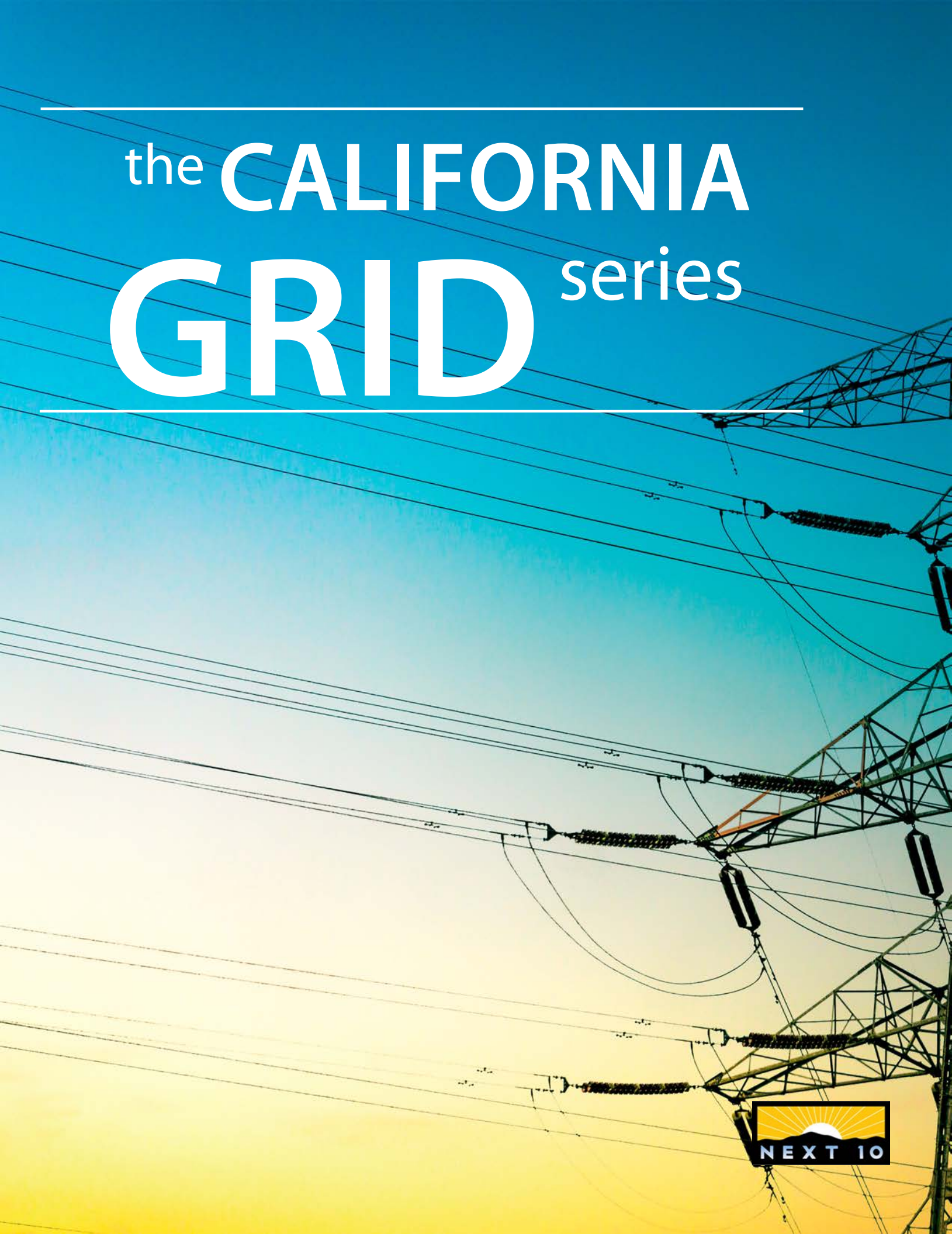
the CALIFORNIA GRID series



the CALIFORNIA GRID series

Executive Summaries

PRODUCED BY:

Next 10

BRIEF AUTHORS:

- Transforming the Grid
- A Regional Power Market for the West
- The Growth of Distributed Energy
by Bentham Paulos of PaulosAnalysis

