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Modernist infrastructural governance meets twenty-first century fragilities: California, a cautionary tale?

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ABSTRACT

In policy literature and the popular press, California's regime of climate governance is often portrayed as a model for other states to follow. For more than two decades, California has pursued a sectorally differentiated project to eliminate greenhouse gas emissions from the production and consumption of electrical power, and to make electricity and the grid the primary energy infrastructure for its economy. Though many aspects of California's climate and energy governance regime are politically praiseworthy, efforts to reconfigure electrical infrastructure for the challenges of the twenty-first century are being opposed and obstructed by incumbent monopoly utilities and their state regulators. In this article, we argue that existing private investor-owned utilities and the commissions that regulate them are poor vehicles for effectuating substantive change. Taking California as an exemplar of dysfunction, we describe how the institutional characteristics of the regulated monopoly utility model fit poorly with the state's commitment to decarbonise the grid and adapt to changing socioecological conditions, and how monopoly utilities oppose and frustrate movements for instutional and sociotechnical change. We argue for thinking beyond this model of energy service provisioning and call for a programme of policy research to help concretise alternative institutional forms and governance frameworks.

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Climate governance; electricity; infrastructure; distributed renewable systems; climate adaptation; sustainability

Key Policy Highlights:

- Existing Investor-Owned Electric Utilities' highly centralised infrastructure and management systems evolved in direct response to the physical properties of fossil fuels, the returns to scale of large thermal generation technologies, and the politics of state energy system regulation.

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- Distributed renewable generation is a service paradigm that is quickly outgrowing the legal and regulatory antecedents laid down in the latter half of the twentieth century.
- Distributed energy resources enable the operation and administration of more localised energy services, allowing the co-location of supply and demand; obviating the need for expensive and potentially ineffective expansion of transmission infrastructure.
- Policy research should seriously consider alternative institutional arrangements to the regulated utility model.

1. Introduction

Amidst the deepening energy crises of affordability, safety, reliability, and equity in California, advocates for "decarbonization" and "energy justice" are increasingly eager to demonstrate alternative sociotechnical models for electrical power provision and infrastructural governance that comport with normative commitments to social and environmental justice. In California and elsewhere, movements advocating for decentralised, distributed, and renewable energy have become engaged in protracted political struggles with incumbent electrical utilities and the regulatory bodies which oversee them regarding the technological, institutional, and financial aspects of the transition away from fossil generation (Boyd 2014; Boyd and Carlson 2016; Clifton et al. 2021; Taminiau and Byrne 2025).

In this paper we discuss recent climate and energy policy developments in California as being representative of a divergent set of electrical infrastructural imaginaries. We provide the historical context necessary to situate these developments relative to previous waves of infrastructural reconfiguration and governance change which have occurred at both the state and federal levels over the past century. This discussion focuses on the genesis of the publicly regulated monopoly investor-owned utility model, from its inception in the 1910s through to its institutionalisation as the foundation of US energy governance in the latter half of the twentieth century. Following from this, we focus on the example of California's energy policy framework and more contemporary climate-inspired reforms. We discuss how the state's electrical infrastructure, climate issues, and cities have become matters of concern in discourses about how to govern "justly, equitably, and sustainably" in the twenty-first century. As part of this discussion, we present maps and data which seek to demonstrate how efforts undertaken by industry, nonprofit organisations, and others have been frustrated by coordinated political opposition from investor-owned utilities and the structure of existing regulatory code developed and enforced by the California Public Utilities Commission (CPUC).

In this study we conceptualise recent changes to the institutional and material dimensions of electrical infrastructural governance in California as part of a longer history of reregulation and resource creation under neoliberal capitalism (Bridge 2014; Bridge and Jonas 2002). Though we make use of the language and concepts the literature on neoliberal resource governance provides, our purpose in this study is not to intervene in debates about how to conceptualise or study infrastructural or resource governance *qua* governance. Instead, we intend to demonstrate that the power of incumbent investor-owned utilities and the fealty of regulators and politicians to the regulated monopoly model are themselves the greatest and most immediate obstacles to experimentation with

alternative material-institutional arrangements or governance frameworks that are better suited to a rapidly changing present.

2. Materials and methods

The findings and analysis reported in this study are the synthetic product of nearly a decade of action research (Bartels and Whittmayer 2018) and practice-based evidence gathering (Fox 2003) conducted by the California Center for Sustainable Communities (CCSC) at the University of California, Los Angeles (UCLA). This work has proceeded through a series of research grants and contracts, led by CCSC researchers, focused on informing policy development processes concerned with the construction of more equitable and sustainable infrastructural systems in California.

Relevant past projects from which the article's results draw include LA County's inaugural Sustainability Plan (2019), facilitation of a Data Access Working Group under Track 2 of the CPUC Rulemaking to Consider Distributed Energy Resource Program Cost-Effectiveness Issues, Data Access and Use, and Equipment Performance Standards (2025/26), implementation of the Bassett-Avocado Heights Advanced Energy Community (BAAEC) project with nonprofit partners on behalf of the California Energy Commission (CEC), and contributions to the LA-100 Equity Study (2023) for the Los Angeles Department of Water and Power (LADWP), among other projects.

As members of an academic research centre, we work both with and apart from outside partners involved in the electrification of residential and commercial buildings, the development of distributed renewable systems, and the governance of electrical infrastructure. We approach our collaborations with the state and project partners as opportunities for the coproduction of knowledge. As Nick Fox writes, this approach seeks to "dissolve the researcher/researched and research/practice oppositions in traditional research and supply an ethically and politically engaged research". (Fox 2003) Additionally, at all times, we find it important to situate the discussion of findings from this work within the broader historical context around the evolution of the business, politics, ecology, and economics of energy service provisioning in California and elsewhere throughout the United States. This exposition of the historical context provides the scaffolding around which the discussion of our results unfolds.

Supplemental to these experience-based findings, the article's results also include novel figures and analyses derived from publicly available data on the geographic and operational attributes of the state's various load serving entities (LSEs). These draw upon geographic information system (GIS) datasets hosted by the CEC, which reference the boundaries of IOU and Community Choice Aggregation (CCA) service territories. These analyses are intended to illustrate the disparate energy geographies of power supply versus power demand, which currently exist in California, and to motivate important discussions about viable alternatives to the incumbent investor-owned utility model.

