The Efficacy of Voluntary Overcompliance for Decarbonization: Evidence from California

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Abstract

A majority of US states have implemented renewable portfolio standard (RPS) programs, regulations that require minimum levels of renewable energy content for electricity providers; many jurisdictions have also introduced forms of voluntary green power, which enable customers to buy renewable power in quantities that exceed mandated levels. This paper assesses whether voluntary green mechanisms have accelerated decarbonization progress relative to just an RPS. I study the case of California, which is notable for having both an aggressive RPS and a substantial portion of customers taking service from retail plans containing renewable energy levels in excess of the state's RPS. This is facilitated by the recent entry of Community Choice Aggregators (CCAs), publicly-owned retailers who procure power on behalf of their member cities, and who often emphasize environmental sustainability values. Using regulatory filings and census data, I estimate a logistic regression model showing that higher income and pro-environment communities tend to join CCAs. I then estimate a second model that shows voluntary green procurement is correlated with community attributes indicating high willingness to pay for decarbonized power. However, CCA voluntary greenness did not translate to greater decarbonization relative to the RPS for the state overall: due to stagnation or backsliding in other parts of the sector, the state average was actually 1% below the soft target of 35.75% in 2021. Within CCAs, the high level of voluntary greenness exhibited by wealthier or larger CCAs does not translate to less wealthy or smaller CCAs. In addition, CCAs' elevated levels of renewable energy are mostly attributable to resources originally procured on behalf of other incumbents, such that CCAs fare no better than other types of retailers at adding new renewable generators to the system on a per-kWh basis. These findings suggest that the primary effect of voluntary green power is to affect the distribution rather than the overall magnitude of decarbonization.

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I. Introduction

Energy production is responsible for about a third of global greenhouse gas emissions, and electricity/heat generation is the largest single subsector contributing to emissions (IPCC 2022). Governments often aim to reduce energy-related emissions by encouraging substitution of electricity for natural gas or petroleum end-uses, while simultaneously deploying decarbonized generation resources to lower the emissions intensity of electricity supply. Common mechanisms to facilitate this transition include renewable portfolio standards (RPS), regulatory mandates that impose minimum levels of renewable energy content for electricity providers (Barbose et al. 2016); incentives or subsidies to stimulate investment (e.g., the Production Tax Credit/Investment Tax Credit); increasing procurement via auctions (Haufe and Ehrhart 2018, Hastings-Simon et al. 2022); cap-and-trade emissions schemes; carbon taxes; and "self-regulation" via voluntary purchases of renewable power. Although a carbon tax is widely considered the most economically efficient policy, political economy challenges make practical implementation difficult. So, in practice, programs like an RPS are more commonly implemented despite being relatively expensive forms of abatement and policymakers may even employ multiple approaches simultaneously (Goulder and Parry 2008). One such example is the dynamic between top-down regulatory standards and bottom-up voluntary overcompliance. Voluntary overcompliance, or voluntary green power programs, enable renewable energy purchases for consumers that exceed policy-mandated minimum percentages (Sumner et al. 2023). Sufficiently large levels of voluntary green power demanded could serve as an additional market-based instrument to induce an increase in the quantity of decarbonized power supplied.

RPS programs and voluntary green programs are both common in the US. 29 US states and the District of Columbia have an RPS while 37 US states offer some form of voluntary green power such as utility green tariffs (NREL 2023). In this paper, I examine the case of California, which has both an aggressive RPS and a high degree of participation in voluntary green power. I provide evidence that voluntary green power procurement has the potential to advance decarbonization goals, but its impact can be undermined by institutional and regulatory barriers. In California, voluntary overcompliance with the RPS is facilitated by Community Choice Aggregators, retail electricity providers that enable community-scale procurement of RPS-eligible[2] resources in excess of the mandated floor. CCAs exist in ten US states with four more considering authorization, and a majority offer green options. California's particular CCA design has two features that present a uniquely strong opportunity to observe the impact of a voluntary green power mechanism on overall decarbonization performance. First, all California CCAs except one offer voluntary green power options, and many CCAs have configured their default offering to overcomply with the RPS. Second, they have the unusual feature of being opt-out rather than opt-in. CCAs with high-renewable default portfolios therefore give rise to an unusually large set of demand for green products, as they capture both customers with high willingness to pay for voluntary green power and customers who are inattentive to the clean energy content of their power. Existing reports on California's CCAs have supported the idea that CCAs have procured more clean electricity than is required by California's renewable portfolio standard (Trumbull et al. 2019, 2020) but the net effect on statewide performance remains unclear. In addition, some previous research explores sociopolitical aspects of the formation of CCAs, such as coalition-building (Hess 2019) and diverse community motivations for CCA formation (Gunther and Bernell 2019).

I empirically test the performance of CCAs with respect to decarbonization relative to the RPS minimum. While my estimation verifies that CCAs engage in voluntary overcompliance by procuring more green power than required by the RPS, I find that the net effect is not meaningfully different from a binding RPS alone. The lack of additionality arises for three reasons. Cracks in the RPS floor allowed instances of underperformance to persist; voluntary gains from high-performing entities were offset by a shedding of renewable contracts in other parts of the sector; and CCAs had no positive spillover effect on other entities in the sector due to geographic constraints on entry. Rather than encourage a faster transition to decarbonized energy, voluntary green power has apparently failed to help meaningfully advance progress. However, I do find that CCA formation and participation in voluntary overcompliance correlates strongly with indicators of high willingness-to-pay for renewable energy. CCAs are therefore an effective mechanism for matching customer preferences for power with the actual renewable content of power procured.

[2] Such RPS-eligible renewable energy sources are bioenergy, geothermal, small hydroelectric, solar, and wind. California recognizes nuclear and large hydroelectric plants as providing carbon-free power but at this time does not count them as RPS-eligible.

This paper contributes to the literature on voluntary versus mandated action to ameliorate a market failure. Voluntary overcompliance with environmental regulation has previously been documented in contexts such as the US EPA's 33/50 program on reducing toxic chemical emissions (Arora and Gangopadhyay 1995, Khanna 2001), and more recently with the rise of environmental, social and governance (ESG) investing and corporate carbon disclosures (Hsueh 2019, Duchin et al. 2022). Findings are more mixed as to whether such self-regulation measures actually translate to meaningful declines in emissions. I look at the performance of voluntary overcompliance in the related but distinct area of electricity sector decarbonization. The work also ties in to literature studying the effects of environmental regulation on decision-making for participants in electricity markets. The impact of pollution permits on firms' generation and investment strategies is a longstanding topic of study (Laffont and Tirole 1994, Fowlie 2010), as is measuring the cost of carbon pricing schemes on energy prices (Borenstein and Kellogg 2022, Holland et al. 2022). The majority of this work, however, focuses on effects in the wholesale market. This study instead focuses on the implications of clean energy mandates for procurement decisions by retail providers.

Electricity use is sometimes conceptualized as consumption of a homogenous good: the kilowatt-hours of energy a customer receives are functionally the same regardless of whether they are generated by burning coal or by spinning a wind turbine, and electricity auctions are commonly modeled as multi-unit procurement of a homogenous good. But from a wholesale cost and grid operations perspective, power generation is understood to be highly variable, as different types of generators have time- and capacity-variant abilities to provide power. As addressing climate change has become an increasingly urgent priority, the emissions attributes of fuels used for generating power have also become important (Borenstein and Bushnell 2015). For economic policy questions concerning electricity decarbonization, then, electricity may be better thought of as a heterogenous product, where kilowatt-hours of energy are differentiated by the type of fuel used to generate them. I consider how such differentiation by emissions attributes may have impacts for the larger electricity industry.

In liberalized electricity markets, generators bid power into the market in accordance with such factors as their short-run marginal costs and the terms of bilateral contracts with retailers. If enough customers choose retail plans that contain higher renewable content than the system average, the increase in demand for electricity that specifically comes from renewable sources could necessitate expanding the buildout and utilization of renewable generation. These voluntary green portfolio offerings can be, but aren't necessarily, features of competitive retail electricity markets. In the US, electricity retail structure differs by state, ranging from zero retail choice to full retail choice. Even in fully liberalized retail settings, competitive retailers might offer consumers the choice of different rate structures but no option to select the clean energy content of the power being procured on their behalf. In this case, customer preferences concerning clean energy will not carry over into sending a signal to the wholesale generation sector. Conversely, a non-competitive retail sector might still contain a monopolist that offers customers a choice between a default procurement portfolio and paying a small premium to receive a portfolio with a larger proportion of clean energy. Therefore, this work focuses on the effects of portfolio heterogeneity—rather than price heterogeneity—on the wholesale sector. This could have implications for the structure of the retail sector but it is not necessarily the same thing as discussing retail competition.

However, the literature on retail competition still provides a useful theoretical framework. The effectiveness and value of competitive electricity retail markets have been debated since the concept was introduced. Joskow (2000) expresses skepticism, as competitive retailers are still inherently tethered to upstream regulated network monopolies, which constrain opportunities for meaningful innovation or cost saving. Though retailers could theoretically provide other value-added services, Joskow concludes that such opportunities are likely small. Littlechild (2000), in contrast, argues that greater competition on the demand side could induce improvements at the wholesale level, and result in better cost-minimization than systems without retail competition. Twenty years after his original argument in favor of retail competition, Littlechild (2021) asserts that sophisticated demand-side engagement is crucial for successful deep decarbonization, and that this emphasizes the importance of expanding and innovating in retail competition more than ever. Empirical literature assessing the performance of retail competition has tended to focus on measuring price impacts, in most cases finding that the introduction of retail competition into liberalized electricity markets has yielded few pricing benefits to consumers (e.g., Joskow 2006, Su 2015). This study measures how the average renewable energy content has changed with the introduction of heterogeneous procurement portfolios into a market. A complete assessment of the modern electricity retailer should account for performance in terms of clean power and not just cost-competitive power. If retailers are shown to help accelerate progress to a decarbonized wholesale electricity supply, this is a substantial value-added service.

California's electricity retailing sector has a particularly complex history. The state introduced a competitive retail market in the late 1990s, but abruptly reversed course in the midst of the 2001 energy crisis. Customers were largely returned to the default service provider for their geographic region and the Direct Access competitive retailer program was indefinitely suspended (Borenstein et al. 2002, Wolak 2003). However, it does not follow that the state came out of the crisis with a small or homogenous set of retailers—there remained many retailers, but each effectively had a geographic monopoly such that any given customer generally had no choice over their selection of retail provider. The past decade has seen a large number of new entrants in the form of Community Choice Aggregators (CCAs), publicly-owned retailers who procure power on behalf of their member cities, and who often tout environmentally-progressive reputations. Because a CCA arises within the territory of an incumbent private electricity provider, CCAs introduce some choice of retail provider and also significantly expand the total number of retailers in the state. Today, there are nearly one hundred separate retailers in the state that vary greatly in size, type of service territory, scope of function, and decarbonized energy content.

The paper proceeds as follows. Section II introduces the empirical setting and explains how California's retailer heterogeneity results in high levels of voluntary overcompliance. Section III models the community characteristics associated with voluntary green procurement. Sections IV and V analyze additionality in terms of net renewables procured and improved investment in renewable generation respectively. Section VI discusses policy implications and Section VII concludes.

II. Theory/Background

A. Retailer Heterogeneity and Voluntary Overcompliance

Customer preferences, regulatory constraints, and budget constraints affect the composition of electricity retail portfolios, which implies variation between retailers even in noncompetitive settings. Under some conditions, this variation could lead to positive impacts in the wholesale provision of electricity.

Electricity can be thought of as three separate businesses: wholesale generation, network services (transmission and distribution), and retail sales of power. In systems with retail competition, multiple retailers compete for customers. In systems without any retail competition, the retailer is synonymous with the network utility and all customers purchase electricity from that firm (a single utility may offer multiple portfolio options). As transmission and distribution of electricity is considered to have natural monopoly characteristics, a typical electricity system is geographically divided into one or more utility service territories. Therefore, systems lacking retail competition may still contain multiple, noncompetitive retailers.