- Electric Vehicles and the California Grid
by Anand R. Gopal and Julia Szinai

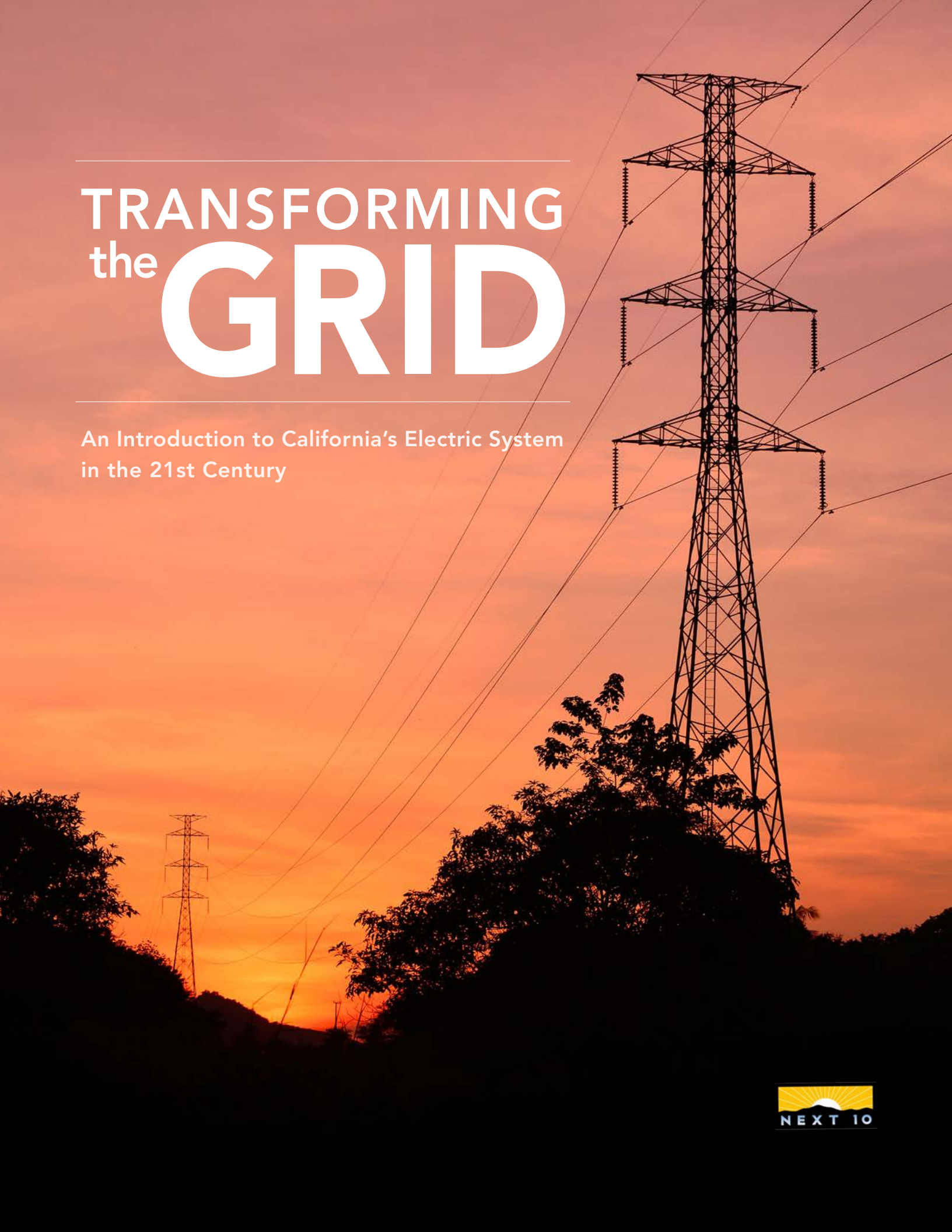
- The Growth in Community Choice Aggregation
by Dr. JR DeShazo, Julien Gattaciecca, and Kelly Trumbull
of the UCLA Luskin Center for Innovation

Summer 2018

With California's grid facing an era of rapid change as access to renewable energy grows, Next 10 published five briefs examining key issues involving the state's power system. The briefs take a deep dive into how the grid might be challenged or helped by regionalization; the rise of electric vehicles; the growth of community choice aggregation, which allows cities and counties to join together to purchase electricity on behalf of their community members; and the increase in distributed energy resources, such as rooftop solar panels. The following document provides executive summaries of the five indidivudal briefs.

To read the full series, visit www.next10.org/ca-grid

NEXT 10



TRANSFORMING the GRID

An Introduction to California's Electric System in the 21st Century

NEXT 10

I.