Additionally, to address the critical issue of IOU regulatory capture as a persistent barrier to change, we additionally analyse data for budgets and staffing allocations for IOU "Regulatory Affairs" activities as compared to those of the CPUC's Public Advocates Office (CalAdvocates). This is the independent wing of the CPUC which is legally mandated to represent ratepayer interests. For the IOUs, budget and staffing data were sourced from the Administrative and General (A&G) or Operations and Maintenance

(O&M) exhibits of General Rate Case (GRC) filings as listed in the specific documents referenced in Table 1, below. These budgets, which support a range of staff positions – including the lawyers, analysts, and experts who argue for rate increases and other rule changes – are almost entirely funded by the ratepayers (customers), not shareholders.

3. Results

3.1. The genesis of the regulated monopoly utility model

In the United States, electricity became part of the "infrastructural bundle" and modernist sociotechnical imaginaries in the late nineteenth century, but it was not until well into the 20th that most people in the country began to buy electricity from private or public "utilities" (Graham and Marvin 2001; Hughes 1983; Nye 1990). With respect to the governance of electricity in the United States, the most consequential outcome of the growth period between 1900 and 1930 was the consolidation of electrical service provision under a relatively small number of large, private firms that were granted status as natural monopolies within their service territories. During this period, investor-owned, state-regulated utilities came to dominate the business of electricity provision, and their success was legitimated by their ability to provide an indispensable resource for developmental projects large and small. But at the turn of the twentieth century there was little consensus about what institutional-regulatory arrangement was best, or whether electricity should be supplied as a public good or sold as a regulated commodity (Boyd 2018, 2024).

The emergence of the regulated natural monopoly as the template for electricity service provision was due in large part to the self-interested actions of a small number of large, Edison-affiliated firms and a supportive cast of electrical industry groups. As sociologists Mark Granovetter and Patrick McGuire show, these groups successfully framed public ownership as an inferior alternative to regulated private management in public and regulatory discourses, using a network of subsidiary firms, trade publications, and professional associations to advocate for their preferred regulatory outcomes (Granovetter and McGuire 1998, 167). This dynamic is paralleled in other sectors, such as the railroads, facilitating integration of "modern" corporations into state-making enterprises (White 2011). Granted monopoly status within their service territories, large and well-capitalised incumbents were free to annex and absorb many of their contemporaries, consisting of a heterogeneous collection of local electrical providers operating in networks branching from manufacturing facilities, public works, and other sources of generation

Table 1. Documents used to evaluate California electric IOU Regulatory Affairs budgets and staffing levels.[9]

Utility	Proceeding	Primary Exhibit/Testimony	Key Chapter/Section
PG&E	A.21-06-021	Exhibit (PG&E-9): Administrative and General	Chapter 5: Regulatory Affairs (Witness: Megan Lawson)
SCE	A.23-05-010	Exhibit (SCE-06): Corporate Services	N/A
SDG&E	A.22-05-015	Exhibit (SDGE-27): Corporate Center General Admin	Section I: SVP Corporate Affairs (Witness: Diana Cooper)
SoCalGas	A.22-05-016	Exhibit (SCG-23): Corporate Center General Admin	Section I: SVP Corporate Affairs (Witness: Diana Cooper)

and co-generation supplying electricity to nearby customers (Granovetter and McGuire 1998; Nye 1999).

The embrace of the regulated private utility across the country, as "the template" for electric service provision, informed as it was by concerted corporate lobbying, did not eliminate all other alternatives (e.g. co-ops, collectives, and municipally-owned utilities, etc.), but the series of consequential state and federal policy decisions taken in the early twentieth century tipped the scales in favour of large private incumbents and their investors. By the 1930s, the establishment of monopoly electrical utilities led to situations where state public utilities commissions were additionally responsible for managing the conduct of a few very large, very wealthy electricity firms which had become providers of another vital and materially demanding infrastructural service. This basic institutional arrangement between the regulators and the regulated, the private and public halves of electrical infrastructural governance, has changed little since the early twentieth century, persisting through the extended liberalisation of the electrical sector that began in the late 1970s and the movements for decarbonisation in the first three decades of the twenty-first century.

As William Boyd writes, the idea of a "just price" for public infrastructural services has been central to the relationship between those regulating and those being regulated (2018). The Supreme Court in 1944 ruled that the outcome for rate-making exercises should produce "just and reasonable rates" and left state regulators to decide exactly how these rates would be calculated. Over time, state commissions and electrical utilities settled on a cost-of-service rate-making procedure tied to the utilities' investments and expenditures, guaranteeing them a rate of return high enough to ensure their continued access to capital markets (Boyd 2018, 767). This approach has endured, and ratemaking has remained a negotiation between affordability for the ratepayer, having sufficient funds to maintain infrastructure and purchase power, and shareholder returns – a balancing act that ostensibly keeps fairness, justness, and reasonableness as its core guiding principles.

3.2. Changes enacted in response to the 1970s oil supply shocks

In the early 1960s, policymakers and economists began to question whether electrical utilities should be opened to competition to discipline vertically integrated firms, achieve greater operational efficiency, and drive down energy costs for consumers. By the 1970s, amid high inflation, oil supply shocks, environmental pressures, and stagnating economy-of-scale gains from gas generation, regulators became more open to deregulation, including in the electrical power sector (Pierce 2011). Advocates for the further commodification of power and market-based governance reform found receptive partners amongst engineers and policymakers, who were broadly supportive of experimentations with wholesale and retail markets for electricity (Boyd 2018, 771; Özden-Schilling 2021).

In 1978, Congress passed the Public Utility Policies Act (PURPA) to encourage the third-party development of cogeneration and renewable resources and encourage competition. New markets for wholesale power exchange were "opened" to "qualifying facilities". These non-utility generators were looking to turn a profit, and their pursuit of it was expected (by liberalisation's supporters) to drive down the costs of energy and correct the pathologies of regulatory capture and sectoral stagnation. PURPA achieved

impacts well beyond the limited public policy goals that motivated its passage; it started to change the structure of the electric industry, providing the first challenge to the tightly integrated vertical monopoly structure (Sweeney 2013).

As James Sweeney observes, the regulatory and industrial changes that PURPA facilitated undercut the argument that the only way to make generation investments profitable was to make them as large as possible (Sweeney 2013, 16). Maintaining a monopoly on generation was no longer consistent with technical reality; it was now possible to coordinate the actions of buyers and sellers through market exchanges that were set up and facilitated by quasi-public bodies responsible for coordinating bulk power exchange. Vertical integration and monopoly power came to be seen as vestiges of a previous era; massive infrastructural investments could be managed and maintained more intelligently by a set of highly specialised firms transacting in various markets for power and energy services.