Electricity retail product offerings might become differentiated as a result of heterogeneous consumer preferences. This is an inherent feature of competitive settings, where retailers compete for customers by tailoring their marketing and product offerings according to consumers' preferences. In grids where multiple retailers exist but do not compete, consumer preferences are still likely to differ between (monopolistic) retailers. The service territories of utilities are geographically tied, and geographic sorting by socioeconomic status or identity group is common. The resulting regional variation, such as sensitivity to electricity price or preference for certain generation resources, impacts the retail product offerings available in that service territory. Prior studies have shown that consumers may consider several different factors when choosing a retail provider. These include both cost-related attributes—discounts, sign-up bonuses, and contract length, for example—and non-price attributes—such as type of supplier or share of renewable energy (e.g., Goett et al. 2000, Amador et al. 2013, Ndebele et al. 2019). Consumers tend to exhibit a modest willingness to pay for greener electricity even in settings where the penetration of renewable energy is already large (Ndebele 2020). To my knowledge, this is the first study to connect such preferences for clean energy to a potential larger effect on the system supply of clean energy.

Binding regulatory requirements constrain the purchasing decisions of a retailer. Regulation dictates that a retailer who would prefer procuring very low levels of renewable energy must instead procure at least the minimum mandated quantity. But if regulatory constraints are unevenly applied—for example, if only some retailers receive exemptions for clean energy purchases—then this creates further differences in the feasible sets of product offerings for retailers. The particular language of the regulation also matters. California's RPS only mandates that each retailer's overall sales must contain a certain level of renewable energy, and this percentage is assessed as the average across each multi-year compliance period. California's RPS therefore allows for the possibility of noncompliance for some years and some portfolios within a given retail supplier's overall offerings.

Electric retailers also face different capacity-related constraints—for example, whether the retailer can achieve economies of scale in purchasing power, the retailer's technical capacity to navigate favorable power contracts, and the cost of borrowing money to finance operations. The retailer's load size and its structure (whether it is vertically integrated with the network utility and whether it is a public or private entity) have large impacts on these parameters. A retailer run by a municipality, for example, may have relatively less specialized expertise in power procurement but can borrow cheaply compared to a private firm. Or a certain utility may have exclusive access to a local hydroelectric facility, which leads to variation in the cost of power procurement.

The price and procurement strategies of retailers could therefore exhibit variation across several parameters including geographic region, size, status as a retail-only business vs vertically-integrated utility, and status as a public vs private entity. In the case of decarbonization, a retailer aggregating the interests of communities with a strong preference for clean energy might create a 100% renewable retail product for these customers, when they previously had no choice but to accept a dirtier default retail option from their utility. Sufficient demand for high levels of renewable procurement would signal the wholesale sector to increase production of renewable energy, encouraging a market-based rather than regulation-based approach to promoting decarbonization. However, identifying and selling to retail customers with high willingness to pay for clean energy is not itself a sufficient condition for spurring decarbonization. Demand for these premium green products may be too low to meaningfully incentivize greater clean energy production. Absent regulatory constraints, carving out areas with high preferences for clean energy may also imply the creation of retailers capturing customers with low preference for clean energy, resulting in a mere reshuffling of the existing clean energy pool. The existence of heterogenous retail portfolio offerings therefore only helps spur decarbonization if it is associated with net additionality in renewable generation.

B. California's Various Load-Serving Entities

Prior to California's experiments with deregulation in the 1990s, most customers were served by either investor-owned utilities (IOUs) or publicly owned utilities (POUs). IOUs are private companies and regulated utilities, which used to be fully vertically integrated. The deregulation of the 1990s forced the IOUs to largely divest from their generation holdings, though IOUs still own some power producing assets as well as a significant portion of the transmission and distribution infrastructure across the state, and they can continue to serve retail functions within their service territory. There are three major IOUs (PG&E, SCE, and SDG&E) and three Small/Multijurisdiction IOUs (Bear Valley Electric Service, Liberty Calpeco, and Pacificorp). These latter three amount to ~1.5% of IOU load and are subject to special regulations as they sometimes also serve customers outside of California.

POUs are often municipal utilities, where the city procures and retails power in addition to owning its own transmission and distribution infrastructure. Irrigation districts, which are a type of local government that primarily serves agricultural areas, and other special purpose districts, are also classified as POUs. However, such areas are organizationally and politically very different from municipal POUs that have a dedicated department to operating a local electric utility. A very small number of customers receive electricity from another public power model known as member-owned electric cooperatives (Co-Ops), which are often located in remote, rural areas. Like the small/multijurisdiction IOUs, Co-Ops sometimes operate in multiple states and constitute an insignificant portion of overall load. Co-Ops are excluded from the analysis for the remainder of the paper.

When the state attempted to introduce retail competition, multiple private retail companies known as Direct Access Providers (DAPs) entered the market. During the California energy crisis, there were fears that continued customer load departure to competitive retailers would cause harmful cost shifts onto remaining customers and interfere with the regulated utilities' ability to repay debt the state took on to deescalate the crisis. As a result, the legislature froze the Direct Access program, prohibiting DAPs from adding new customers. Today, DAPs still procure electricity and retail it to certain commercial and industrial customers, but total load share is capped at about 10%.

The decision to halt Direct Access was controversial, so a year later the legislature passed AB117. Rather than re-authorize competitive private suppliers of electricity, AB117 enabled local governments to become new participants in energy procurement by forming a community choice aggregator (CCA). DAPs and CCAs share the characteristic that they acquire transmission and distribution from the IOU, with the main difference being a private versus public ownership model. CCAs may only arise within the existing service territory of an IOU, and they are public entities formed via Joint Powers Agreements (JPAs) between one or more cities or counties. A CCA then purchases power on behalf of the customers living in that geographic region, meaning that any given customer in an IOU service territory will see at most one CCA. Unlike traditional competitive retailers that must entice customers to switch from a default provider, CCAs in California are opt-out entities and therefore avoid the large marketing costs generally associated with successful startup of new retailers. CCAs are particularly notable in California for their rapid growth and high market penetration. The first operational CCA launched in 2010, and by 2021 over eleven million customers participated in a CCA. As some CCAs procure very high levels of renewable power, the emergence of these "leadership communities" may indicate a decarbonization benefit to allowing the formation of new retailers.

As of 2021, there are 92 separate Load Serving Entities (LSEs) that serve as retail electricity providers in California. The LSEs vary greatly in terms of service territory size, types of customers served, governance structure, and regulatory oversight. Summary statistics for the five categories of LSE are given in Table 1, with major structural and governance differences diagrammed in Figure 1.

Table 1: Size of each type of LSE in California

	Number of LSEs	Total 2021 Sales (MWh)	Percentage of Total Sales
CCA	25	50,635,122	21.3%
CO-OP	4	395,943	0.2%
DA	10	24,383,037	10.3%
IOU	6	102,732,588	43.2%

POU	47	59,723,829	25.1%
Total	92	237,870,520	100.0%

Figure 1: Major Structural Differences between LSE Types

	Vertically Integrated	Generation/Retail Only
Public	POU, Co-Op	CCA
Private	IOU	DAP

C. Clean Energy Policy in California

California's SB 100 "established a landmark policy requiring renewable energy and zero-carbon resources supply 100 percent of electric retail sales to end-use customers by 2045" (CEC, n.d. a) In the California regulatory context, *renewable* energy refers to biofuel, geothermal, eligible (small) hydro, solar, and wind. Nuclear and large hydro are zero-carbon resources but are not considered renewable due to environmental impact. The sum of renewable and this other zero-carbon generation is the total amount of *clean energy* procurement in each portfolio. In the empirical analysis, I measure LSE performance with respect to both renewable energy and total clean energy. The remaining possible types of specified procurement are fossil carbon resources: coal, natural gas, and a residual "other" category that encompasses such fuels as petroleum, diesel, and propane. Finally, unspecified power "refers to electricity that is not traceable to specific generation sources by any auditable contract trail or equivalent." Unspecified power indicates the extent to which an LSE is buying off the short-term market rather than contracting for power. While the exact proportions of each fuel type contributing to unspecified power may not be known, state calculations find that the average emissions intensity of unspecified power is slightly higher than that of a typical natural gas plant in California.

The primary mechanism for achieving SB 100 is the Renewable Portfolio Standard (RPS), which "sets continuously escalating renewable energy procurement requirements for the state's load-serving entities." (CEC, n.d. b) Thus, the primary driver for decarbonizing electricity in California is not to directly restrict construction or operation of fossil plants but rather to ratchet up the percentage of clean energy retail purchases, altering retailers' decisions and thereby indirectly stimulating greater investment in renewable generation. LSEs were required to achieve 33% renewable energy by 2020 and 60% by 2030. While this sounds clear, the RPS's particulars make assessing progress far from straightforward. There are several subtle but important differences between total quantity of renewable energy procured and total quantity of renewable energy counted towards RPS compliance. In this paper, I report renewable procurement and additionality in terms of MWh sold, but RPS compliance is measured in terms of renewable energy credits (RECs). REC accounting can diverge from actual procurement, such that performance using RPS accounting definitions may present a different picture than performance based on accounting of real resources procured. The exact language of the 2030 target mandates 60% *renewable energy*, while the 2045 target mandates 100% *clean energy*. The percentages are assessed on a per LSE basis, such that a retailer could offer a 100% renewable product and an out-of-compliance product as long as the average proportion of renewable energy exceeded the RPS floor. Performance is assessed per multi-year compliance period (e.g., 2016–2020), so a retailer could be out-of-compliance for some of the years as long as the overall period average is sufficient. And crucially, RPS enforcement is not centralized under one agency. The POUs are regulated by the California Energy Commission (CEC) while IOUs, CCAs, and DAPs are regulated by the California Public Utilities Commission (CPUC). Although the wording of the RPS implies that every LSE should individually meet the minimum standard, differences in the way the CEC and CPUC implement regulations also explain why LSE performance is far from uniform.

D. Regulation Under the CPUC

The RPS came into effect in 2002 with an initial target of 20% renewable energy by 2017, which each of the three major IOUs met years ahead of schedule. Thus, voluntary overcompliance has actually been a feature of this setting even before significant entry from CCAs. Consistent with the literature, overcompliance signaled that standards could be tightened, and RPS targets were subsequently revised upwards and accelerated multiple times. 33% renewable energy was required by 2020, but this value jumps to 44% by the end of 2024. IOUs, CCAs, and DAPs are all subject to the same percentage-based requirements and fall under CPUC jurisdiction.

Starting with the 2021–2024 compliance period, the CPUC also imposed an additional criterion that at least 65% of procurement must be executed via long-term contracts. IOUs are decades old and have experience and financial infrastructure to sign long-term contracts. This requirement is more difficult to satisfy for CCAs and DAPs. CCAs are newer and often lean organizations that in many cases have struggled to get credit ratings. DAPs face a unique set of challenges. The DAP program was suspended after the California Energy Crisis in 2000–2001, and the total load that DAPs can serve is strictly capped. It is difficult for DAPs to add new customers, but the threat of losing customers is very real. DAP customers are commercial and industrial loads, which tend to be more price-sensitive and attentive than residential consumers. In addition, customer commitments to DAPs are on the order of just one to two years. These structural realities make DAP load forecasting uncertain. Consequently, DAPs have tended to buy most of their power on the short-term market, so the majority of their sales are ascribed to unspecified power. This translates to difficulty in fulfilling their RPS and long-term contracting obligations. According to a recent CPUC staff report, which refers to the DAPs as electric service providers or ESPs: “while the ESPs were forecasted to be in compliance on average, compliance verification indicates that only 7 of 14 ESPs were considered to be on track to meet their 2017-2020 compliance period requirements, while eleven ESPs are considered high risk in not meeting their 2021-2024 requirements. Three ESPs failed to meet RPS compliance period 2014-2016 compliance requirements.” (CPUC Staff 2021) The outlook for meeting long-term contracting requirements by 2024 looks similarly bleak, as “of the twelve ESPs that forecast serving load in the 2021-2024 compliance period, three ESPs are forecasted to have procured enough long-term RPS energy, seven have procured some long-term RPS energy, and two have not procured any long-term RPS energy to meet the 65 percent requirement.” (CPUC Staff 2021) Perhaps as an indication of the difficulties in maintaining the DAP business model, by the end of 2021 the total number of DAPs serving load had already dropped to ten.