Introduction

CLIMATE change is the key challenge of the 21st century and California has been at the global forefront of the development of strategies to reduce greenhouse gas emissions while maintaining economic growth. With California's electricity sector serving as one of the largest sources of greenhouse gas emissions in the state, lawmakers and regulators face critical questions about how the sector can maintain affordability and reliability as it decarbonizes. An increasingly clean power system is also key to decarbonizing other parts of the economy, including transportation – the largest source of statewide emissions – and heat.

Given this challenge, California's energy system is undergoing a radical transformation driven by disruptive technologies, consumer preferences, and aggressive clean energy policies. The old paradigm of central suppliers serving passive customers is giving way to a more decentralized and digitized system, with modular and smart technologies generating and controlling energy with greater efficiency and higher value.

As the state looks to transform its power system and deliver an increasing amount of renewable energy reliably and affordably, this paper sets out to provide an overview of the current features of, and challenges facing, California's electric grid. Key takeaways from this analysis include:

California's resource diversity, combined with a willingness to innovate, is creating opportunities for industry and policy leadership, environmental improvement, and economic growth.

California's significant investment in energy efficiency has kept energy demand flat, even as the economy has boomed. Though the state has among the highest electricity prices in the country, it has among the lowest expenditure per capita.

California's renewable energy sectors such as wind and solar are mature. The state's Investor Owned Utilities (IOUs) are meeting Renewable Portfolio Standard (RPS) goals well ahead of schedule.[1] While renewable energy in the state is affordable and abundant, the addition of these resources requires a new approach to managing the grid. Fortunately, there are a growing set of options for managing the variability of renewable energy, and the state is currently weighing the prospect of expanding its regional energy market to balance demand and cost concerns.

There is growing consensus that electrification of transportation and heat are critical to deep decarbonization, while also helping integrate more renewables. However, building electrification and broader adoption of electric vehicles will increase electricity demand in the state, creating new challenges for how the state manages a rapidly evolving power system.

New distributed energy technologies are expanding the role of customers, saving energy, lowering costs for consumers, reducing emissions, and providing more reliable service. But distributed energy, community choice aggregation programs (CCAs) and competitive electricity service providers are causing significant changes to traditional business models, and policies and business practices are still evolving.

The need to cut emissions across the economy, combined with increasingly common distributed energy resources, will create a new paradigm. Instead of forecasting demand and meeting it with controllable supply (fossil fueled generators), we are moving to an era of forecasted supply (such as wind and solar) and controllable demand.

As California's energy system grows to accommodate new energy demands and a shift to more renewable resources, the grid and associated regulatory bodies and energy markets face critical challenges to help balance competing concerns: reliability, affordability, and environmental and social issues. This paper aims to provide background on the state's power system and these associated concerns as state lawmakers look to develop policies that will shape the future of California's clean energy economy.

1 The three IOUs include San Diego Gas & Electric (SDG&E), Pacific Gas & Electric (PG&E), and Southern California Edison (SCE).

FEATURES OF CALIFORNIA'S POWER SYSTEM

California's electric power system, and the western U.S. electrical grid of which it is an integral part, is an engineering marvel.

Like all power systems, it has to balance supply and demand in every instant, be reliable, resilient, and affordable. But what makes California's grid stand apart from other regions of America and the world is its tremendous diversity.

Electricity supply in many states is dominated by only one or two fuel sources. California gets energy from natural gas, large hydro, nuclear, solar photovoltaic (PV), wind, geothermal, biomass, small hydro, solar thermal, coal, petroleum coke, waste heat, and oil – in that order.

California is also unique for its leadership on clean energy. California is the birthplace of the global wind energy industry; the leading state in the country for solar, geothermal, and biomass energy; the most energy efficient state per capita and per GDP; and one of the cleanest in terms of emissions per megawatt-hour (MWh).[2] The state is even home to the world's largest solar rooftop at the new Apple Headquarters in Cupertino, with panels from SunPower, based in San Jose.[3]

California is full of business and technology innovators in the energy space, from start-up tech firms to Silicon Valley giants who are jumping in to energy issues. Apple and Google now power their global operations entirely with renewable energy.[4] Tesla, based in Fremont, is a global leader in electric vehicles and energy storage, as well as the leading US distributed solar company.

California's diverse and innovative power system is due in part to the state's varied natural resources, including mountains, forests, deserts, oil and gas deposits, active geology, and the Pacific Ocean. It is also due to historical factors and decisions to innovate in both policy and technology. But most of all it reflects the will of the people – citizens, voters, entrepreneurs, activists, policymakers, and customers – to reduce greenhouse gas emissions from the power sector. Polls have shown consistent strong support for climate action. In the most recent poll by the Public Policy Institute of California, 81 percent of residents view global warming as a very serious or somewhat serious threat to the state's future economy and quality of life. Two-thirds support state efforts to cut carbon emissions, independent of the federal government.[5]

This issue brief is intended to provide an introduction to the California power system that is accessible to the lay reader, enabling Californians and key decision makers in the state to understand the issues facing California's power system. It is part of a series of briefs designed to provide an overview of key policy and technology considerations facing the future of California's energy grid.