California was an early adopter of liberalising reforms. In 1996, California's Assembly passed the Utility Industry Restructuring Act, accelerating the transition from vertical integration to a more decentralised, exchange-based model (Sweeney 2013, 38). However, open and well-regulated markets for wholesale and retail electricity exchange did not materialise as smoothly as reformers had hoped they would. California's deregulatory enthusiasm was met with a series of crises, most notably Enron's exploitation of power market design vulnerabilities. However, the cascading disasters that arose from Enron's exploitation of the system's vulnerabilities did not discredit the real-time wholesale market as a technology of grid governance or pause the process of utility dis-integration that had been previously initiated. As a result, utilities emerged from this period of crisis as primarily "poles and wires" companies, responsible for the maintenance and operation of distribution-level infrastructure, the upkeep of the state's transmission network, and the retail sale of power procured from wholesale generators.

As these changes were occurring, substantive commitments to action on climate change were also beginning to take shape. California's legislature passed several bills, starting in 2002, which directed the CPUC and the utilities to pursue the "decarbonization" of their primary energy supply. SB100, established in 2018, created the Renewable Portfolio Standard, which required utilities to generate 60% of electricity sold using "eligible renewable and carbon zero energy resources" by 2030, and 100% by 2045. Additionally, Republican Governor Schwarzenegger also launched a subsidy programme to encourage the installation of a million rooftop solar arrays under a bi-directional tariff system called net metering. Building on the avoided cost paradigm, net energy metering (NEM) required utilities to purchase the electricity generated from rooftop systems at retail rates, compensating rooftop system owners "on-bill" for the energy they sent back to the grid. The policy was not met with enthusiasm by the state's investor-owned utilities. But as the owners and operators of essential infrastructure, utilities had to comply with these directives, developing interconnection protocols for residential and commercial renewable generation and storage systems.

3.3. Recent institutional and regulatory forms

Today, the California Independent System Operator (CAISO) manages bulk flows of power across transmission-level infrastructure and facilitates the matching of supply and

demand for power through its wholesale markets. Utilities procure power in these markets (and other long-term contracts for generation) for distribution to commercial and domestic customers. California's neoliberal experiment with market governance of the grid succeeded in diversifying the generation mix, partially dis-integrating monopoly utilities, and marketizing the operation of transmission infrastructure through digital means. But these market reforms and the decarbonisation responsibilities that came into existence soon afterward did not render investor-owned utilities any less central to the provision of power or the long-term planning of energy infrastructure. Though out of the generation business permanently, utilities still retained ownership of transmission, and ownership and operational control of the distribution portion of the grid. Institutionally, these reforms left the energy governance landscape in California mostly unchanged. Waves of market and climate reforms produced a very limited delegation of climate planning, programme implementation and retailing functions to organisations such as Regional Energy Networks (RENs), Community Choice Aggregations (CCAs), and others. These limited but significant delegations of administrative responsibility have taken place at the same time that state, local, and regional governments (responding to the absence of a coherent national climate governance framework) have attempted to govern energy transition and climate action locally through a variety of avenues, such as amendments to building codes, land use planning, and measures to encourage the development of renewable energy infrastructure (Kaplan Weinger 2026; Kennedy and Stock 2022).

We have observed in the course of our work with cities, nonprofits, public utilities, and other actors involved in climate and energy governance that the single greatest obstacle to infrastructural change in California is the continuing centrality of incumbent investor-owned utilities. The critiques of our interlocutors highlight the seemingly unassailable political-economic power of monopoly electrical utilities (especially the state's investor-owned utilities) and what they describe as the overly-deferential regulatory posture of the California Public Utilities Commission (CPUC). Furthermore, as the movement for a reconfiguration and re-spatialization of the electrical grid has grown, actors have also attempted to alter existing governance arrangements through organised actions, such as the municipalisation of their local portions of the grid, as well as campaigns to organise policy advocacy and representation at the state level (Clifton et al. 2021; Hess and Jordan 2023).

Echoing our interlocutors and collaborators, we contend that the large-scale deployment of new distributed renewable generation technologies is incommensurate with the organisational principles and financial incentive structures which have evolved to maintain the existing, highly centralised, power system operated by contemporary utilities. In many respects, publicly regulated monopoly utilities behave as if they are eternal. However, this is more fiction than fact – for it is only society's demand for energy that is perpetual. The regulated monopoly utility model is actually quite fragile. Public awareness of this truism is increasing. There has been a recent outpouring of dissatisfaction regarding the degree to which the political economy of the monopoly utility model is resistant to the kinds of infrastructural transformation and reimagination necessary to build energy systems that can respond to the changing geographies of climate risk, social concern, and the primary flows of energy available to renewable generation systems (Bryant and Westerling 2014; Huang et al. 2023; Sathaye et al. 2012).

There is little evidence that current utility configurations and financial infrastructures are conducive to fundamental shifts towards a more distributed and resilient power system architecture. To date, California's strategy has been to persist in the application of large-scale, highly centralised grid technology solutions, even as the state has mandated a shift to the use of renewable energy generation and storage which can be deployed in a highly decentralised manner. As we discuss, this centralised architecture is a major source of vulnerability to the impacts of climate change, such as from wildfire and extreme heat. An institutional framework that continues to favour centralisation and separation between supply and demand for power is, in California, a poor fit for the rapidly changing present.

3.4. Utility opposition to the proliferation of distributed energy resources

While the liberalising reforms of the late twentieth century and the climate reforms of the early twenty-first can be said to have "restructured" the electrical utilities, these private firms still maintain considerable power as the owners and operators of the grid's transmission and distribution hardware. California's IOUs have toed the line on decarbonisation, incrementally purchasing more electricity from renewables in compliance with the state's Renewable Portfolio Standard (RPS) – they continue to resist the development of distributed energy resources in different forms. This is evident in their persistent opposition to the compensation of owners of distributed roof-top solar systems, the implementation of community solar projects, microgrids, and other distributed energy resources, as well as their (failed) opposition to the formation of public power retailers known as Community Choice Aggregation (CCAs), as shall be discussed below.

Under the current governance system, California's IOUs are assured a fixed rate of return for their shareholders of about 10%. Their customers' electricity rates therefore reflect both these shareholder returns as well as the costs of purchasing power from generators and distributing it. Shareholder calculations of utility profits depend upon the total value of their capital assets; most notably transmission and distribution equipment. Consequently, electrical IOUs in California (and elsewhere) have a strong preference for capital-intensive solutions to socioeconomic and socioecological problems. In California, IOUs have interpreted the advent of new public load serving entities (e.g. CCAs) and the attempts to increase the deployment of DERs as threats to their business. As such, they actively work to neutralise them through a variety of different arguments put forth to CPUC which seek to further justify and strengthen their monopoly position.