E. Differing Regulation for POUs

Between the inception of the RPS and the passage of SBX1-2 in 2011, POUs were not subject to state regulatory oversight. POUs were instead simply directed to implement and enforce their own renewable energy purchase programs. Evidence suggests that many POUs had taken efforts to also achieve 20% renewable energy by 2013. But enforcement was not formalized under a state agency until CEC (not CPUC) regulation of POUs began in 2013. In recognition of this different timeline, the RPS trajectory for POUs was set at 20% by 2013, 20% by 2016, and 33% by 2020 (The CPUC set interim targets for the LSEs within its jurisdiction of 20% renewable by 2013, 25% by end of 2016, and 33% by 2020.). POUs were therefore only expected to procure similar proportions of renewable energy as their IOU/CCA/DAP counterparts starting in 2020. Going forward, the targets are the same for all LSEs (meaning in the eight years between 2016 and 2024, the compliance floor for POUs nearly doubles from 20% to 44%).

The CEC regulatory code for POU RPS enforcement enumerates multiple exemptions and allowances that are specifically granted to POUs. Perhaps most significantly, the early development of POUs was often driven by access to hydroelectric resources for irrigation and power production. Large hydroelectric power is generally not considered a renewable resource under CPUC definitions. However, the CEC version of the RPS enforcement guidelines states that if most of the POU's electric load is served by certain hydro generators (e.g., legacy hydro, certain eligible facilities) then under some circumstances POUs can count that hydro as "renewable" and in others they can subtract it from their total procurement obligation. Several POUs own or have very long-term contracts with other legacy forms of generation as well, particularly coal and gas peaking plants. In the current 2021–2024 RPS compliance period, POUs that can prove they are unable to feasibly exit legacy coal contracts are allowed to reduce their RPS procurement target by a certain amount that accounts for this unavoidable coal generation. Similarly, for future RPS periods, there are provisions for POUs that own gas peakers to be able to slightly reduce their RPS procurement targets. While these may be defensible concessions in the context of the economic and institutional realities that POUs face, they also undermine pure decarbonization objectives.

The CEC also acknowledges that, because POUs may own network infrastructure, there may be exceptional circumstances that prevent a POU from meeting each RPS deadline. POUs can claim a “delay of timely compliance” for multiple reasons, including inadequate transmission capacity, permitting/interconnection delays, and unanticipated increase in retail sales due to transportation electrification. In short, all the major supply-side and demand-side challenges to achieving a high RPS can be argued as exceptions for POU noncompliance. POUs are also allowed to argue that the cost of meeting RPS procurement exceeds a cost limitation that the POU itself determines will cause disproportionate rate impacts.

The regulations dictating that all retailers should eventually achieve 100% clean energy-powered electricity might seem uniformly applied, but closer inspection reveals unevenness in several important regards. RPS compliance was first enforced for LSEs under CPUC jurisdiction, and then only later did it also apply to POUs. The particulars about which resources count towards or against each LSE’s procurement obligation differ depending on the regulatory authority. And extensions or exceptions are granted to only certain types of LSEs, which is justified based on the utility’s obligations besides retailing. Ultimately, the procurement decisions of the LSEs are optimized based around the RPS’s particular set of rules and exceptions (i.e., sufficient procurement of eligible RECs), as they apply to that particular retailer. This is not necessarily the same as actually procuring that same MWh quantity of renewables.

Faced with a slightly different set of rules, and certainly a different set of constraints based on institutional histories, the various groups of LSEs are likely to take divergent approaches to procurement. Due to such institutional differences, it is also plausible that factors explaining the success of some LSEs in procuring decarbonized energy may not translate over to other groups of LSEs.

III. Regression Analysis

The empirical exercises discussed in this section are intended to test whether CCAs act as a channel to facilitate matching between consumer preferences for green energy and accessing green energy. I estimate the associations between a variety of attributes that might indicate higher willingness to pay for decarbonized power, and the proportion of decarbonized power present in various LSEs’ default portfolios. I find that communities forming CCAs and receiving more decarbonized power tend to be higher income and politically supportive of climate change mitigation policy.

A. Methodology

I estimate reduced-form equations to determine the effects of LSE type and community characteristics on the equilibrium quantity of green electricity procured on behalf of retail customers. This is accomplished via two empirical exercises. The first is a binomial logit model of CCA formation to gain insight into the community characteristics associated with a desire to access a mechanism for voluntary green procurement. The second is an OLS regression of green power on community characteristics to determine whether participation in a CCA and indicators of higher willingness to pay correlate with the actual intensity of decarbonized power procured.

The logistic regression takes the form:

$$is\_CCA_i = X'\beta + \epsilon_i$$

where each i represents a community, X is a vector of community characteristics, and ϵ is an idiosyncratic error term. The outcome variable is_CCA_i takes on the value one if the community became served by a CCA in any year between 2010 and 2020. A range of covariates that might indicate higher propensity for CCA formation are included so as to attenuate omitted variable bias. These contain measures of income, broad political preferences, specific political preferences on environmental issues, relative average cost-of-service, and presence of local renewable resources that could provide local economic benefits. The model considers all communities eligible for CCA formation, that is, all communities originally within the network service territory of an IOU. I exclude any community served by POUs because these communities cannot form a CCA that enters into competition with their local POU. Communities that were in the process of forming a CCA at the end of the observed period are recorded as served only by an IOU. This group includes communities in which a CCA became operational after 2020 and other communities that abandoned the process of CCA formation in that period. A community where a CCA was formed but then went bankrupt is coded as having a CCA.

Access to or participation in an alternative retailer does not automatically mean the community must be "greener" than others. The purpose of the second regression model is to determine whether the community characteristics that correlate with CCA formation also significantly correlate with the intensity of decarbonized energy actually procured for that community. In the OLS regressions, the outcome variable of interest is the percentage of a certain type of energy (renewable energy or overall clean energy) in the default electricity portfolio for a given community. The renewable energy regression takes the form:

$$pct\_renewable_i = X'\beta + \epsilon_i$$

where each i is a community, and the vector X contains variables measuring community characteristics and size of the LSE. The clean energy regression is of the same structure.

The goal of this regression is to assess which community characteristics are important determinants of decarbonized energy procurement, and whether those characteristics have differing effects depending on the type of LSE the community belongs to. The analysis therefore encompasses all communities served by an IOU, POU, or CCA, which have geographic service territories that can be mapped to communities. I exclude the DAPs for two reasons. First, DAP customer identities are confidential but are usually large commercial/industrial loads, where pure cost considerations are more likely to govern procurement decisions. Second, DAPs are the least geographically tied to a specific region. Therefore, it is not plausible to run them in a regression on community characteristics, although it is evident that these businesses are different in character from the other three types.

The community characteristics considered here are the same as those in the logit regression, with two additions. First, I include a covariate for the size of the LSE, to test the effect of economies of scale on decarbonized energy procurement. Second, I have a public/private governance fixed effect. Consider two identical sets of communities, where one set is served by a public power provider (i.e., CCA or POU) and the other is served by a private utility (IOU). Their procurement portfolios may look substantially different due to divergent political and economic incentives. The IOU's chosen portfolio may account for customer preferences somewhat, in terms of relevant economic interest, but ultimate accountability is to shareholders. In contrast, in public power settings, induced preference theory and positive responsiveness predict that constituent preferences would be relatively more salient determinants of decisions such as power procurement. Indeed, Wald tests show that the CCAs and POUs pool in the renewable energy regression but are distinct from the IOU group (see Appendix for detail). The question is not just how decarbonized energy procurement correlates with certain community characteristics, but whether access to the CCA mechanism allows for these preferences to be better expressed.

The goal of these regressions is to understand CCAs as a matching mechanism between communities that already have high willingness to pay for decarbonized power and increased intensity of decarbonized power received—not community characteristics causally altering procurement. Therefore, the analysis is not threatened by identification problems involving regression of endogenous variables. Due to clustering at the community level, I cannot detect variation within a given community. As this means a coarsening of information about heterogeneity in consumer preferences, any matching I do find is likely an underestimate.

B. Data

In most cases, a single LSE is the default provider for a set of cities, towns, or counties. The decision to join a CCA and determination of default electricity portfolio is made at the local government, not individual actor level. Therefore, data were collected for each city and town in California. In the case of unincorporated communities, the decision of electricity provider is assessed by county government such that the same LSE will serve all unincorporated portions of that county. So, data for all census designated places within a given county were aggregated into a single observation per county. This yields a total number of communities equal to 482 cities or towns + 57 counties containing unincorporated communities = 539 observations. The number is reduced to 523 after dropping observations with missing data. Of these, 470 are IOU or CCA communities and used for the binomial logit estimation. Although communities are of heterogenous sizes, this does not result in a clustering problem because the outcomes in question and level of decision-making are also at the community level (i.e., whether the community joined a CCA, and what the community decided should be the percentage of decarbonized energy they receive by default), so it is appropriate to use a community as the unit of analysis.

Data were compiled for 18 parameters describing socioeconomic, demographic, and other characteristics of each community that would indicate higher willingness to pay for green power. Regression tables contain a subset of these variables, as covariates that did not improve the explanatory power of the regression were removed. Table 2 lists the variables that are used in the regressions and their sources, while Table 3 lists summary statistics. Four of these variables are used to test for political and ideological support for voluntary green power: two indicators of general political ideology (party identification and vote share for Donald Trump in 2020), and two indicators of relevant policy preferences as measured by votes on ballot propositions (one that would have disfavored public provision of electricity and another that would have suspended AB32, which established California’s cap-and-trade program for controlling GHG emissions). The variables that test for socioeconomic propensity for voluntary green power are median income and measures of educational attainment. Variables that potentially affect the demand for electricity, besides income, are measures of the structure of the local economy (shares of agriculture and manufacturing) and local climate (winter and summer temperatures). Indicators that the community might perceive a benefit from a CCA that purchased power locally are megawatts of power production from nearby photovoltaic and hydro installations. I also add an indicator for communities that are not in either PG&E or SCE's original service territory. The politics of the other four IOUs (SDG&E and the three small utilities) are more likely to be dominated by a single city or county, whereas PG&E and SCE have service territories that include many large political jurisdictions.

Table 2: Community Characteristics: Names, Descriptions, Units of Measurement

Variable Name	Description	Units
med_income[1]	Median household income	$100,000's
pct_white[1]	Percentage identifying as non-Latino White	%
pct_asian[1]	Percentage identifying as Asian	%
pct_some_college[1]	Percentage with at least a high school diploma, some college but no bachelor's	%
pct_bachelors[1]	Percentage with at least a bachelor's	%
pct_democrat[2]	Percentage registered with Democratic Party	%
population[1]	Population size	Million people
med_age[1]	Median age	Decades
pct_yes_prop_16[2]	Voting Yes on Prop 16, a ballot measure where yes indicated opposition to local/public power	%
pct_yes_prop_23[2]	Voting Yes on Prop 23, a ballot measure that would have suspended AB 32	%
pct_trump[2]	Vote for Donald Trump in the 2020 presidential election	%
pct_manufacturing[1]	Manufacturing share of employment	%
pct_agri[1]	Agricultural share of employment	%
hydro[4]	Hydro production within same county	MW
pv[4]	PV production within same city/county	MW
temp_jan[3]	Average temperature in January	Tens of Degrees Fahrenheit
temp_aug[3]	Average temperature in August	Tens of Degrees Fahrenheit
lse_size[5]	LSE size	Billion MWh sales in 2020
not_PGE_SCE	Indicates if the community is outside PG&E or SCE's original service territories	Binary indicator

Notes to Table 2.

[1] Data for income, race, education, age, population, and employment category come from ACS 5-year tables, 2020 vintage. Census data was pulled with Place (i.e., city/town/CDP) as the granularity, so all CDPs in a given county were aggregated to yield a single value for the unincorporated county.

[2] Data for political party affiliation, presidential vote, vote on Prop 16, and vote on Prop 23 come from the CA Secretary of State's database. These report a single value for the unincorporated counties so no additional mapping was needed. There were six entries missing for Prop 16 (mostly unincorporated counties), so those entries were dropped from the dataset.

[3] Temperature data comes from NOAA Monthly Temperature Normals (1980–2010). Weather stations were matched to cities where this mapping was straightforward (taking simple averages where multiple stations serviced the same city). Otherwise, for smaller cities/towns, the county average value was simply applied.

[4] Local hydro and local PV production come from the CEC arcGIS (https://cecgis-caenergy.opendata.arcgis.com/) and CEC Energy Almanac (https://www.energy.ca.gov/data-reports/energy-almanac/data-renewable-energy-markets-and-resources). For PV, all CEC-registered solar plants were mapped to the city or unincorporated county where they are physically located. For hydro, all cities within a given county were assigned the value of total hydro production in that county.