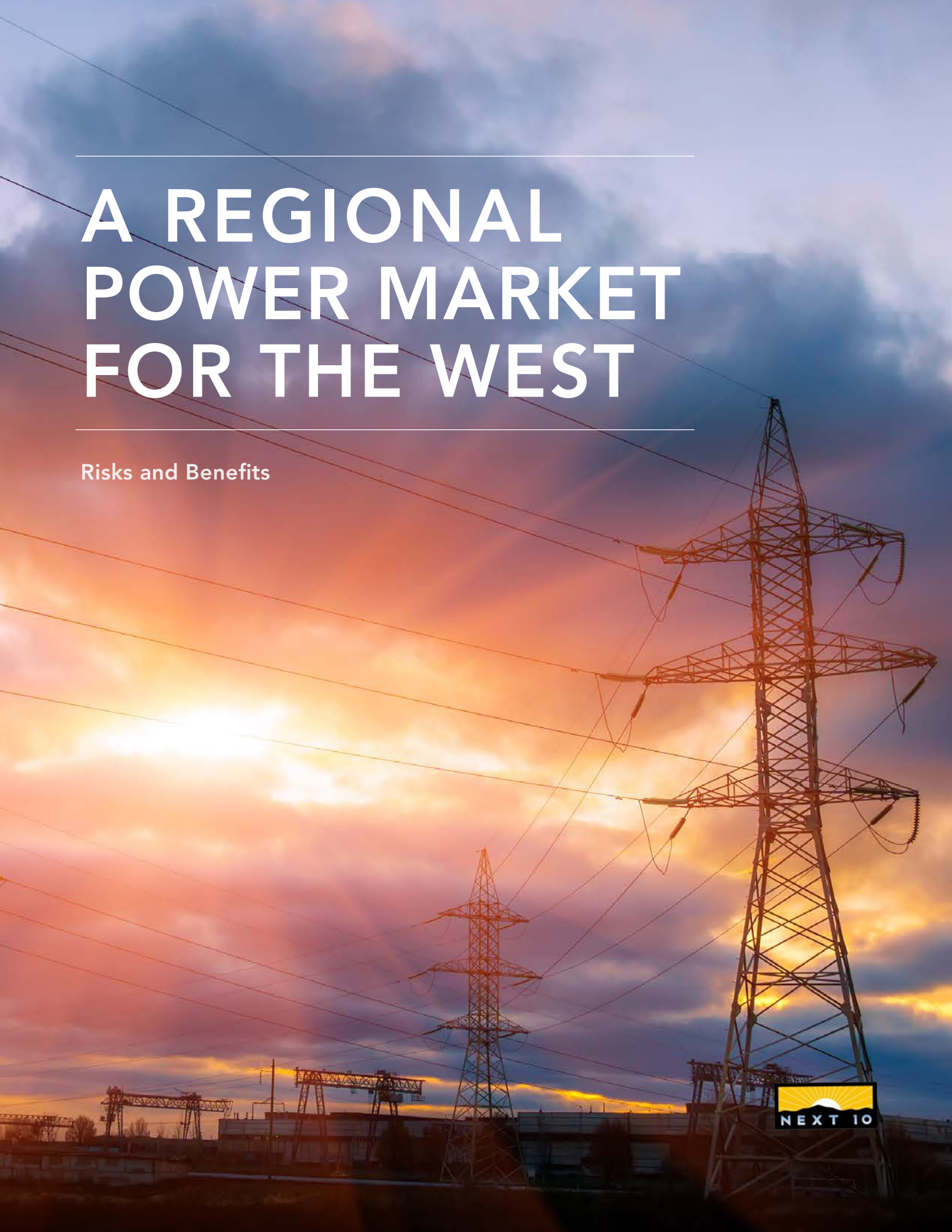
To provide an overview of California's power system, this brief will first walk readers through the basics of how the power system works, including the technical, regulatory, and financial aspects. A discussion of various important environmental and social issues that are impacted by energy use will then be provided. Lastly, the authors will look at some visions of the future, and how the state might address the biggest energy problem of this generation—climate change—while maintaining a reliable and affordable power supply.