The power of California's investor-owned utilities to shape policy regarding the construction and operation of distributed energy resources is also evident in a series of revisions to the Net Energy Metering (NEM) programme. Under NEM 1.0 (1995) and NEM 2.0 (2016), rooftop solar customers were credited for any excess supply of self-generated electricity that was exported back to the grid at, or near, retail rates. These early programmes were instrumental in driving solar adoption statewide, particularly among single-family homeowners. In 2022, the CPUC revised the basis on which rooftop solar owners would be compensated for their excess generation, adopting NEM 3.0, which compensates them using a net billing tariff in which export values are tied to the avoided cost of electricity. This effectively credits these systems less for power exported in the middle of the day, and more for power exported during evening peak hours.

These varying valuations of solar output are closely tied to the implementation of dynamic, time-of-use (TOU), retail rate structures over the past decade. Under TOU pricing schemes, higher rates are charged during the peak demand hours (4-9 PM) and lower rates during off-peak hours. Rates also vary seasonally, being typically higher in summer months than in winter months. Theoretically, these TOU rate structures send price signals to energy users that reflect the time-variant component of the utility's cost of service. Their objective is to shift customer energy use from peak hours to off-peak hours – although the efficacy and equity implications of these structures remain unclear (White and Sintov 2020). The justification for the switch from tiered, volumetric, rate structures to TOU is two-fold: allowing rates to vary with time helps them to better reflect the cost of supplying power when conditions change, and the higher prices associated with times of peak load and congestion discourage consumers from overconsuming during these periods. TOU, however, also functions as a way for utilities and the CPUC to constrain the operational domain over which distributed renewable systems can be compensated for their output and – by extension – the commercial landscape for developers.

Following the adoption of NEM 3.0 in 2022, the CPUC changed NEM export power compensation in 2024 to directly reflect the TOU pricing scheme, transforming it into what is now effectively a Net Billing model. The decision did away with a flat, time-invariant compensation structure, and introduced one that compensated users for electricity exported back to the grid according to the TOU price when export occurred. By paying customers less for power exported during off-peak periods, the CPUC effectively diminished the value of distributed solar-only systems and increased the payback periods of systems yet-to-be-installed. The CPUC rationalised this decision to incentivize the pairing of rooftop solar generation with battery storage so that power could be used when the grid was most constrained. However, this decision to change the compensation structure according to the logic of TOU also served to ensure that distributed renewable systems remained merely a supplement for grid-supplied power. Further, the utilities are clamping down on the ability of property owners to install off-grid systems, seeking to influence County Supervisors to require grid-connected systems under the auspices of the IOUs' legal "obligation to serve".

3.5. The ongoing debate over the value of distributed energy resources

The CPUC's decision to move to a Net Billing model was vociferously opposed by a broad coalition of industry, nonprofit, and public groups, who argued that these changes effectively reduced the value of solar-only installations. Although it is true that early solar adopters were largely white and affluent households, low- and moderate-income households now make up a significant portion of new adopters (Forrester et al. 2024). Supporters of a more decentralised grid have been at pains to show that stable commercial models such as residential rooftop solar and storage and "community solar" can alleviate energy cost burdens for ratepayers and provide resilience benefits. Advocates for a more distributed grid also hold that distributed solar PV and batteries will reduce the need for generation and transmission from far-flung places, obviating the need for new lines through increasingly fire-prone areas, and these are the real reasons for the utilities'

concerns. These characteristics have obvious systemic resilience benefits in terms of reducing reliance on imported power.

Overall, the "economic" value of Distributed Energy Resources (DERs) has been fiercely debated by the utilities and their critics, yielding little in the way of consensus. In 2024, the CPUC ruled to compensate owners of "community solar" systems (1-20 MW) at a rate closer to system-wide wholesale prices, and below what many community solar developers and industry groups considered to be a fair price. This decision was decried by supporters of distributed renewable generation and climate reform as an example of the CPUC's continued deference to the utilities' desires for centralisation and maintenance of administrative control. Monopoly utilities prefer capital-intensive, centralised approaches to energy transition and climate risk abatement, and they have used their political power and position to contain the threat posed by distributed generation and storage. The co-location of generation and load that is presupposed by distributed energy technologies is therefore fundamentally at odds with the primary growth driver underpinning the modern investor-owned utility model.

At the time of this writing, investor-owned utilities are supporting a legislative effort to eliminate the net energy metering programme altogether, reneging on existing net energy metering agreements and contracts and commitments with the NEM 1.0 and NEM 2.0 customers by retroactively changing the terms and conditions that residential ratepayers agreed to when they had rooftop solar systems installed (Perkins 2024). The proposal, justified in terms of cost recovery and distributional equity, is rather ironically paralleled by the utilities' desire to honour long-term procurement contracts they entered into when renewable generation capacity was far more expensive than it is now.

The final reform measure utilities have advanced to bolster the centralised generation and distribution model is a new income-graduated fixed charge, approved by the CPUC in 2024.[1] Currently, investor-owned utilities' system-wide fixed costs are recovered on the basis of electricity usage. Fixed charges change existing recovery mechanisms, and the argument advanced by investor-owned utilities (and accepted by the CPUC) for such charges is that many system-wide fixed costs do not scale based on use, and that they should not be apportioned based on use. The new charges split users into disadvantaged and non-disadvantaged categories based on enrolment in income-based rate relief programmes. Low-income ratepayers are expected to see increases of around $24.15/month, though low-income customers and those living in deed-restricted affordable housing are eligible for discounted flat rates of $6/month or $12/month. Framed as a means to harden the grid and fund wildfire mitigation efforts, this shift, like the retreat from net energy metering, reflects the utilities' broader strategy to compensate for selling less electricity and protecting cost recovery in an era when consumers can increasingly offset their consumption of energy from the grid with on-site distributed renewable generation.