[5] Finally, LSE size is based on the total MWh of retail sales for that LSE in 2020, which was calculated by summing up sales across all portfolios offered by each LSE as reported in the 2020 Power Source Disclosure filings. This variable is only used for the regression analyses concerning renewable and carbon-free procurement. It is not included in the logit regression about CCA membership, since the size of a community's LSE is clearly dependent on whether it formed a CCA or not.

Table 3: Summary Statistics - CCAs, IOUs, and POUs

Statistic	N	Mean	St. Dev.	Min	Max
med_income	539	0.849	0.418	0.256	2.500
pct_white	539	0.448	0.248	0.009	0.899
pct_asian	539	0.110	0.137	0.000	0.690
pct_some_college	539	0.513	0.141	0.109	0.840
pct_bachelors	539	0.331	0.207	0.010	0.876
pct_democrat	539	0.433	0.116	0.155	0.745
population	539	0.069	0.203	0.0002	3.973
med_age	539	3.929	0.747	2.320	7.530
pct_yes_prop_16	533	0.491	0.106	0.059	0.811
pct_yes_prop_23	538	0.407	0.110	0.075	0.662
pct_trump	539	0.349	0.154	0.040	0.801
pct_manufacturing	539	0.083	0.039	0.000	0.233
pct_agri	539	0.046	0.090	0.000	0.636
hydro	539	0.499	0.816	0.000	2.594
pv	539	0.027	0.168	0.000	2.717
temp_jan	539	4.922	0.557	2.748	5.980
temp_aug	539	7.345	0.639	5.690	9.480
lse_size	523	0.026	0.023	0.00002	0.059

Data on electricity procurement by type of generation facility are from the Power Source Disclosure (PSD) filings by each LSE in 2020, from which are calculated weighted averages of the percent of electricity from sources that are renewable and the percent from clean energy sources. For example, MCE is a multi-jurisdiction entity composed of CCAs in several communities in Contra Costa, Marin, Napa, and Solano counties. If MCE had a 30 percent renewable portfolio that supplies 90 percent of its sales and a 100 percent renewable portfolio that supplies the other 10 percent, each community in MCE is assigned a renewable energy percentage of 37 percent (0.9x.30 +0.1x1.0).

Some cities within a multi-jurisdiction CCA select a higher renewable portfolio as their default. When this information is known, each city within a CCA is assigned the renewable and clean energy percentages that correspond to its default portfolio. For example, Calabasas has "Lean Power" as its default option, while Beverly Hills has "100 percent Green Power" as its default option. Then Calabasas is assigned 40 percent renewable, while Beverly Hills is assigned 100 percent. This procedure does not account for the fact that some customers opt for a choice other than the default rate.

C. Logit Regression Results

The binomial logit model indicates that CCA formation is significantly correlated with higher median income, political support for local power, and political support for state regulation of GHG emissions. I run multiple specifications to reduce the risk of functional form errors, resulting in a piecewise linear structure for my preferred specification. I test for structural breaks by identifying one optimal breakpoint, creating dummies for the resulting two segments, and re-estimating the generalized linear model to obtain two coefficients per independent variable.[3] A more detailed explanation of the model selection process and robustness tests can be found in the Appendix. This includes ANOVA tests confirming that the additional piecewise variables significantly improve explanatory power, and reported improvements to model fit from the piecewise versus the fully linear model.

To aid in model interpretation, I assess the relative importance of each significant variable by changing each in isolation within its range of variance in the sample. I construct a hypothetical community with average characteristics for all covariates and determine the model's prediction of the probability of CCA formation. I then perturb each covariate by one standard deviation, holding all other variables constant, and measure the difference in predicted probability of CCA formation. I find that median income, political support for local power, and political support for state regulation of GHG emissions all have large effects on the probability that a CCA had been formed by 2020. An otherwise-average community with income one standard deviation below the sample mean (from $87,000 to $44,000) has an estimated probability of CCA formation that is 27.5 percent lower (from 39.7 percent to 12.2 percent). Communities with one standard deviation more support for environmental policy ballot measures are associated with an approximate 25% increase in the probability of CCA formation.

I find that the model performs well in terms of correctly classifying CCA communities. As an additional validity check, I look at the overlap between misclassifications and communities that formed CCAs after 2020 (i.e., a time period outside the range used to train the model). There were thirteen communities for which the model predicted a probability of CCA formation higher than 70%, but which did not actually form CCAs during the observation period.

[3] Thus, the reported coefficient for the segment above the breakpoint is the difference in slopes for the two segments. For example, the coefficient for median income is 3.612 for communities with median income below the breakpoint of $108,000 and 3.612 - 4.750 = -1.138 for communities with median income above $108,000 (the median household income for the entire sample is $87,000).

Ten of these thirteen became CCA communities by 2023 (one of the other three was a POU until 2013).

Table 4: CCA Formation

	Linear	Piecewise Linear
med_income	1.035^{***}	3.612^{***}
	(0.394)	(0.845)
med_income.seg		-4.750^{***}
		(1.233)
pct_yes_prop_16	-6.465^{***}	-9.193^{***}
	(1.976)	(2.527)
pct_yes_prop_16.seg		71.038^{***}
		(17.796)
pct_yes_prop_23	-9.347^{***}	-9.537^{***}
	(1.807)	(2.268)
temp_jan	0.231	0.742^{*}
	(0.316)	(0.400)
temp_jan.seg		-9.282^{***}
		(2.979)
temp_aug	-1.033^{***}	-1.842^{***}
	(0.301)	(0.392)
temp_aug.seg		3.721^{***}
		(0.913)
not_PGE_SCE	-3.084^{***}	-3.336^{***}
	(1.081)	(1.142)
Constant	11.791^{***}	14.524^{***}
	(2.238)	(2.885)
Observations	470	470
Log Likelihood	−177.044	−147.402
Akaike Inf. Crit.	368.088	316.805

Note: *p<0.1; **p<0.05; ***p<0.01

D. Community Characteristics and Decarbonized Energy Procurement

The OLS regression assesses the correlation between community characteristics and decarbonized energy procurement. I run a version of the model where the outcome variable is the percentage of renewable energy in a community's default portfolio (Table 5) and a second version where the outcome variable is the percentage of total carbon-free energy, i.e., renewable plus large hydro and nuclear (Table 6). The importance of LSE-type fixed effects is considered as well. The preferred specification for the renewable energy regression pools CCAs and POUs, while preferred specification for the total carbon-free regression does not pool any of the three groups (for the results of alternative specifications, see the Appendix). The CCA and POU group exhibits strong income and scaling effects, meaning that wealthier and larger communities tend to procure more renewable energy. Increasing CCA/POU size by one standard deviation is associated with a 6.7% increase in renewable energy. Political preferences also appear to be significant determinants of renewable procurement. Stronger Democratic party vote and preference for environmental protection are associated with CCAs and POUs that procure higher levels of renewable energy. A one standard deviation increase in these parameters yields a predicted 4% and 3.7% increase in renewable procurement, respectively. In the regression on the proportion of clean energy in each LSE's portfolio, size is once again a highly significant variable. Income effects are only significant for the CCA group.

The pooling of CCAs and POUs reflects their political similarity relative to IOUs. CCAs and POUs are linked to local governments, with each one representing a relatively small set of similar cities. In contrast, the IOU group is dominated by PG&E and SCE, which serve geographically large service territories across dozens of communities. The regressions suggest that for the types of LSEs that are more responsive to the preferences of local constituents—CCAs and POUs—income, political and policy preferences, and scale of the operation are strong predictors of how much that community would likely pursue voluntary green power. These results are in line with intuition: places with a higher willingness to pay for green power are also places leading the charge on voluntary greenness. However, as the CCA/POU pooled group is separate from the IOU group, this may also indicate that the degree of voluntary greenness in CCA/POU communities is quite distinct from that in IOU communities. CCAs are carved out of existing IOU service territory. Although CCAs with high voluntary greenness successfully facilitate matching the groups who most want renewables with the highest levels of renewables, this separation also implies that the residual—the communities remaining with the IOU—have lower preferences and willingness to pay for decarbonization. The net effect on the system will not just depend on the expansion of voluntary greenness. It will also be influenced by the degree to which LSEs representing communities with less interest in decarbonization change their behavior in response to the rise in voluntary greenness. To understand these dynamics, I turn to timeseries data on actual sales of electricity by fuel type for each LSE.

Table 5: Percent Renewable Regression Coefficients, Pooled vs Two Groups

	Pooled	[CCAs & POUs] vs IOUs
med_income	0.057***	0.074***
	(0.016)	(0.018)
med_income.IOU		−0.087***
		(0.026)
pct_white	0.049	0.098***
	(0.033)	(0.029)
pct_democrat	0.193	0.346***
	(0.144)	(0.128)
pct_yes_prop_23	0.119	0.337***
	(0.135)	(0.122)
pct_trump	−0.100**	−0.205***
	(0.050)	(0.074)
pct_trump.IOU		0.179**
		(0.074)
pct_manufacturing	−0.341**	−0.277**
	(0.149)	(0.132)
temp_jan	0.077***	0.072***
	(0.012)	(0.019)
temp_jan.IOU		−0.029
		(0.023)
lse_size	−3.269***	19.617***
	(0.313)	(2.246)
lse_size.IOU		−20.221***
		(2.229)
not_PGE_SCE	−0.168***	−0.095***
	(0.017)	(0.017)
is_IOU		0.116
		(0.116)
Constant	−0.031	−0.279*
	(0.133)	(0.145)
Observations	523	523
Log Likelihood	379.514	452.059
Akaike Inf. Crit.	−739.028	−874.118

Note: *p<0.1; **p<0.05; ***p<0.01

Table 6: Percent Clean Energy Regression Coefficients, Pooled vs Unpooled

	Pooled	Unpooled
med_income	0.059**	
	(0.024)	
med_income.CCA		0.106***
		(0.021)
pct_white	−0.002	
	(0.040)	
pct_white.POU		0.889***
		(0.136)
pct_asian	−0.146**	−0.103**
	(0.068)	(0.045)
pct_yes_prop_23	−0.059	
	(0.104)	
pct_yes_prop_23.POU		1.185***
		(0.415)
pct_trump	−0.125*	−0.058
	(0.068)	(0.049)
pct_trump.CCA		−0.495***
		(0.100)
pct_trump.POU		−0.928***
		(0.340)
hydro	−0.026***	
	(0.010)	
hydro.CCA		−0.133***
		(0.019)
temp_jan	−0.066***	0.055***
	(0.017)	(0.014)
lse_size	−5.740***	−17.083***
	(0.456)	(0.815)
lse_size.CCA		20.569***
		(4.038)
lse_size.POU		32.929***
		(5.261)
not_PGE_SCE	−0.407***	−0.958***
	(0.025)	(0.038)
is_POU		−0.487***
		(0.116)
is_CCA		−0.555***
		(0.057)
Constant	1.255***	1.195***
	(0.092)	(0.057)
Observations	523	523
Log Likelihood	189.577	348.086
Akaike Inf. Crit.	−359.154	−664.172

IV. Power Source Disclosure Analysis

This section calculates the degree of voluntary overcompliance for each LSE between 2017 and 2022, and shows that gains due to CCA voluntary green power have been insufficient to offset deteriorating performance by other types of LSEs. I assemble a panel of administrative data about electric generation sources and sales, and quantify the degree of voluntary overcompliance present in each CCA. I then look at the trends in CCA performance as compared to IOU, POU, and DAP performance. I also consider heterogeneity within CCAs, finding that relatively high-income CCAs procure far more voluntary green power than relatively low-income CCAs, and large CCAs similarly outperform smaller CCAs. I then expand the analysis from sales of power to implications of voluntary green power for investment, finding that CCAs largely represent a transfer of existing resources as opposed to addition of new ones.

A. Data and Methodology

Data come from the CEC's Power Source Disclosure (PSD) program, which is intended to provide consumers "accurate, reliable, and simple to understand information on the sources of energy that are used to provide electric services" (CEC n.d. c). These compliance documents are filed by all operational LSEs each year. PSD filings from 2010 through 2020 were obtained via data requests to the CEC. Each document contains information on MWh procured from each generation source and total retail sales. Data for 2021 and 2022 come from a summary of PSD filings published on the CEC website, which contains total retail sales and percentages procured from each generation source for all portfolios.