2 See Next10's 2017 California Green Innovation Index, for example, at http://next10.org/2017-gii.

3 Kyle Graycar, "Apple's New Campus Hosts the Country's Largest Solar Commercial Project," Pick My Solar, May 3, 2017, https://blog.pickmysolar.com/apples-new-campus-country-largest-solar-commercial-project

4 Apple, "Apple now globally powered by 100 percent renewable energy," press release, April 9, 2018, https://www.apple.com/newsroom/2018/04/apple-now-globally-powered-by-100-percent-renewable-energy/. Google, "100% renewable is just the beginning," undated, https://environment.google/projects/announcement-100/

5 Public Policy Institute of California, "Californians' Views on Climate Change," January 2017, http://www.ppic.org/publication/californians-views-on-climate-change/



A REGIONAL POWER MARKET FOR THE WEST

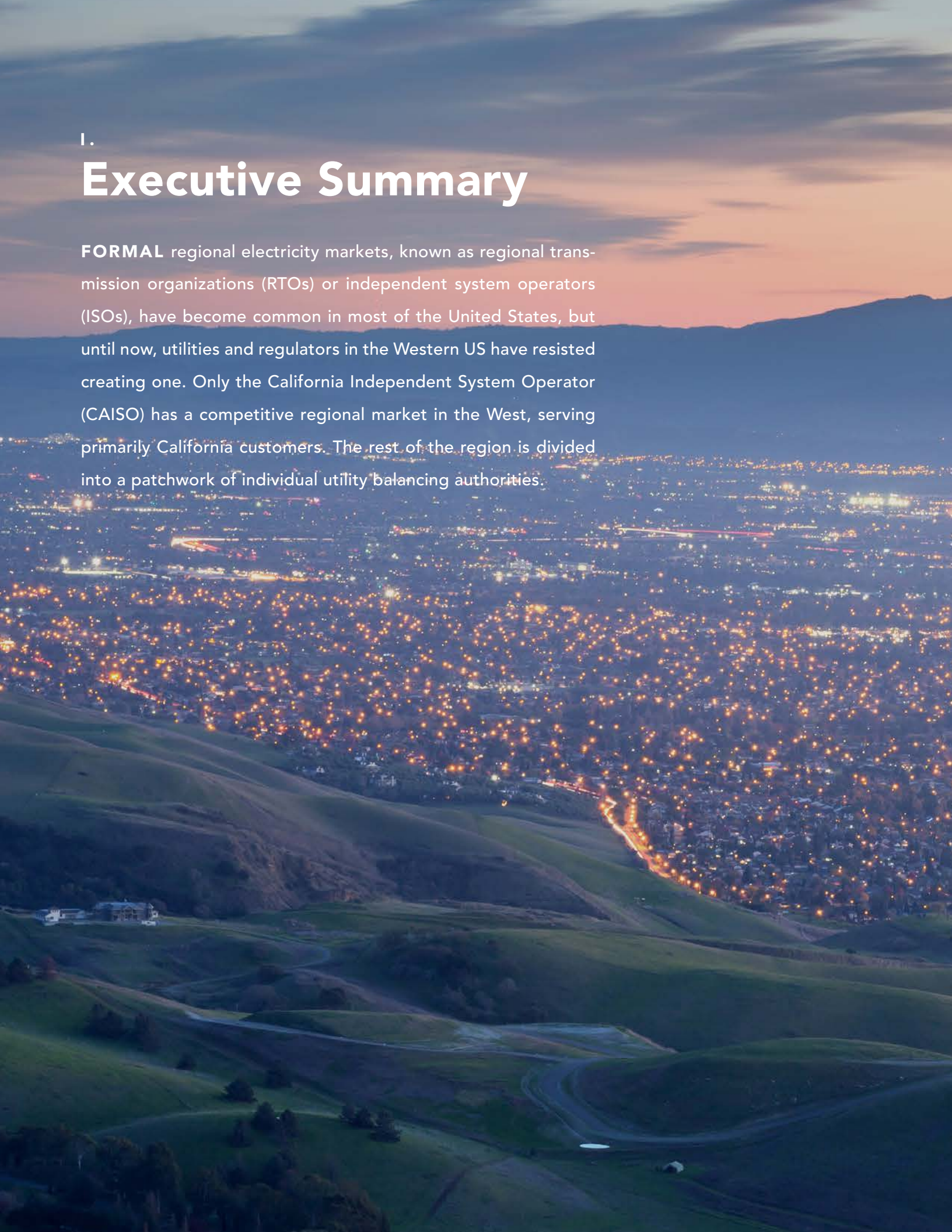
Risks and Benefits

NEXT 10

I.