3.6. The socialisation of wildfire damages & infrastructural hardening

California's investor-owned utility model is not only being threatened by the potential for a more distributed, renewable system, but by the impacts of climate change itself. Specifically, the increasing spread and potential for wildfires in utilities' rural areas and transmission corridors. Instead of embracing the need for a radical reimagining of the

current system, however, the landscape of infrastructural decay and climate risk exposed by the recent wildfires has inspired state and utility efforts to harden the existing grid – efforts which are being financed by hundreds of millions of dollars in additional ratepayer funds. For example, only two months prior to the devastating Camp Fire in 2018, Governor Gavin Newsom approved the reappropriation of nearly $200 million from the Greenhouse Gas Reduction Fund to CalFire for "purposes relating to forest health, fire prevention, and fuel reduction". (CA Senate SB 901, 2018). The reappropriation appeared logical at face value, but instead of going to programmes concerned with the health and condition of forests, these funds mostly served to shore-up the financial health of the utilities responsible for the wildfires. These generous state outlays have not been enough to prevent utility bankruptcies.

Following the Camp Fire, which burned hundreds of thousands of acres in Northern California and led to more than 100 deaths, PG&E filed for bankruptcy after having paid out nearly $25.5 billion "to resolve its fire-related liabilities" after admitting that its equipment started the fire (Blunt 2022). In April 2019, Governor Newsom's Strike Force published a report addressing California's wildfire risks and energy future. The report states:

> Utilities rely on credit to finance ongoing infrastructure investments, including wildfire mitigation. As utilities' credit ratings deteriorate, their borrowing costs increase and those costs for capital necessary to make essential safety improvements are passed directly to customers. These downgrades, and the prospect of additional utility bankruptcy filings, directly impact Californians' access to safe, reliable and affordable electricity.[2]

In June 2019, the Commission on Catastrophic Wildfire Cost and Recovery, established by SB 901, published a report recommending "the critical need to provide cost recovery for those with serious damages while not bankrupting utilities in the process".[3]

The costs associated with responding to intensifying climate hazards and decades worth of deferred infrastructure maintenance are increasingly being borne by ratepayers. In 2021, the CPUC authorised PG&E to collect $13.5 billion in rate increases to fund the partial undergrounding of 1,230 miles of transmission through fire-prone areas. These efforts were supposed to remedy decades of conscious neglect on behalf of the utility, who changed their line inspection and safety protocols to cut costs in the short term (Blunt 2022). The CPUC granted utility requests for rate increases such that they could "harden" their portions of the grid and conduct fire prevention programmes. This pattern of socialising the costs of utility mismanagement has persisted; Southern California Edison, whose transmission infrastructure is suspected of having caused the 2025 Eaton Fire, received a 17% rate increase to mitigate fire risk through undergrounding and other measures.[4] Edison's undergrounding is aimed at their distribution system, which has not been implicated in the fire's ignition. However, Edison's undergrounding efforts are not likely to provide much in the way of wildfire mitigation benefits because the Eaton fire was likely sparked by a downed transmission line that had been depowered for decades, but may have been temporarily re-energized by induction due to improper grounding procedures. It is estimated that further wildfire mitigation could raise the average residential customer's bill by about 10% (Stone 2025).

In addition to these wildfire-related rate increases, the state has established a wildfire fund to reimburse eligible claims arising from a covered wildfire caused by a utility

company that participates in the Fund. By assisting in capitalising the Fund, and undertaking certain other obligations specified in the law, utilities and their investors would be afforded additional protection: "when the $21 billion California Wildfire Fund was created, it was funded from California's surplus fund. Over time, $10.5 billion will be paid back by utility shareholders and the other $10.5 billion will be paid back by utility ratepayers".[5] PG&E, SCE, and SDG&E were each required to seed the fund at levels based on their respective liabilities and histories of safety, totalling $7.5 billion. The bill anticipated PG&E would be responsible for 64.2%, SCE for 31.5%, and SDG&E for 4.3%. Subsequently, the companies will contribute their adjusted share of $300 million annually to the fund until they reach $10.5 billion. The legislation authorising the fund also extends a monthly surcharge on ratepayer bills from the Department of Water Resources that will finance their portion of the fund over the next several years. The charge is estimated to cost $2.50 per month for the average ratepayer.[6]

3.7. Greening the grid while protecting IOU territory and profitability

Overall, California's attempts to realise its climate goals and improve the functioning of its electrical infrastructure without shattering the IOUs' territorial governance have required increasingly complex infrastructural arrangements. Along with formal and substantive changes to the governance of the grid, the state has also created opportunities for new public authorities to go into the business of retailing power. In 2002, in response to the Enron scandal, the California state legislature approved a bill that made it possible for Community Choice Aggregations (CCAs) to begin procuring and selling power through existing distribution and transmission infrastructure. CCAs are local, non-profit organisations incorporated by local governments that purchase electricity on behalf of residents and businesses in place of the investor-owned utilities. However, CCAs bear no responsibility for the physical management or operation of the infrastructure that is used to transmit the power they buy and sell; rather, they are permitted to use the local investor-owned utility infrastructure to do so.

California now has 25 active CCAs, representing over 200 local governments and more than 15 million customers – approximately one third of the state's total population. The maps contained in Figures 1 and 2 compare the geographies of the state's IOU service territories (Figure 1) with those of its more recently established CCAs (Figure 2). The IOU territories reflect historical processes of infrastructure development, competitive mergers and acquisitions, and phases of regulatory organisation and authorisation which have unfolded over more than a century. By contrast, CCAs are far more contemporary entities, whose boundaries have recently been negotiated among sympathetic groups of customers and their municipal government representatives as a means of leveraging collective power to advance common interests in transforming the energy system. It is not by coincidence that these existing CCAs primarily serve coastal communities. These areas are more affluent and actively engaged in the ongoing energy transition, with higher rates of EV and electrical appliance adoption, and a greater capacity to pay price premiums for more renewably generated electricity.