Table 8 indicates how many LSEs of each type filed PSD documents in a given year. Over the five-year period examined, the number of CCAs has more than doubled, while the number of DAPs has decreased by nearly a third.

Table 8: Number of LSEs with PSD filings by year

	2017	2018	2019	2020	2021
CCA	9	19	19	22	25
CO-OP	2	4	4	4	4
DA	14	14	13	13	10
IOU	6	6	6	6	6
POU	44	46	46	47	47
Total	75	89	88	92	92

Source: CEC Power Source Disclosure program

The PSD data support the idea that types and relative quantities of power resources will differ depending on whether the LSE is an IOU, POU, CCA, or DAP. Table 9 shows notable differences in the amounts of clean energy procurement, with the CCA group outpacing other types of LSEs. There are also differences in the extent to which each LSE type relies on specified fossil procurements versus unspecified power to satisfy the balance of its retail sales (Figure 2 plots 2021 values in bar chart form to make qualitative differences more evident). These dynamics will be explored further in the next sections.

Table 9: Electricity Sources Aggregated by Type

		Renewable	Other Carbon-Free	Fossil	Unspecified	Total
CCA	2017	51%	35%	1%	12%	100%
	2018	49%	34%	3%	14%	100%
	2019	50%	31%	0%	19%	100%
	2020	50%	30%	0%	19%	100%
	2021	48%	29%	0%	24%	100%
IOU	2017	31%	26%	23%	20%	100%
	2018	36%	23%	18%	23%	100%
	2019	33%	32%	12%	24%	100%
	2020	31%	24%	17%	28%	100%
	2021	38%	20%	19%	22%	100%
POU	2017	28%	19%	41%	12%	100%
	2018	29%	14%	41%	15%	100%
	2019	31%	25%	36%	8%	100%
	2020	34%	22%	34%	10%	100%
	2021	34%	19%	38%	9%	100%
DAP	2017	31%	5%	0%	64%	100%
	2018	26%	4%	0%	70%	100%
	2019	30%	1%	0%	69%	100%
	2020	21%	0%	0%	79%	100%
	2021	23%	10%	0%	66%	100%

Source: CEC Power Source Disclosure program

Note: Unspecified power is treated as a separate category from renewable energy and carbon-free energy, regardless of how much renewable/carbon-free energy contributed to system power throughout the year.

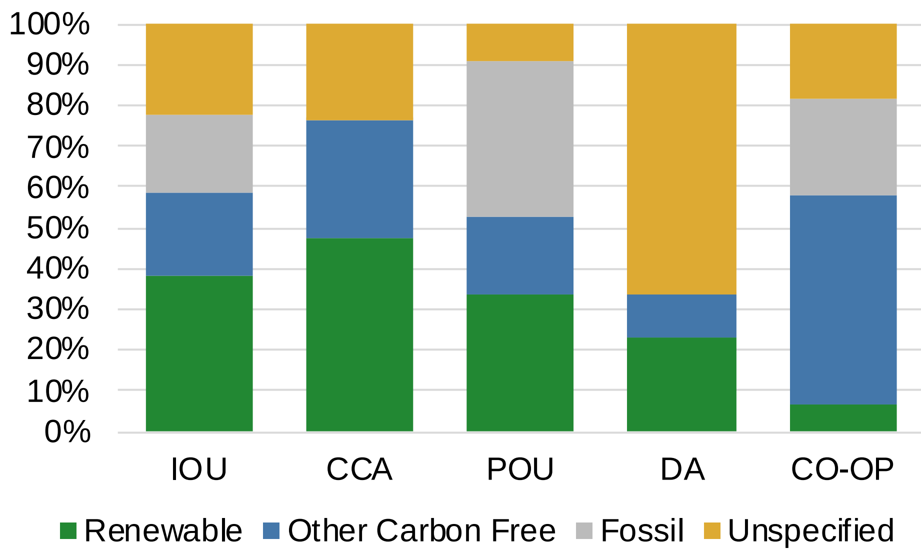

Figure 2: breakdown of power by category for each LSE type, 2021 data

B. Quantifying Voluntary Green Participation

Empirical papers assessing customer motivations for switching between retailers in deregulated electricity retail settings find that renewable energy content is an important feature for some, and customers are willing to pay a premium for greener energy. But existing literature also shows that customers in liberalized retail markets exhibit high levels of inertia in switching, which has made it more difficult for new retailers to attract customers (Hortacsu et al. 2017). As shown in Table 10, green "opt-up" options exist in California for some POUs, one DAP, and nearly all IOUs and CCAs. This translates to approximately 83% of statewide load having access to a voluntary green rate.

Table 10: California LSEs Offering Choice of Multiple Procurement Portfolios, 2021

	Number of LSEs	Number Offering Portfolio Choice	Percentage (by load) Offering Portfolio Choice
IOU	6	4	99.3%
CCA	25	24	99.9%
POU	47	13	75.2%
DA	10	1	2.2%
CO-OP	4	0	0.0%

When a city joins a CCA, all customers are automatically enrolled in that CCA. The city can further select between the CCA's portfolio offerings as its default. Some CCAs only offer portfolios with clean energy content set significantly above the RPS threshold, meaning 100% of their customers participate in voluntary green power. Further, some cities choose to default all their constituents onto the most expensive and most green option straight away. This unique structure means that the pool of CCA participants actually taking service from a voluntary green rate equals the set of customers who would actively switch to a voluntary green power portfolio, plus all CCA customers on voluntary green service who are too inattentive to opt back to the IOU. In most cases, the set of customers opting up from the LSE's default portfolio to an even cleaner portfolio is quite small. The set of customers who are located in jurisdictions with an automatic 100% clean energy default and who chose to opt down to a less expensive, less green rate, is also small. This agrees with the literature that the majority of customers are inattentive.

Table 11: Opt-Up Rates for California LSEs Offering Multiple Portfolios, 2021

LSE	Type	% on Least Green Plan	% on More Green Plans
Apple Valley Choice Energy	CCA	99.8%	0.2%
Baldwin	CCA	100.0%	0.0%
Central Coast Community Energy (3CE)	CCA	99.2%	0.8%
Clean Energy Alliance	CCA	1.3%	98.7% [1]
Clean Power Alliance of Southern California	CCA	21.6%	78.4% [2]
CleanPowerSF	CCA	93.9%	6.1%
Desert Community Energy	CCA	9.7%	90.3% [1]
East Bay Community Energy	CCA	83.3%	16.7% [2]
Lancaster Choice Energy	CCA	99.1%	0.9%
Marin Clean Energy	CCA	96.4%	3.6%
Peninsula Clean Energy	CCA	91.8%	8.2% [3]
Pico Rivera Innovative Municipal Energy	CCA	97.3%	2.7%
Pioneer Community Energy	CCA	100.0%	0.0%
Pomona	CCA	100.0%	0.0%
Rancho Mirage Energy Authority	CCA	99.4%	0.6%
Redwood Coast Energy Authority	CCA	99.1%	0.9%
San Diego Community Power	CCA	93.7%	6.3%
San Jacinto Power	CCA	99.9%	0.1%
San Jose Clean Energy	CCA	96.6%	3.4%

Santa Barbara Clean Energy	CCA	12.7%	87.3% [1]
Silicon Valley Clean Energy	CCA	96.6%	3.4%
Solana Energy Alliance	CCA	99.1%	0.9%
Sonoma Clean Power Authority	CCA	96.6%	3.4%
Valley Clean Energy Alliance	CCA	99.4%	0.6%
3 Phases Renewables	DA	1.0%	99.0%
PG&E	IOU	98.0%	2.0%
PacifiCorp	IOU	98.8%	1.2%
SDG&E	IOU	99.6%	0.4%
SCE	IOU	99.9%	0.1%
Alameda Municipal Power	POU	95.2%	4.8%
Burbank Water and Power	POU	99.9%	0.1%
City of Healdsburg Electric Utility	POU	91.5%	8.5% [4]
CCSF	POU	93.4%	6.6%
LADWP	POU	99.8%	0.2%
City of Palo Alto Utilities	POU	97.0%	3.0%
City of Pasadena	POU	95.2%	4.8%
PWRPA	POU	88.4%	11.6%
City of Riverside Public Utilities	POU	99.9%	0.1%
City of Roseville	POU	99.8%	0.2%
Silicon Valley Power	POU	97.0%	3.0%
SMUD	POU	90.9%	9.1%
Turlock Irrigation District	POU	100.0%	0.0%

Notes to Table 11.

1. All communities in this CCA were automatically enrolled in the most premium, most green rate. Therefore, the "% on Least Green Plan" really represents active opt-downs from the default option.
2. Some communities in this CCA were automatically enrolled in the most premium, most green rate. However, data on the precise breakdown of load by member community are unavailable.
3. One community in this CCA was automatically enrolled in the most premium, most green rate.
4. Municipal electricity use was automatically enrolled in the most premium, most green rate.

The results on opt-ups and opt-downs reported here are on a per-LSE basis, which does not show how many customers opted to leave CCA service to return to the incumbent IOU. Data obtained from select CCAs indicates that the proportion of opt-outs tends to be less than ten percent. Opt-out rates are unlikely to be large enough to significantly affect the analysis. Hortacsu et al. (2017) identifies search frictions/inattention and an incumbent provider brand advantage as two major sources of inertia in competitive retail electricity markets. In this paper's setting, CCAs tend to offer either the same rate as the incumbent IOU or moderate cost savings on the order of 5%, and they automatically enroll all customers of member cities, so pricing considerations are unlikely to overcome consumer inattention. Further, any brand loyalty—at least for the CCAs in Northern California—is not likely to lie with incumbent utility PG&E, due to that utility's unpopularity following its role in the deadly 2018 Camp Fire. Overall, then, the entry of CCAs has led to a particularly large increase in the proportion of customers taking service from voluntary green power portfolios, and this increase is mainly driven by automatic enrollments rather than active consumer switching.

C. Impacts on System-Wide Performance

I assess progress both in terms of procurement amounts (TWh) and as percentages. Though the RPS increased from 27% to 35.75% (+8.75%) between 2017 and 2021, there was only a moderate increase in total sales of renewable energy during this timeframe (Table 12a) such that the state's overall intensity of RPS-eligible sales went from 29%, or +2% relative to 2017 RPS, to 34%, or -1.75% relative to 2021 RPS (Tables 12b, 12c). It should be noted that total sales of electricity in California were moderately declining during this time frame. This may be due to factors such as continued improvements in energy efficiency, deployment of behind-the-meter energy resources, declines in California's overall population and number of large commercial/industrial loads, or declines in net consumption related to the pandemic recession. On a percentage basis, then, there have been year-on-year increases in statewide electricity sales from renewable resources (Table 12b). However, the introduction of large-scale mandates around building and vehicle electrification will require much higher electricity usage in the coming decades, so sustaining future progress will depend on large increases in renewable energy purchases.

Disaggregating renewable energy procurement by LSE category reveals that the trends for each LSE group look very different from one another. While TWh procurement from POUs and DAPs has been quite flat, IOU procurement generally fell and CCA procurement increased. On a percentage basis, the CCAs appear to consistently outperform other types of LSEs; DAPs appear to be falling increasingly behind. The dynamics between IOUs and CCAs are discussed further in Section D. Table 12c restates LSE procurement as percentages relative to the annual RPS target in that year, making clear that CCAs are the only group to exceed mandated levels.

As no new hydroelectric or nuclear projects have been built in recent years, unsurprisingly Table 13a is qualitatively similar to Table 12a, showing roughly constant levels of clean energy purchases over the period of analysis. On a percentage basis, there is an even more evident stratification between CCAs as high performers, IOUs and POUs in the middle, and DAPs as consistent underperformers.