Executive Summary

FORMAL regional electricity markets, known as regional transmission organizations (RTOs) or independent system operators (ISOs), have become common in most of the United States, but until now, utilities and regulators in the Western US have resisted creating one. Only the California Independent System Operator (CAISO) has a competitive regional market in the West, serving primarily California customers. The rest of the region is divided into a patchwork of individual utility balancing authorities.



With the growth of renewable energy and aggressive goals to decarbonize the power system in California, parties are taking a new look at whether a regional power market would help integrate more variable wind and solar energy in order to avoid curtailment and reduce reliance on natural gas for power generation.

The debate, which has been going on literally for decades, has been put high on the agenda by Governor Jerry Brown, who sees it as critical for meeting climate goals. The election of President Donald Trump, who has proven to be antagonistic to California's policies across the board, may add a new element of risk, since the Federal Energy Regulatory Commission (FERC) – an independent agency but one whose commissioners are appointed by the president – will need to approve the rules and governance of a regional market. Recent actions by the US Department of Energy to prop up at-risk coal and nuclear plants on reliability and "national security" grounds are also causing concerns, though they have been rejected by FERC so far.

The proposed vehicle for expanding CAISO into a regional entity is Assembly Bill 813, which has been pending in the legislature for nearly two years. Proponents of the bill, primarily clean energy industry and environmental groups, emphasize the technical and economic merits of a regional grid. They say it would increase the state's ability to develop renewable energy and cut carbon emissions at the lowest cost. The smaller group of opponents, chiefly labor groups plus the Sierra Club and TURN, emphasize potential risks to governance and the loss of renewable energy construction jobs to other states.

This paper attempts to capture the debate as objectively as possible, to help policymakers understand a deeply complicated set of legal, economic, and technical issues. The paper has a substantial amount of background about how electricity markets function, how they are regulated, and what is happening with the California power grid.

The main focus, though, is on the debate for and against regionalization. To simplify the debate, this brief focuses on the key arguments on each side.

The Case For Regionalization

Regionalization has a large number of supporters, including Governor Brown, CAISO, and members of two coalitions, the Fix The Grid Coalition and Secure California's Energy Future, made up primarily of clean energy industry and environmental groups. They cite the following arguments in favor of a regional RTO.

1. Easier Integration of Renewables

A bigger, more liquid, and transparent market would enable easier integration of wind and solar power, and help meet the state's renewable energy and climate goals at the least cost. It would allow California solar to be exported rather than curtailed, and enable access to a greater variety of excellent resources, such as wind energy in Wyoming, Montana and New Mexico.

2. Manage and Use Existing Transmission Better

A Western RTO would enable more efficient use of existing transmission lines, through increased transparency and competition. Eliminating duplicative transmission fees would lower costs. It would also create a more unified and efficient process for planning and allocating costs from transmission lines that cross state borders, which are currently regulated by individual states. By weighing all options across the region, only the most necessary new lines would be built.

3. Reduce Operational Costs

As shown by the $330 million saved to date by the CAISO's Energy Imbalance Market (EIM), shared operations in a Western RTO can cut operational expenses. Utilities can share reserves, reducing the number of power plants they need to keep on standby. A bigger pool also reduces the variability caused by demand and by wind and solar power, smoothing it out over a larger number of customers and geographic area.

4. Improve Competition, Choice, and Consumer Savings, Growing Jobs

A transparent regional market would facilitate greater competition between generators, which would help cut utility bills. One study found that savings could rise to $1.5 billion per year for California consumers by 2030. Lower power costs would spur job creation across the economy.

5. Put Competitive Pressure on Coal-fired Plants

A regional market will also increase pressure on the least competitive power plants, which are often the oldest and least efficient. In competitive markets in other parts of the country, older coal plants are retiring in large numbers in the face of lower cost natural gas, wind, and solar power. The West's excellent wind and solar resources will be strong competitors with existing coal and natural gas power plants, including some in California, helping reduce local pollution in-state.

The Case Against Regionalization

Opponents to regionalization include labor unions, the Sierra Club, The Utility Reform Network (TURN), and some municipal utilities.

1. Governance

The current CAISO board is appointed by the governor and approved by the state Senate, though it is a non-profit corporation, not a state agency. CAISO has a strong connection to state policies and coordinates with state energy and environmental agencies. A regional RTO would have a board strictly independent of all stakeholders, including policymakers, with state regulators represented on an advisory committee. Opponents of regionalization fear this would decrease control by state policymakers.