At their core, CCAs function to pool customer load as a means of gaining leverage in the negotiation of power procurement contracts with developers and operators of generation assets. This leverage allows them to articulate various preferences in terms of the

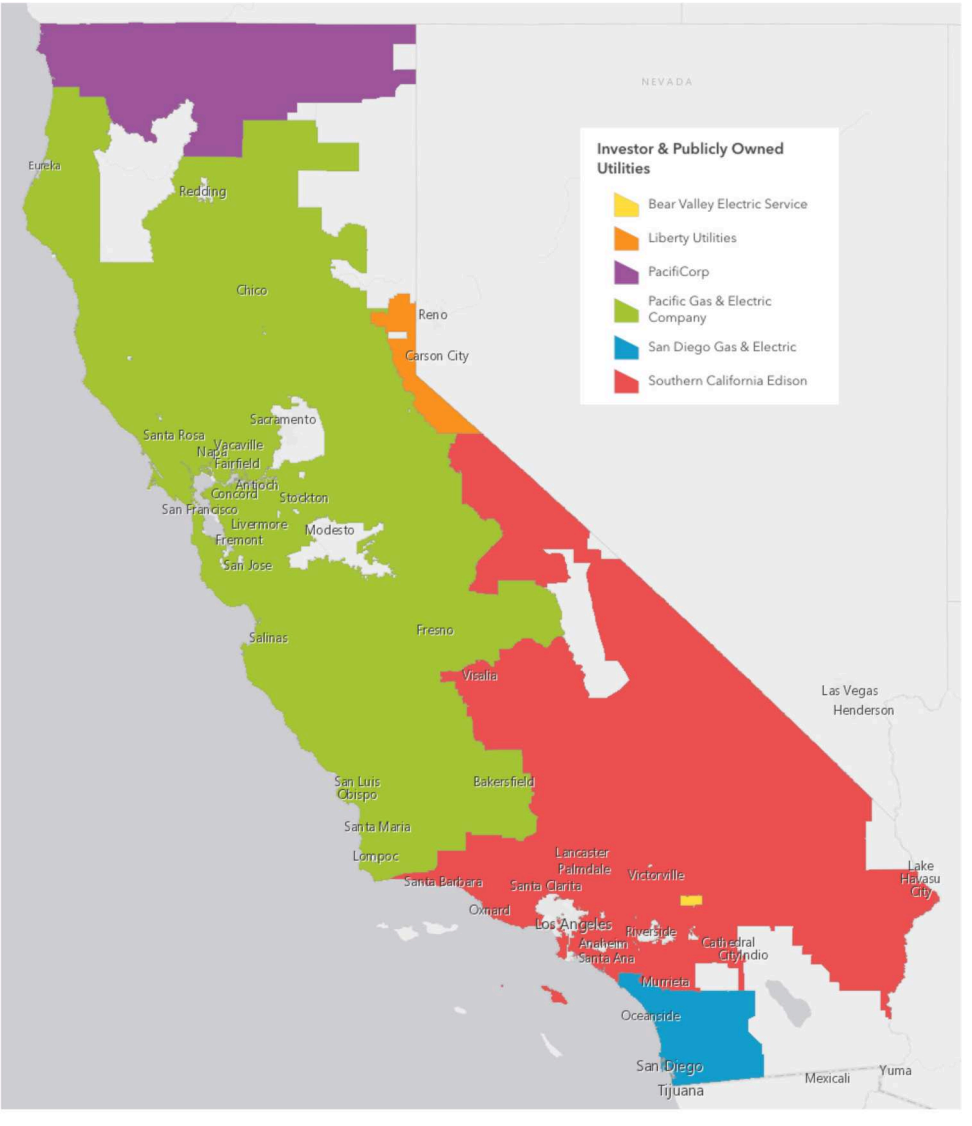

Figure 1. California electrical Investor Owned Utility (IOU) service territories.[7]

Source: https://cecgis-caenergy.opendata.arcgis.com/datasets/CAEnergy::electric-load-serving-entities-iou-pou/explore?location=37.271910%2C-119.270421%2C6

cost, renewability, and locality of the power being purchased. In addition to power procurement, however, CCAs also invest in energy efficiency and conservation programmes, the installation of EV charging infrastructure, and are at the forefront of efforts to establish local energy resources and programmes such as solar and storage for resilience, low-income rooftop and "community" solar, among others. And while the CPUC initially welcomed CCAs as harbingers of a more sustainable energy system, it has since ensured that CCAs do not threaten IOU territories or profitability. As new retailers, CCAs have been able to take advantage of the falling costs of renewable procurement, but their formation and operations have been opposed by investor-owned utilities, who resent having to transmit

Figure 2. California Community Choice Aggregation (CCA) service territories.[8]

Source: https://cecgis-caenergy.opendata.arcgis.com/datasets/CAEnergy::electric-load-serving-entities-other/explore?location=37.236675%2C-119.002499%2C6

and distribute the power purchased by CCAs and (in some instances) bill customers for the power they consume.

Utilities feel that CCAs are absconding with large numbers of their customers and load, and that CCAs do not adequately compensate them for the use of their infrastructural investments. CCAs are important players in the struggle for lower-cost renewables and greater community control, and their rate-setting activities, like those of investor-owned utilities, are regulated by the CPUC. To ensure that CCAs pay their fair share of operations and maintenance costs, CCAs must pay a power charge indifference adjustment (PCIA) fee to utilities for the use of their poles and wires. In regulatory proceedings, California's investor-owned utilities successfully argued that without the PCIA, the

remaining utility customers would need to assume costs that investor-owned utilities incurred in anticipation of serving the customers that now receive electric service from CCAs.

In essence, the PCIA serves to help investor-owned utilities pay down the cost of older, more expensive renewable procurement contracts by forcing CCAs to charge their customers a small, periodically re-negotiated premium for opting-in. Thanks to the falling price of renewable generation contracts, CCAs have entered into far less costly arrangements with newer generators, and this, in part, has enabled them to offer lower rates than the utilities. But through the PCIA, utilities are able to partially neutralise their price disadvantage, and continue drawing revenue from ratepayer bills. Further, as the utilities are able to access lower-cost contracts themselves, it is unclear whether the CCAs will be able to continue to offer lower resource costs than the IOUs over the long term. The fact that these rates are negotiated on an ongoing annual basis gives the CPUC a degree of disciplinary control over the relationship between CCAs and the utilities that support them.

3.8. IOU regulatory capture and the resource asymmetry problem

Reflecting on all of the different ways in which utilities have been successful in reasserting their monopoly power begs the question of how they continue to remain so central despite their persistent mismanagement of energy infrastructure. One important explanation is the phenomenon of regulatory capture. This is a concept that was first formalised by George Stigler, who observed that regulated firms have a large and concentrated interest in the outcome of regulatory decisions; whereas individual interests are comparatively dilute (Stigler 2021). Consequently, regulated firms have strong incentives to allocate resources to influence regulatory decisions in ways that are maximally beneficial to the firms' interests, as opposed to those of the general public. To this end, one important measure of the degree to which regulatory capture is occurring within a sector is the relative amount of financial and human resources allocated to regulatory decision-making processes by the different parties involved.