Table 12a: Annual renewable resource procurement by LSE type (TWh)

	2017	2018	2019	2020	2021
Total CCA	6.2	12.1	21.3	23.2	24.1
Total IOU	50.4	51.8	36.6	33.8	39.1
Total POU	17.5	18.2	18.4	20.2	20.2
Total DA	5.7	6.3	5.9	6.8	5.7
Combined	79.9	88.4	82.2	83.9	89.1

Table 12b: Annual renewable procurement by LSE type (%)

	2017	2018	2019	2020	2021
Total CCA	51%	49%	50%	50%	48%
Total IOU	31%	36%	33%	31%	39%
Total POU	28%	29%	31%	34%	34%
Total DA	31%	26%	30%	29%	23%
State Avg.	29%	31%	32%	33%	34%
RPS Level	27%	29%	31%	33%	35.75%

Table 12c: Annual renewable procurement by LSE type relative to RPS target (%)

	2017	2018	2019	2020	2021
Total CCA	+24%	+20%	+19%	+17%	+12%
Total IOU	+4%	+7%	+2%	–2%	+3%
Total POU	+1%	0%	0%	+1%	–2%
Total DA	+4%	–3%	–1%	–4%	–12%

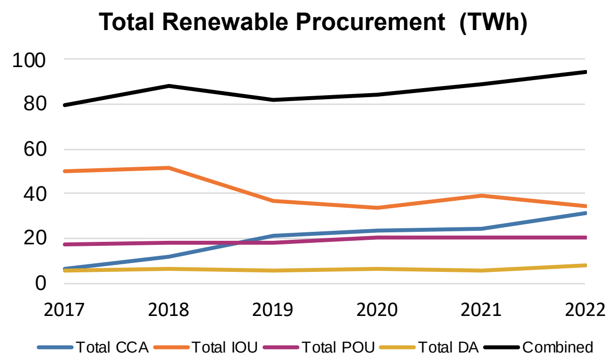

Figure 3a: Trends in renewable resource procurement by LSE type (million MWh)

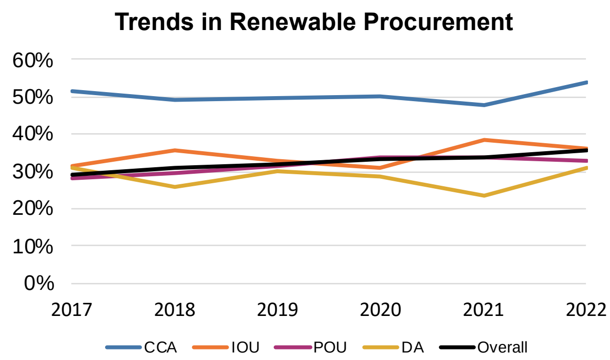

Figure 3b: Trends in renewable procurement by LSE type (%)

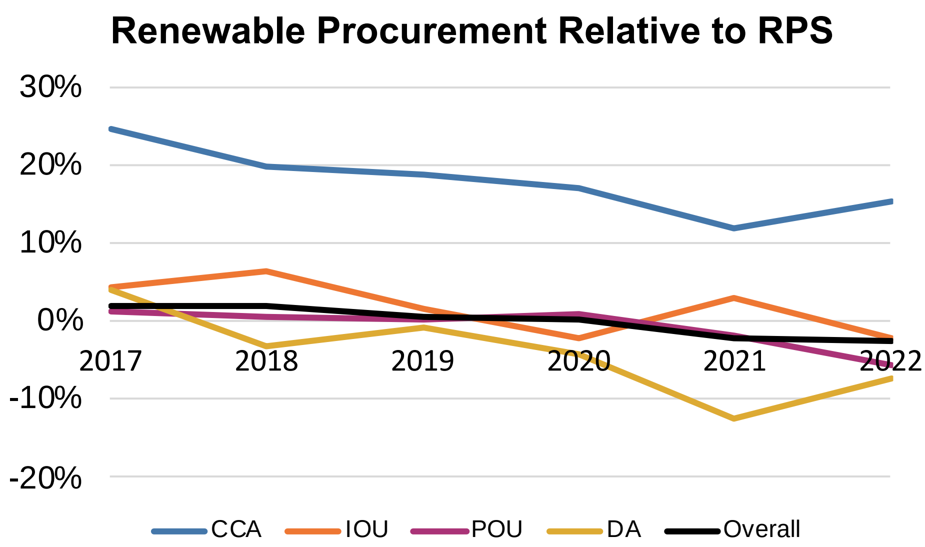

Figure 3c: Trends in renewable procurement by LSE type relative to RPS target (%)

Table 13a: Annual clean energy procurement by LSE type (MWh)

	2017	2018	2019	2020	2021
Total CCA	10.5	20.5	34.5	37.3	38.6
Total IOU	91.8	85.2	72.2	59.9	60.2
Total POU	26.4	27.0	32.9	33.2	31.4
Total DA	6.6	7.2	6.0	6.8	8.2
Combined	135.4	140.0	145.6	137.2	138.4

Table 13b: Annual clean energy procurement by LSE type (%)

	2017	2018	2019	2020	2021
Total CCA	87%	83%	81%	80%	76%
Total IOU	57%	58%	64%	55%	59%
Total POU	48%	44%	56%	56%	53%
Total DA	36%	30%	31%	29%	34%
Combined	53%	51%	55%	55%	52%

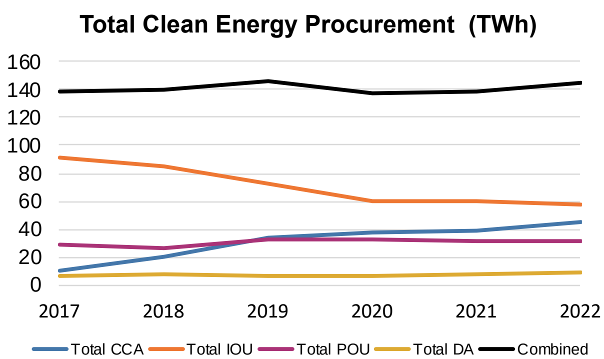

Figure 4a: Trends in clean energy procurement by LSE type (million MWh)

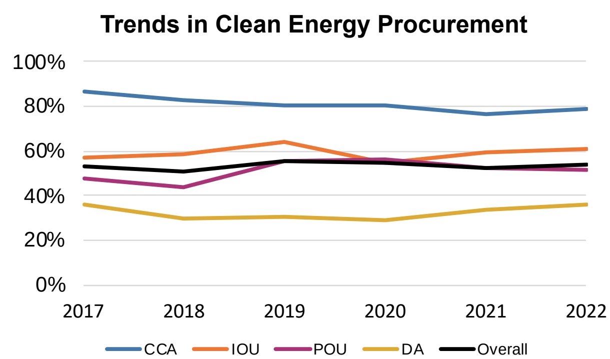

Figure 4b: Trends in clean energy procurement by LSE type (%)

D. IOU and CCA Trends

During the time period analyzed, POU and DAP performance remained fairly unchanged. While the combined effect of IOUs and CCAs was also relatively constant, this is because IOU procurement of renewables declined while CCA procurement increased.

The required minimum amount of renewable energy for each LSE is a percentage-based standard. Once load departs an IOU in favor of a CCA, an IOU continuing to hold all its existing contracts would be overprocured. Jettisoning contracts with carbon-emitting generators would increase the relative percentage coming from clean power; jettisoning a portion of its renewable contracts could allow an IOU to still be above the state-mandated floor but would decrease its MWh of renewable procurement. Indeed, I observe that after customers left IOUs for CCAs, in subsequent years IOUs decreased their levels of renewable procurement, which also reduced their percentage of retail sales supplied by renewable resources. In fact, although CCAs consistently increased provision of renewable energy during 2017–2020, these increases were more than offset by the fall in renewable procurement by IOUs. The trend appeared to change in

2021, when IOUs procured more renewables and drove up overall state levels, but IOU procurement resumed its decline in 2022.

In addition to the difference between IOUs and CCAs in overall renewable procurement, individual CCAs also differ substantially in the share of renewables in their electricity supply. The regression modeling implies that there are both strong income and scaling effects. I separate the CCA group into two equal, smaller groups according to median income (here labeled as "high income" and "low income"). Likewise, CCAs can be divided into two equal groups according to MWh of electricity sales in 2020, here labeled as "large" and "small." I then reproduce Tables 12–13 and Figures 3–4, except now I further disaggregate the CCA category into rich and poor, and large and small. Both stratifications show a significant difference between the two groups in renewable procurement.

Tracing trends in the level of renewable procurement relative to the RPS floor (Table 14b) shows that wealthier CCAs succeed in voluntarily procuring renewables in excess of state requirements. However, the degree of overcompliance has declined over time due to both decreases in the percentage of renewables that wealthy CCAs procured and increases in the RPS mandate. In contrast, levels of voluntary greenness have eroded substantially for less wealthy CCAs, which now procure levels of renewables close to the RPS floor. By 2021, the less wealthy CCAs procured a lower fraction of renewable electricity than the average of the three big IOUs. Similar results hold for large versus small CCAs. The renewables share has gradually declined for large CCAs, but the fall has been precipitous for small CCAs. By 2021, small CCAs had a lower renewable share than any other LSE type except for DAPs.

While CCAs overall demonstrate voluntary overcompliance with the RPS mandate, these results emphasize that the performance of individual CCAs is highly heterogenous. Concerns about other LSE types stagnating or even regressing with respect to renewable performance could also be applied to some CCAs. Moreover, the gap between large/wealthy and smaller/poorer CCAs appears to be growing, with the latter losing ground to the IOUs as suppliers of electricity from renewable sources. As a result, many CCA customers receive less green electricity than the IOU that serves their community. Unless CCAs serve wealthier communities or are able to achieve economies of scale—perhaps by aggregating themselves into larger CCAs—then this new model of LSE fails to persistently outperform its IOU, POU, or DAP counterparts.

Table 14a: Trends in Renewable Procurement
for High versus Low Income, and Large versus Small, CCAs

	2017	2018	2019	2020	2021
Poor CCAs	44%	41%	39%	39%	38%
Rich CCAs	55%	52%	52%	53%	50%
Small CCAs	40%	40%	35%	37%	31%
Large CCAs	53%	50%	51%	51%	50%
IOU average	31%	36%	33%	31%	39%
POU average	28%	29%	31%	34%	34%
DA average	31%	26%	30%	29%	23%

Table 14b: Trends in Renewable Procurement Relative to the RPS
for High versus Low Income, and Large versus Small, CCAs

	2017	2018	2019	2020	2021
Poor CCAs	+17%	+12%	+8%	+6%	+2%
Rich CCAs	+28%	+23%	+21%	+20%	+14%
Small CCAs	+13%	+11%	+4%	+4%	–5%
Large CCAs	+26%	+21%	+20%	+18%	+14%
IOU average	+4%	+7%	+2%	–2%	+3%
POU average	+1%	0%	0%	+1%	–2%
DA average	+4%	–3%	–1%	–4%	–12%

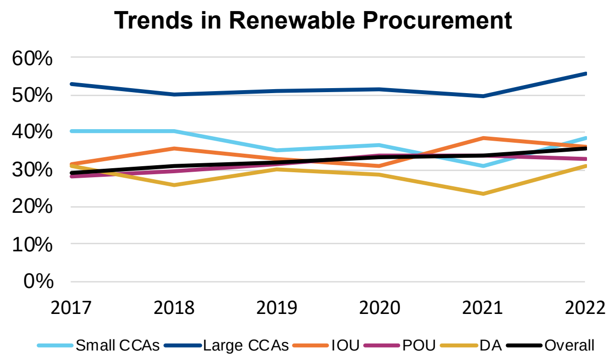

Figure 5a: Total renewable procurement, large vs small CCAs

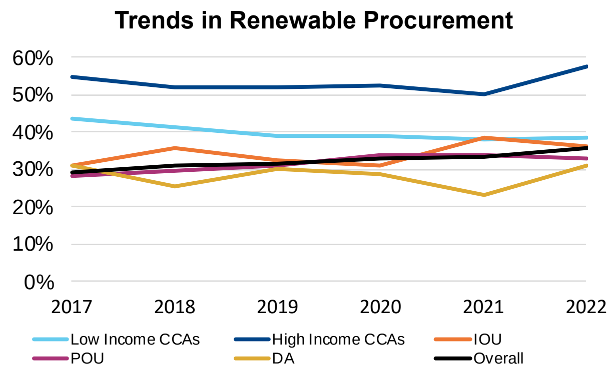

Figure 5b: Total renewable procurement, high vs low income CCAs

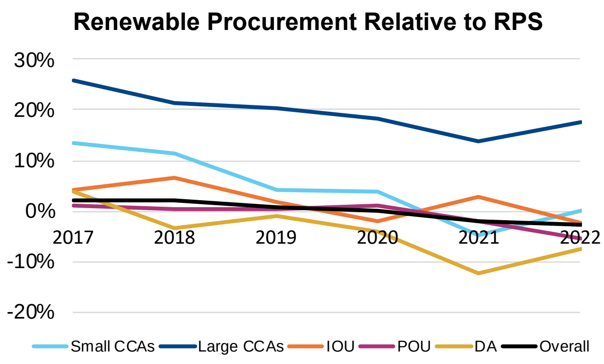

Figure 5c: Procurement relative to RPS, large vs small CCAs

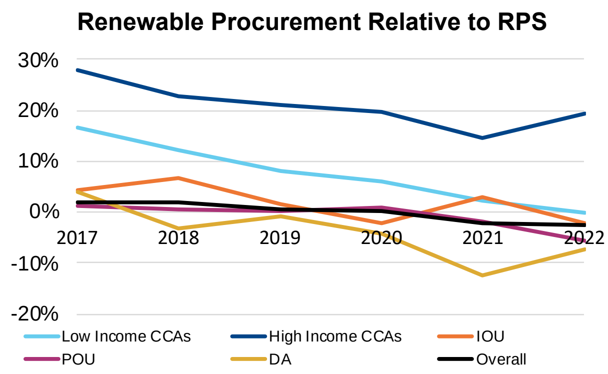

Figure 5d: Procurement relative to RPS, high vs low income CCAs

The issue extends to considerations of overall clean energy levels as well. When summing renewables and other carbon-free sources to yield total clean energy procurement, the gap between small and large CCAs persists. Here, IOUs are consistently at or above the clean energy levels that small CCAs offer. Less wealthy CCAs have significant levels of large hydro (and some nuclear) procurement, such that in 2018 and 2019 they are actually cleaner than either rich CCAs or IOUs (despite declining levels of renewable procurement during the same time period), but this appears to have been a temporary gain.

