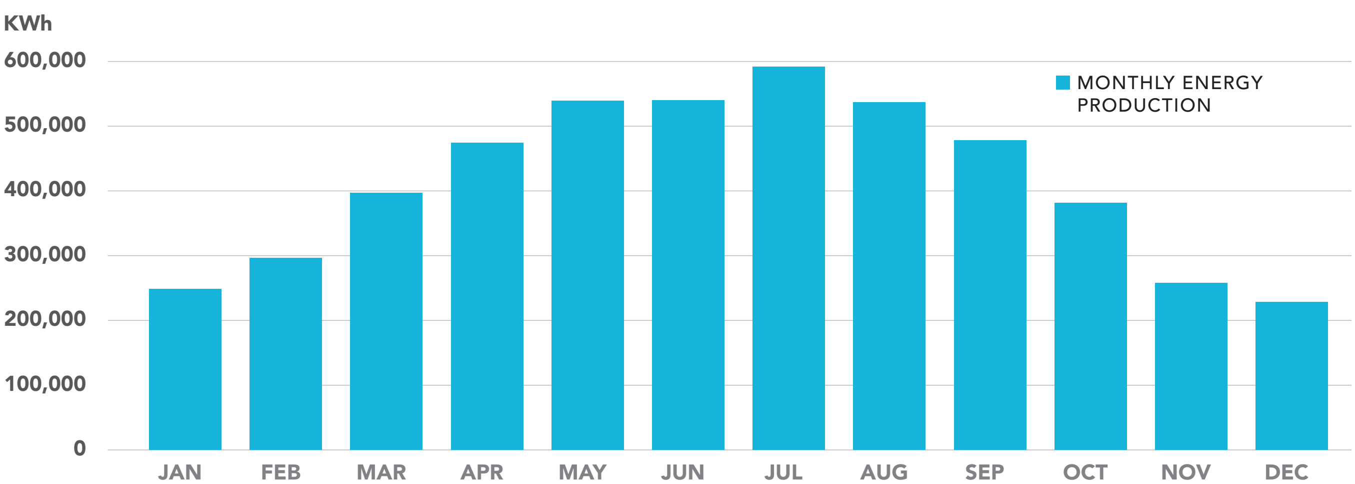


FIG 12 Electricity generation from all MCE's FIT installations



2. Estimation of the resulting avoided costs from distributed electricity generation of all of MCE's and SCP's FIT installation, for one year, based on the Avoided Cost Calculator model developed by Energy+Environmental Economics (E3).

TABLE 9 Avoided Costs Estimated by E3 model for Climate Zone 2 of PG&E's territory

MONTHLY LEVELIZED VALUE OF ELECTRICITY ($/MWH)									
Date/Time Stamp	Energy	Losses	Ancillary Services	Emissions	Capacity	Transmission	Distribution	Avoided RPS	Total Levelized Value
January	$33.20	$2.41	$0.31	$10.92	$0.00	$0.00	$0.00	$14.78	$61.61
February	$33.70	$2.45	$0.31	$11.09	$0.00	$0.00	$0.00	$14.78	$62.33
March	$27.73	$1.98	$0.26	$9.27	$0.00	$0.00	$0.00	$14.78	$54.01
April	$23.01	$1.60	$0.23	$10.12	$0.00	$0.00	$0.00	$14.78	$49.74
May	$18.46	$1.10	$0.19	$8.69	$0.00	$0.00	$0.00	$14.78	$43.21
June	$26.39	$1.81	$0.26	$10.31	$0.01	$0.00	$0.00	$14.78	$53.55
July	$31.92	$2.27	$0.30	$11.17	$0.00	$0.00	$0.00	$14.78	$60.45
August	$30.91	$2.20	$0.29	$10.94	$43.72	$0.00	$0.00	$14.78	$102.83
September	$33.01	$2.35	$0.31	$11.31	$134.40	$0.00	$0.00	$14.78	$196.15
October	$35.70	$2.50	$0.33	$11.76	$0.15	$0.00	$0.00	$14.78	$65.22
November	$36.15	$2.60	$0.34	$11.72	$0.00	$0.00	$0.00	$14.78	$65.58
December	$37.25	$2.71	$0.34	$11.66	$0.00	$0.00	$0.00	$14.78	$66.73

TABLE 10 Total Avoided Cost for all FIT installation, per month

	MCE		SCP	
	Elec. Prod. (kWh)	Avoided Costs ($)	Elec. Prod. (kWh)	Avoided Costs ($)
January	249,052	$15,344	466,194	$28,721
February	296,522	$18,483	555,051	$34,598
March	397,402	$21,465	743,887	$40,180
April	474,533	$23,602	888,268	$44,180
May	538,660	$23,277	1,008,300	$43,572
June	540,136	$29,126	1,011,070	$54,521
July	591,712	$39,888	1,107,610	$74,665
August	537,138	$59,646	1,005,450	$111,649
September	478,217	$155,979	895,162	$291,972
October	381,633	$26,769	714,371	$50,108
November	258,047	$16,922	483,031	$31,676
December	228,980	$15,434	428,621	$28,891
TOTAL	**4,972,032**	**$445,935**	**9,307,015**	**$834,733**

TABLE 11 Avoided Cost for all FIT installations, per cost category

Date/Time Stamp	Energy	Losses	Ancillary Services	Emissions	Capacity	Transmission	Distribution	Avoided RPS
MCE	$147,156	$10,334	$1,400	$52,824	$87,813	$26,196	$46,746	$73,466
SCP	$275,458	$19,344	$2,620	$98,880	$164,374	$49,035	$87,503	$137,519