Comparing IOU and CPUC budgets and staff allocations specifically for the purposes of litigating rate-making and other regulatory proceedings (i.e. "Regulatory Affairs") reveals the scale of this asymmetry in California's energy system. In 2025–26, the CPUC's total annual operating budget was ~$1.9 billion, with some ~1,500 authorised full-time employment positions (FTEs). And while this budget may look substantial on paper, only a fraction is dedicated to "Regulatory Affairs," however. The majority of the commission's funding actually goes to Pass-Through Programs (~$1B+) such as California LifeLine (discounted phone service), the California High Cost Fund, and Broadband Infrastructure grants. Additionally, hundreds of CPUC full time employment (FTE) positions are dedicated to rail safety, gas pipeline inspections, and wildfire safety field audits, as opposed to rate-case litigation. The core regulatory staff, e.g. the people actually processing rate-cases, developing rules, and performing oversight on utility operations, are primarily employed within the Energy Division (~250 staff) and the Administrative Law Judge (ALJ) Division (~50–60 judges).

The information contained in Table 2 seeks to provide a direct comparison between the resources available to CalAdvocates, relative to the IOUs' combined Regulatory

Table 2. Comparison of California IOU and PUC Regulatory Affairs budgets and staff headcounts.

Entity	Department/Category	Annual Budget (Requested/Auth)	Estimated Headcount
PG&E	Corporate Affairs (includes Regulatory & Gov)	~$30 – $45 Million*	~70–100 FTEs
SCE	Policy, External Engagement & Ratemaking	$35 Million	~120–150 FTEs**
SDG&E	Regulatory & External Affairs	~$10 – $15 Million	~40–60 FTEs
SoCalGas	Regulatory & External Affairs	~$47 Million	~80–110 FTEs
IOUs	**All Regulatory Affairs Staff (Combined)**	**~130 Million**	**~400–450 FTEs**
CPUC	**Public Advocates Office**	**~$48 – $55 Million**	**~180–195 FTEs**

*PG&E's total A&G department budget is ~$154.2M, which includes Legal, Finance, and Risk. Corporate Affairs is a subset of this. **Estimated based on labour escalation and historical vacancy data in SCE's 2025 GRC testimony.

Affairs budgets, for 2025–2026. As these figures demonstrate, a single large utility will frequently employ a regulatory and policy staff nearly 75% the size of the entire state's consumer watchdog. And overall, the combined scale of the regulatory teams for all four major IOUs outnumber the public advocates tasked with auditing them at a rate of roughly 2–1. Beyond these staff positions, "Regulatory Affairs" budgets often include millions of dollars for outside consultants and "expert witnesses" who testify on the utility's behalf. Furthermore, individual utilities typically also have an additional 50 + in-house attorneys and spend millions more on elite outside law firms; expenses which are not directly included in these Regulatory Affairs budgets.

4. Discussion

Utilities' official status as the premier capital managers of electrical infrastructure has made them extremely durable and politically powerful. But as we have discussed, this power and durability are what make them obstacles to substantive change. Investor-owned utilities perceive the re-localization of retailing functions and the co-location of supply and demand for power as threats and have repeatedly mobilised to quash efforts to reorganise the way electricity is generated, distributed, and sold to customers. Existing legal and regulatory conditions give investor-owned utilities little to no incentive to encourage the proliferation of distributed renewable systems in their service territories, since these systems, in a very direct way, compete with the existing grid to satisfy customer demand for electricity. In the eyes of those committed to the regulated monopoly model, the proliferation of distributed renewable systems and movements to re-localize (or downscale) are perceived as threats to a sufficiently "progressive" status quo.

The infrastructural arrangements that utilities and regulators favour require the extensive use of high-voltage transmission lines to bring electricity from distant generators to load basins. However, this model is clearly at odds with the changing geographies of wildfire risk. The solutions utilities propose to mitigate such risks, unsurprisingly, involve massive investments in hardening or undergrounding of infrastructure, which are a significant source of revenue generation. Overall, the size, organisational capacity, and indispensability of monopoly utilities have made them more than a match for regulators and other state bodies, who see no other option but to socialise the costs of the utilities' continued existence. Moreover, the pursuit of absolute energy use reductions (e.g. conservation) has now faded almost entirely out of the state's policy-making agenda.

The state's investor-owned utilities have also repeatedly put the integrity of their business ahead of public safety: California's three major investor-owned utilities have

been responsible for some of the state's worst wildfires, enormous property damage, and hundreds of deaths. Their transmission lines span rugged terrain and cut through highly flammable vegetation. Pacific Gas & Electric has had to declare bankruptcy three times, and has been bailed out by the state. In the aftermath of the Camp Fire, they extended stock ownership to the victims to help engender opposition to any local takeover or buy-out of distribution infrastructure. Even if people wished to defect, they would have had to pay a high price for doing so. Yet, despite repeated instances of criminal negligence, the utilities, as implementers of climate and energy policy, and capital managers of electrical infrastructure, appear to remain too big to fail.

Rather than consider new institutional forms better suited to the needs of the present, it appears that California's Public Utilities Commission, like many others across the country, is committed to finding ever more convoluted ways to sustain the incumbent utility model. In some respects, this position is understandable. Over almost a century, monopoly electrical utilities have become tightly woven into existing modes of life, and the demands of the present moment threaten to outstrip the capacity of regulators and the state. So too have these modes of life become increasingly reliant on continuous access to affordable, yet still high-quality, sources of electrical power. The re-spatialization of operational control of, and administrative authority over the grid appears to be a bridge too far. Electrical systems are under increasing pressure, and the organisations responsible for their financial and physical management have proven themselves to be poor stewards of public welfare.

A re-spatialization of power, we believe, might create openings for more effective and democratic forms of infrastructural governance. Presently, alternatives to the monopoly model of electric service provision are under development in California and elsewhere. One emerging model for sectoral reorganisation is distributed energy services (DES). Prioritising the co-location of renewable supply and demand for power, DES-type approaches to grid management involve turning portions of existing distribution-level infrastructure into load balancing zones operated by a public, private, or intersectoral Distribution Service Operator (DSO). Under a DES/DSO-type approach to grid operation, substations become interfaces between the transmission system/ wholesale market and distribution service/ retail market territories (Bell 2023; Kristov 2023). Reconfiguring the grid's topology to function in this way would dramatically increase the number of organ

isations responsible for ensuring grid reliability and service, and could require some type of supra-local, state-level regulatory structure, but DES/DSO framework would help re-localize and downscale infrastructure investment decisions, and abstract them from the highly formalised and centralised administrative law courts where such decisions are currently made.