Table 15: Trends in Clean Energy Procurement for High versus Low Income, and Large versus Small, CCAs

	2017	2018	2019	2020	2021
Poor CCAs	76%	87%	89%	80%	57%
Rich CCAs	91%	81%	79%	80%	81%
Small CCAs	56%	57%	57%	55%	47%
Large CCAs	90%	87%	83%	83%	80%
IOU average	57%	58%	64%	55%	59%
POU average	48%	44%	56%	56%	53%
DA average	36%	30%	31%	29%	34%

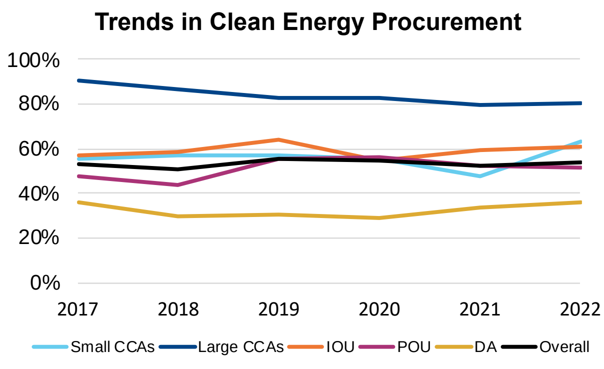

Figure 6a: Total clean energy procurement, large vs small CCAs

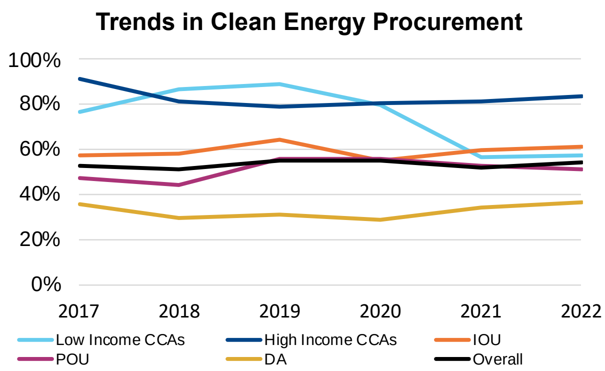

Figure 6b: Total clean energy procurement, high vs low income CCAs

V. Implications for Investment

Assuring sustained progress towards system-wide decarbonization is more nuanced than simply measuring year-on-year gains in renewable electricity sales. The ultimate goal of voluntary increases in the demand for renewable energy is to affect expansion of the supply of renewable electricity. CCAs must therefore also be assessed in terms of their impacts on the supply of new renewable energy generators. Three aspects of this are explored below: relative success in procuring novel renewable resources, effects on long-term contracting, and differences in the speed of bringing new construction online.

Even if CCAs procure total renewable energy levels in excess of state mandates, it is not immediately obvious whether they also have higher levels of *new* resources in their portfolios than incumbents do. If CCAs do seek out new sources of procurement to a larger extent than IOUs do, then they may demonstrate an additional dimension to voluntary overcompliance: responsibility for increasing the total capacity of the system. Consider the set of new renewable resources procured in California between 2010 (the first year of CCA operations) and 2020. Each plant in this set can be matched to the retailer(s) that procured power from it in the first year it sold power. This may be different from the allocation of generation in later years, because unless 100% of a generator's capacity is under a long-term contract to a particular LSE, the set of retailers buying power may change year to year. Table 17 shows the total amount of added procurement originally attributable to IOUs, the total amount originally attributed to CCAs, and these values normalized to 2020 load size. Though CCAs claim a larger share of renewable procurement in terms of raw MWh sold, much of this turns out to be reallocated from resources originally procured on behalf of incumbent IOUs. Proportionately, CCAs are actually responsible for a smaller percentage of new renewable generation sources than IOUs are.

Table 17: Relative Procurement of Additional Renewable Generation Sources, 2010–2020

	IOU	CCA
Procurement of New Resources, 2010–2020	14,997,935	5,281,521
2020 Load	109,209,697	46,478,145
New MWh/sold MWh	0.14	0.11

The CPUC's publicly-available database of RPS projects includes a list of all long-term contracts signed by IOUs and CCAs through 2021. Long-term contracting is important because it gives greater certainty to renewable developers and is necessary for ensuring sufficient capacity into the future. Figure 7 shows cumulative totals of MW long-term contracts signed by IOUs and CCAs respectively by year since 2010, when CCAs entered the market. Two key features stand out. First, the rate of total additional capacity under long-term contracts has remained relatively constant, regardless of the rising popularity of CCAs. Second, IOUs virtually stopped signing new long-term contracts in the latter half of the 2010s, instead shifting this responsibility to CCAs. This implies that CCAs do have sufficient capability to contribute to California's long-term contracting needs, but again this is offset by stagnation on the part of IOUs—a reallocation rather than an indication of additional progress.

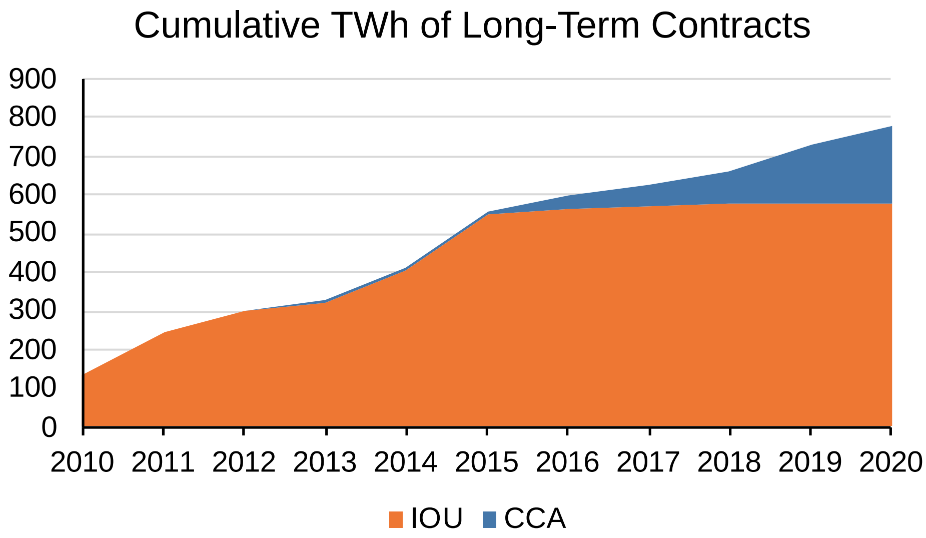

Figure 7: Trends in cumulative long-term contracts signed between 2010 and 2020 (TWh)

The same database can be used to assess how the length of time between initial contract signing and commencement of power delivery has evolved over time. The large time lags inherent to investing in new power generation infrastructure are a challenge for accurate forecasting, and delays create uncertainty around meeting short-term renewable deployment targets. Table 18 measures the average difference in years between the date of contract execution and the commercial online date for renewable generators under long-term contracts. CCAs bring new resources online more quickly than incumbents on average. This may be an indication of an important advantage. Even if additionality (in terms of total procurement, or total new procurement) is not evident, the ability to bring resources online sooner would be beneficial for project developers, LSEs, and state planners alike. However, Figure 8 shows that the overall trend is for the time lag to decrease as renewable technologies have become more mature over time. And as noted in Figure 7, the onus of long-term contracting procurement shifted almost entirely from IOUs to CCAs. As the lack of comparable data make formal analysis difficult, it remains unclear whether this is a structural advantage of CCAs or simply a reflection of a time trend.

Table 18: Average time (years) between Contract Execution and Commercial Online Date for long-term contracts signed between 2010 and 2020

Overall Average	IOU Average	CCA Average
2.94	3.1	2.5

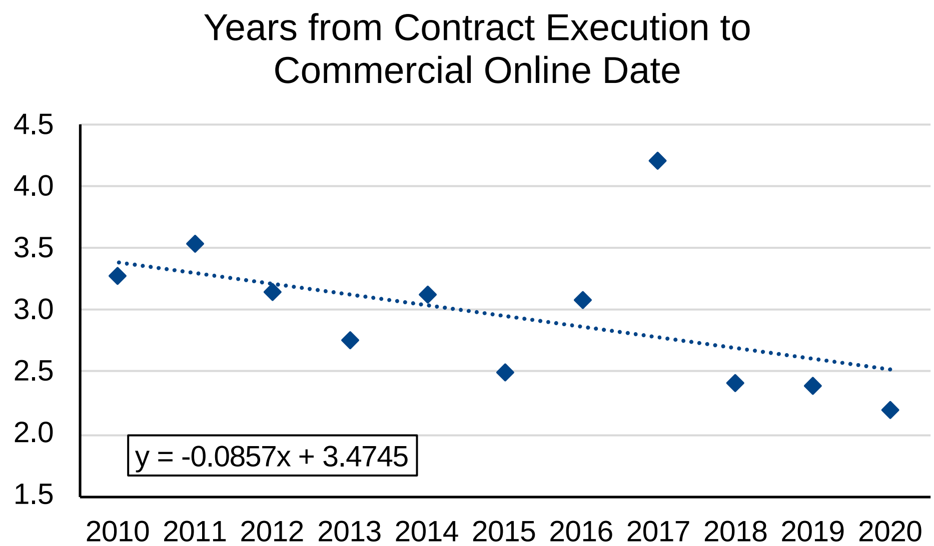

Figure 8: Trends in time delay between contract execution and commercial online dates (years)

VI. Policy Implications and Discussion

California is attempting to achieve total decarbonization of its energy sector, with just over 20 years to go. Overall numbers suggest that so far, we have been meeting our benchmarks and are on schedule. Disaggregating these numbers reveals a more complex picture. Not all retailers in the state have been keeping pace. And despite the efforts of a select group of CCAs in procuring very high levels of renewable energy, the state on the whole is still hewing close to the RPS floor. In the next decade, the necessary rate of progress will dramatically ramp up. Retailers had to manage a 13% increase over seven years (20% in 2013 to 33% in 2020), which some struggled to meet. Now they face a 27% increase in ten years (33% in 2020 to 60% by 2030), with the additional imposition of long-term contracting requirements. In the same timeframe, electricity demand is going to drastically increase, as California transitions from petroleum-fueled cars and natural gas-fueled homes to electrified options. Given such significant structural changes, we cannot speculate about the exact trajectories of each LSE. But is not a large stretch to suppose that if we see some groups struggle to meet state standards now, intervention may be needed to avoid more severe problems with noncompliance later on. Communities that have surged ahead in the race to decarbonize should be appropriately recognized for their achievement. However, the fact that these CCA gains occurred alongside undesirable indirect effects for IOU communities—and that such successes have generally not extended to less wealthy or small CCAs—needs to be recognized too.