2. It Could Undermine California Policies

An independent regional RTO would have to consider the policy needs of any Western states whose utilities join, rather than working solely with California. Opponents fear this would compromise state policies, and expose California to attacks from other states and to greater scrutiny by FERC.

3. It Could Increase Sales by Regional Coal Plants

California imports about nine percent of total demand from coal plants in other states. While coal has been in decline nationally, opponents say a regional power market could help these old coal plants, and drive up carbon emissions. They fear that Trump Administration proposals to prop up uncompetitive coal plants would be more likely to succeed in a regional RTO.

4. It Could Shift Construction Jobs to Other States

California's renewable portfolio standard (RPS) requires at least 75 percent of renewable electricity to be delivered directly into the CAISO grid, meaning it must be located in or near CAISO. Expanding the RTO to a broader region would make more out-of-state projects eligible, thus shifting construction jobs to other states.

5. There are Other Ways to Integrate Renewables

While opponents of a Western RTO concede that a regional grid could help integrate renewables, they argue that California has many other ways to do that, using distributed energy resources like rooftop solar, energy storage systems, controllable demand (known as demand response), and electric vehicles that can be tapped to provide grid services when they are plugged in. They argue that relying more on distributed energy than on regionalization could improve reliability, create more jobs in California, and capitalize on the state's competitive advantage in advanced technology.

Tradeoffs and Takeaways

Not all of these arguments are equal or deserving of the same consideration. Some, such as fears of what FERC or the Trump Administration may do in the future, are speculative, so cannot be proven one way or another.

But all of the issues raised involve tradeoffs and options that will require further decisions down the road.

Key takeaways include:

1. JOBS: A regional RTO would facilitate regional development of renewables, which could mean construction jobs happening in other states to meet California's needs. However, those projects, especially wind farms, would lower the cost of electricity for all Californians and create a more diverse energy supply, which would ease integration.

Research shows that cheaper electricity would lower costs for business, creating a much larger number of jobs across the California economy. Lower costs come from developing the best resources in the region, rather than restricting development to California. On the whole, studies say that regionalization would lead to greater job growth in California.

2. GOVERNANCE: There is a perception that moving from a state RTO to a regional RTO would mean state policymakers would be giving up control.

It is true that a regional RTO would need to have a staff and board that were fully independent, from both market participants and from policymakers. The point of independence is to insulate the regional market from political interference and control by market participants.

But CAISO, despite having a board appointed by the governor, is already independent from stakeholders. Because it has been responsive to state policy goals, some people think of it as a state agency, regulated by state policymakers. But it is not, and hasn't been for almost two decades. A regional RTO, just like CAISO, would have to operate under a framework of FERC orders and federal law that require cooperation, free trade, and fair competition.

3. THREATS TO POLICY: Threats to California state policies are the same whether or not the state is part of a regional RTO. FERC already has jurisdiction over CAISO and interstate electricity sales. Most legal challenges to clean energy policy happen under interstate commerce rules, not under RTO or FERC rules. FERC must follow federal law and all decisions are subject to appeal to the courts.

The primary goal of federal law and FERC policies is to facilitate competition, as a way to ensure "just and reasonable" rates. State policies that don't interfere with competition are unlikely to run afoul of FERC challenges. Clean energy policies, like RPS, can be crafted to be compatible with federal rules.

4. INTEGRATING RENEWABLES: There are no technical absolutes about how renewable energy can be integrated. Bulk solutions, such as transmission lines and regional markets, are the traditional way to manage the variability of wind and solar. Distributed energy resources, like batteries and demand response, can also be used to integrate renewables, and they are increasingly affordable and capable.

A bulk approach is still a lower cost option than one that relies heavily on distributed energy, but the two need not be mutually exclusive. Most distributed energy resources are in their infancy, and wide-scale adoption will take time, based on current costs and trends. Unfortunately, a distributed-intensive scenario was not included under the SB350 studies mandated by the state to investigate a western RTO, nor has it been adequately studied by other agencies, labs, universities, or think tanks. A detailed study should be undertaken to better understand the potential of distributed energy to help decarbonize the grid reliably and affordably.

Given the benefits of both bulk and distributed approaches, it is likely that a high-renewables future will include more of both.