As alluded to above, the full suite of capabilities of distributed renewable resources is under-appreciated and their benefits undervalued. Studies of rooftop solar potential in California show that the state could nearly double California's in-state energy production (Gagnon et al. 2016). Beyond the current model of rooftop solar owned by the building proprietor, additional distributed solar capacity could be developed through lease or other arrangements on land that is already built, and/or disturbed, including parking lots, garages, commercial and industrial sites, brownfields, abandoned quarries and more, not requiring an owner implementor (Bell 2023). Such an approach would have to be created through new legal instruments, but might greatly increase the number

of sites suitable for distributed generation or storage. This is not to say that some heavy industries with very high energy demand would not need high-voltage energy services, but for most end-uses of electricity, including electric vehicle charging, the low- and medium-voltage DES production could go very far in meeting the state's demand (Bell 2023).

At the same time, for a genuine energy transition to occur, high energy efficiency retrofits of the large stock of older buildings should be actively implemented. This would mean massive investments in elevating the thermal performance and liveability of existing buildings through the installation of deep retrofits, including new insulation, better windows, eliminating leaks and so forth. Such investments would not only improve the current building stock, but they would, if combined with DES, potentially reduce the need for investments in monolithic transmission assets and immense acreages of solar and storage arrays. As Bell and others describe it, the grid to network DES is decentralised, and can be operated by heterogeneous participants over a cost-based common carrier network. This would not support a "natural" monopoly but rather enable the establishment of "independent small and medium-sized providers, operating cooperatively" (Bell 2023, 163).

DES operators could encompass a range of dispatchable energy capacity combined with integrated battery storage. Further, this approach gets away from DES being solely a means to offset part of all of a customer's load (solar today is restricted by CPUC and IOU rules not to exceed that load). A DES-like approach might encourage public and cooperative community energy projects. It also might help re-localize (if not democratize?) energy governance. Obviously, this will not occur overnight, nor are DES low-to-medium grid energy services simple. Any new arrangements must involve engineering to ensure the availability of sufficient reactive power, energy storage, as well as performing switching, communication controls, and new management organisations. But faced with the growing cost and vulnerability of the existing energy system, the lack of innovation and entrenchment of the incumbent utilities that adamantly obstruct alternatives that could significantly supplement electric generation at low cost and where it is consumed are blocking the development of a new energy system going forward.

California Senate Bill 332, introduced by Senator Wahab in February 2025 as the "Investor-Owned Utilities Accountability Act", signals growing political momentum behind alternatives to the current utility model. If enacted, the bill would have directed the CEC to appoint a research institute to assess the benefits and challenges of transitioning IOUs into public entities, nonprofit public benefit corporations, or mutual benefit corporations. The goal would be to evaluate "practical, financial, legal, labor, and technical considerations for a smooth and just transition to a model that prioritizes the needs of California's people and ecology" (Investor-Owned Utilities Accountability Act 2025) This potentially transformative legislation reflects a growing recognition that IOUs, in their current form, are structurally misaligned with the needs of a decarbonising, distributed, and climate-vulnerable energy system.

5. Conclusion

It is increasingly obvious that distributed energy resources are poorly aligned with the technical limitations of existing utility-owned and operated electrical transmission and

distribution networks. These are systems which were designed to accommodate unidirectional flows of power produced by the continuous operation of large-scale thermal generating assets located far from population centres. In contrast, distributed energy resources allow for the co-location and coordinated management of energy supply and demand at the point of consumption. These capabilities are fundamentally incompatible with the idea that shareholder value can be created through the continued growth and hardening of transmission and distribution infrastructure.

The concretisation and implementation of fundamental reforms to the monopoly IOU business model must involve policy and operations research efforts that give questions about re-spatialization of power, energy justice, and sustainability accounting practices more thorough and rigorous treatment. Would transformation entail the creation of smaller-scale public utilities, a patchwork of multiple utilities? How would the financial entanglements of existing utilities (with, for example, pension funds) bear on the question of institutional transformation? How could new kinds of energy service providers manage autonomous, distribution-level networks (like microgrids and virtual power plants) that exist within their putative territories? What should become of the transmission network? These questions and others remain unexplored, but they are critical to any substantive transition to a more distributed, more renewable, less centralised energy future. Continuing to pursue the construction and deployment of distributed energy resources in the current ad hoc manner and hoping for the best will surely not be enough. The propulsive problem of climate change and greenhouse gas emissions led to a path of decarbonisation for the incumbent utilities, but no concomitant change in their structure, impeding the types of deep structural changes in provision of electricity that could be possible, ensuring less impact on the environment and greater resilience. Further, the neglect of building energy performance seriously impedes more parsimonious needs for generation.

Simply throwing more money at flawed arrangements that need continuous jawboning to serve the interests of the consumers is no way to govern electrical infrastructure in the twenty-first century. Centralised thermal power generation is substantively different from distributed renewable generation, and institutional arrangements should reflect this fact rather than rely on enlisting enormous swaths of land into solar, to maintain the incumbent approach. We must not get stuck in the past, and we should be willing to seriously consider alternatives that depart radically from current arrangements. We should be investing in an integrated future, and there is no reason why solutions to California's present problems must be found within the grammar of infrastructural governance inherited from the twentieth century.

Notes

1. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M531/K094/531094134.PDF.
2. https://www.gov.ca.gov/wp-content/uploads/2019/06/Strike-Force-Progress-Report-6-21-19.pdf.
3. Blunt 2022.
4. It is worth noting here that the willingness of the CPUC to authorize customer rate tariff increases so that the state's investor-owned electrical utilities may recoup expenses incurred for wildfire risk management and damage recovery efforts effectively amounts to the use of energy bills as a vehicle for the socialization of costs related to climate adaptation. Previous

attempts to similarly socialize these types of costs via other mechanisms – such as municipal taxes, bonds, insurance premiums, etc. – have, to date, been much more contentious affairs..

5. https://www.lexology.com/library/detail.aspx?g=21cbe6f4-b44a-4fc6-92c2-78cb9f5acd37.
6. https://californiawildfirelawsuit.com/news/understanding-assembly-bill-1054-and-the-california-wildfire-fund/.
7. https://cecgis-caenergy.opendata.arcgis.com/datasets/30410214d637434ba1003cbdcc32cf55_0.
8. https://cecgis-caenergy.opendata.arcgis.com/datasets/07224640a2fe42f89399be796e7b8810_0.
9. Note the inclusion of SoCalGas in these documents due to the common practice of joint IOU filings in response to different rulemaking decisions..

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Data availability is not applicable for this article as no new data were analysed in this study.

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