It is important to note that power purchases do not exactly reflect the physical realities of the grid. Procurement data tend to reflect annual accounting. But the actual mixture of power delivered at any single instance reflects real-time grid dispatch, which may be very different than what is contracted for. The physics of the power grid dictate that consumers cannot be selective about their electrons. Eventually, if California achieves a grid entirely powered by clean energy resources, then delivered power would indeed be carbon-free at all times. Currently, however, a customer who chooses a retail portfolio comprised of 100% renewable energy purchases is still actually receiving electricity generated by the same mixture of generators that serves everyone on California's grid. Thus, the impact of CCAs offering nominally high levels of renewable power procurement is much more modest in a physical grid sense if systemwide levels remain largely unchanged.

One motivation for forming CCAs was so communities could break away from the IOU, gaining the ability to make their own decisions over power procurement rather than being forced to take the IOU's default power offering. The findings about LSE size imply that scaling up does allow for improved technical capacity. Ironically then, one way for communities to unlock higher levels of renewable energy may be to band back together rather than fracture the retail space further.

Besides the scaling implications, the regression results suggest that the types of communities most likely to participate in voluntary greenness are well-matched with expectations: these portions of California tend to be wealthier and more politically in favor of environmental causes. Voluntary greenness may therefore be considered a successful mechanism in terms of facilitating the matching of consumers with higher preferences for green energy with higher percentages of green energy actually procured on their behalf. However, these patterns in voluntary green participation also imply that the remaining group is on average less wealthy with lower preference for greenness. This is clearly illustrated with the departure of CCAs from incumbent IOU service territories. Given that their median customer now has relatively lower willingness to pay for voluntary greenness, IOUs will rationally cluster closer to the RPS floor, attenuating the overall value of voluntary greenness to the grid. Despite a significant proportion of the state's customers taking service from a voluntary green portfolio, the resulting swell in renewable energy sales is not clearly additional relative to the rising statewide RPS floor.

VII. Conclusion

The evidence from California sheds light on tactics for enhancing the successful adoption of voluntary greenness as well as potential pitfalls that may weaken its efficacy. For other jurisdictions considering voluntary greenness as a mechanism for decarbonization, the findings impart three key lessons. First, the strategies employed by California's CCAs and some of its POUs demonstrate that so-called voluntary greenness might better be thought of as "inattentively green." Active customer switching between default portfolios and voluntary green portfolios is small. Rather than offer opt-in green options, LSEs gained a large portion of customers participating in voluntary greenness by making their default offering a voluntary green portfolio and giving customers the choice to opt back down. Second, the communities most likely to pursue voluntary greenness share certain traits like high income and strong preferences for decarbonization. Instead of treating electricity as a homogenous good, voluntary greenness better reflects consumers' preferences by matching portfolios with more decarbonized energy to customers with high willingness to pay for decarbonization. Third, this matching also implies changes in procurement strategies for retailers serving customers with low interest in voluntary greenness, which can undermine overall progress. Even with a large number of customers defaulted onto voluntary green service, such efforts may not be as effective as simply enforcing a renewable portfolio standard. This does not suggest that voluntary greenness lacks promise: as long as it is implemented with an understanding of potential larger system impacts, it can still be a significant policy instrument. It may be particularly effective in cases where there are political frictions to passing larger, sweeping policies like a state- or federal-level RPS, but where there are nonetheless local communities with strong preferences for decarbonization.

References

Amador, Francisco Javier, Rosa Marina González, and Francisco Javier Ramos-Real. "Supplier Choice and WTP for Electricity Attributes in an Emerging Market: The Role of Perceived Past Experience, Environmental Concern and Energy Saving Behavior." Energy Economics 40 (November 2013): 953–66. https://doi.org/10.1016/j.eneco.2013.06.007.

Arora, Seema, and Shubhashis Gangopadhyay. "Toward a Theoretical Model of Voluntary Overcompliance." Journal of Economic Behavior & Organization 28, no. 3 (December 1995): 289–309. https://doi.org/10.1016/0167-2681(95)00037-2.

Barbose, Galen, Ryan Wiser, Jenny Heeter, Trieu Mai, Lori Bird, Mark Bolinger, Alberta Carpenter, et al. "A Retrospective Analysis of Benefits and Impacts of U.S. Renewable Portfolio Standards." Energy Policy 96 (September 2016): 645–60. https://doi.org/10.1016/j.enpol.2016.06.035.

Borenstein, Severin, and James Bushnell. "The U.S. Electricity Industry After 20 Years of Restructuring." Cambridge, MA: National Bureau of Economic Research, April 2015. https://doi.org/10.3386/w21113.

Borenstein, Severin, James B Bushnell, and Frank A Wolak. "Measuring Market Inefficiencies in California's Restructured Wholesale Electricity Market." American Economic Review 92, no. 5 (November 1, 2002): 1376–1405. https://doi.org/10.1257/000282802762024557.

Borenstein, Severin, and Ryan Kellogg. "Carbon Pricing, Clean Electricity Standards, and Clean Electricity Subsidies on the Path to Zero Emissions." Cambridge, MA: National Bureau of Economic Research, July 2022. https://doi.org/10.3386/w30263.

California Energy Commission. "Power Source Disclosure Program." Accessed October 31, 2024. https://www.energy.ca.gov/programs-and-topics/programs/power-source-disclosure-program.

———. "Renewables Portfolio Standard - RPS." Accessed October 31, 2024. https://www.energy.ca.gov/programs-and-topics/programs/renewables-portfolio-standard.

———. "SB 100 Joint Agency Report." Accessed October 31, 2024. https://www.energy.ca.gov/sb100.

CPUC Staff. "Final Report Providing an Assessment of Expansion of Direct Access, Appendix A." California Public Utilities Commission, May 7, 2021. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M390/K217/390217161.PDF.

DeShazo, JR, Julien Gattaciecca, and Trumbull, Kelly. "The Growth in Community Choice Aggregation: Impacts to California's Grid." Next 10, July 2018.

Duchin, Ran, Janet Gao, and Qiping Xu. "Sustainability or Greenwashing: Evidence from the Asset Market for Industrial Pollution." SSRN Electronic Journal, 2022. https://doi.org/10.2139/ssrn.4095885.

Fowlie, Meredith. "Emissions Trading, Electricity Restructuring, and Investment in Pollution Abatement." American Economic Review 100, no. 3 (June 1, 2010): 837–69. https://doi.org/10.1257/aer.100.3.837.

Goett, Andrew A., Kathleen Hudson, and Kenneth E. Train. “Customers’ Choice Among Retail Energy Suppliers: The Willingness-to-Pay for Service Attributes.” The Energy Journal 21, no. 4 (October 2000): 1–28. https://doi.org/10.5547/ISSN0195-6574-EJ-Vol21-No4-1.

Goulder, Lawrence H., and Ian W. H. Parry. “Instrument Choice in Environmental Policy.” Review of Environmental Economics and Policy 2, no. 2 (July 1, 2008): 152–74. https://doi.org/10.1093/reep/ren005.

Gunther, Stephen J., and David Bernell. “Challenging the System: The Role of Community Choice Aggregation in California’s Transition to a Renewable Energy Future.” The Electricity Journal 32, no. 10 (December 2019): 106679. https://doi.org/10.1016/j.tej.2019.106679.

Hastings-Simon, Sara, Andrew Leach, Blake Shaffer, and Tim Weis. “Alberta’s Renewable Electricity Program: Design, Results, and Lessons Learned.” Energy Policy 171 (December 2022): 113266. https://doi.org/10.1016/j.enpol.2022.113266.

Haufe, Marie-Christin, and Karl-Martin Ehrhart. “Auctions for Renewable Energy Support – Suitability, Design, and First Lessons Learned.” Energy Policy 121 (October 2018): 217–24. https://doi.org/10.1016/j.enpol.2018.06.027.

Hess, David J. “Coalitions, Framing, and the Politics of Energy Transitions: Local Democracy and Community Choice in California.” Energy Research & Social Science 50 (April 2019): 38–50. https://doi.org/10.1016/j.erss.2018.11.013.

Holland, Stephen, Erin Mansur, and Andrew Yates. “Decarbonization and Electrification in the Long Run.” Cambridge, MA: National Bureau of Economic Research, May 2022. https://doi.org/10.3386/w30082.

Hortaçsu, Ali, Seyed Ali Madanizadeh, and Steven L. Puller. “Power to Choose? An Analysis of Consumer Inertia in the Residential Electricity Market.” American Economic Journal: Economic Policy 9, no. 4 (November 1, 2017): 192–226. https://doi.org/10.1257/pol.20150235.

Hsueh, Lily. “Voluntary Climate Action and Credible Regulatory Threat: Evidence from the Carbon Disclosure Project.” Journal of Regulatory Economics 56, no. 2–3 (December 2019): 188–225. https://doi.org/10.1007/s11149-019-09390-z.

Intergovernmental Panel On Climate Change (Ipcc), ed. “Emissions Trends and Drivers.” In Climate Change 2022 - Mitigation of Climate Change, 1st ed., 215–94. Cambridge University Press, 2023. https://doi.org/10.1017/9781009157926.004.

Joskow, Paul L. “Markets for Power in the United States: An Interim Assessment,” n.d., 36.

———. “Why Do We Need Electricity Retailers?; Or, Can You Get It Cheaper Wholesale?” MIT-CEEPR. MIT Center for Energy and Environmental Policy Research, 2000. http://hdl.handle.net/1721.1/44965.

Khanna, Madhu. “Non-Mandatory Approaches to Environmental Protection.” Journal of Economic Surveys 15, no. 3 (July 2001): 291–324. https://doi.org/10.1111/1467-6419.00141.

Littlechild, Stephen. “The Evolution of Competitive Retail Electricity Markets.” In Handbook on Electricity Markets, edited by Jean-Michel Glachant, Paul L. Joskow, and Michael G. Pollitt. Edward Elgar Publishing, 2021. https://doi.org/10.4337/9781788979955.00011.

———. “Why We Need Electricity Retailers: A Reply to Joskow on Wholesale Spot Price Pass-Through.” Research Papers in Management Studies. University of Cambridge, August 22, 2000. https://www.jbs.cam.ac.uk/wp-content/uploads/2020/12/wp0021.pdf.

National Renewable Energy Laboratory. “Voluntary Green Power Procurement,” 2023. https://www.nrel.gov/analysis/green-power.html.

Ndebele, Tom. “Assessing the Potential for Consumer-Driven Renewable Energy Development in Deregulated Electricity Markets Dominated by Renewables.” Energy Policy 136 (January 2020): 111057. https://doi.org/10.1016/j.enpol.2019.111057.

Ndebele, Tom, Dan Marsh, and Riccardo Scarpa. “Consumer Switching in Retail Electricity Markets: Is Price All That Matters?” Energy Economics 83 (September 2019): 88–103. https://doi.org/10.1016/j.eneco.2019.06.012.

Su, Xuejuan. “Have Customers Benefited from Electricity Retail Competition?” Journal of Regulatory Economics 47, no. 2 (April 2015): 146–82. https://doi.org/10.1007/s11149-014-9263-x.

Sumner, Jenny, Eric O’Shaughnessy, Sushmita Jena, and Jesse Carey. “Status and Trends in the U.S. Voluntary Green Power Market (2021 Data).” Golden, CO: NREL, 2023. https://www.nrel.gov/docs/fy23osti/86162.pdf.

Tirole, Jean, and Jean-Jacques Laffont. “A Note on Environmental Innovation.” Working Papers MIT Department of Economics, 1994.

Trumbull, Kelly, JR DeShazo, Julien Gattaciecca, Colleen Callahan, and Michelle Einstein. “The Rapid Growth of Community Choice Energy and Its Acceleration of Renewable Energy: A California Case Study.” Working Paper. UCLA Luskin Center for Innovation, November 6, 2019.

Trumbull, Kelly, Julien Gattaciecca, and J R DeShazo. “The Role of Community Choice Aggregators in Advancing Clean Energy Transitions:” UCLA Luskin Center for Innovation, October 2020.

Wolak, Frank A. “Diagnosing the California Electricity Crisis.” The Electricity Journal 16, no. 7 (August 2003): 11–37. https://doi.org/10.1016/S1040-6190(03)00099-X.