5. MORE, OR LESS, COAL?: Coal power is in decline across the country, and especially in competitive markets. The argument that coal would thrive in a regional RTO relies largely on market failures and poor decisions by regulators, and on the threat of future action to undermine competitive markets – not on the presence of greater regional competition. Given the enormous amount of high quality renewable energy resources across the West, and the relatively small amount of coal power plants, it is hard to envision coal succeeding in a truly competitive market, so long as rules do not unfairly favor incumbent or obsolete technologies.

Conclusion

There is strong agreement in California about clean energy and climate policies, but not on the vexing question of whether a regional power grid would be a good, or necessary, way to reach those goals. Support for regionalization is strong, but concerns remain.

With clean energy technologies becoming the most competitive options, their growth may well be best served by a larger and more independent power market. Proponents argue that these trends are unstoppable, and a formal regional market will simply accelerate the domination of wind and solar in the Western power system. Opponents counter that a regional market will disconnect state policy from market operations, enhance federal moves to prop up coal plants, and drive construction jobs to other states.

In either case, RTOs have a limited ability to set electricity sector policies. States play a much more prominent role, making procurement decisions, setting emissions policies, and determining retail rates. While it is not always an easy process, RTOs around the country have generally accommodated state policies on clean energy. And in the end, participation in an RTO is voluntary; utilities and states can withdraw if they are unhappy.

The research in this paper is intended to inform the debate around a regional grid by presenting arguments and evidence in a straightforward summary. This analysis explores complex legal, policy, and engineering issues, to shed light on the debate and help further inform discussions.

Adding to the difficulty for policymakers is the asymmetrical nature of the debate: technical arguments on integrating renewables and cutting carbon, on the one hand, versus governance issues on the other. Weighing this apples-to-oranges comparison will be necessary in deciding whether to move toward a regional grid.

In the meantime, the success of CAISO's Energy Imbalance Market has helped the region evolve toward more cooperative and competitive markets, and increased the comfort level of participating utilities and regulators. The rapidly declining cost of wind and solar is lowering resistance to their adoption, putting more Western states on the same page about what the future will look like.

The trends point toward regional cooperation, but the specifics will need to be worked out in partnership with other stakeholders, and not in a single California bill. The bill is the first step in allowing greater regional cooperation to proceed

CPUC Chair Michael Picker has characterized the creation of a coordinated Western market as an evolutionary process. "The success of the EIM was that people can ease into it," he pointed out during a 2017 CAISO symposium. "The EIM is like living together before you get married, then you get married and buy a house."

ELECTRIC VEHICLES AND THE CALIFORNIA GRID

I.

Executive Summary

TRANSPORTATION is the single largest source of greenhouse gas (GHG) emissions in the state of California, as in many other major economies throughout the world. While California has seen marked success in decarbonizing its electricity sector, emissions from transportation have not seen a similar decline and, despite having the strongest clean transportation policies in the nation, have increased slightly in recent years. In fact, these emissions increased 1.8 percent between 2015 and 2016 despite an overall emissions reduction of 2.8 percent. In order to achieve the steep GHG emissions reduction goals set forth by landmark climate policies Assembly Bill 32 and Senate Bill 32, California must ensure the transportation sector delivers significant emissions cuts.

To that end, a variety of policies have been implemented to help electrify the transportation sector – from passenger vehicles to high speed rail. In his final "State of the State" address, Governor Jerry Brown announced a new electrification target: getting 5 million zero emission vehicles on the road by 2030.

As vehicle manufacturers and nations around the world move from internal-combustion engines to zero-emission vehicles (ZEVs), vehicle automation and greater utilization of mobility-on-demand services like ride-hailing are further disrupting transportation systems. As the state looks to add hundreds of thousands of electric vehicles to the grid each year, California's electricity system will need to evolve to accommodate shifting demand patterns and increased electrification of transportation.

Part of a series of briefs analyzing key issues facing the future of California's grid, this brief investigates trends in the electrification of the transportation sector along with mobility and charging infrastructure trends to determine the impacts policy leaders should be aware of and the strategies that can optimize grid performance as more electric vehicles hit the road.

Key takeaways include:

- **Electricity demand will increase only modestly as electric vehicles (EV) sales surge.**
  - » California currently has about 369,000 plug-in electric vehicles (PEVs)—including both fully battery electric vehicles and plug-in hybrid electric vehicles—on the road but is predicted to reach more than five million PEVs on the road by 2030.
  - » The California Energy Commission forecasts that 3.9 million PEVs will add about 15,500 GWh of charging demand, equivalent to about five percent of California's current total annual energy load.
- **Transportation trends towards automation and increased usage of mobility services like ride-hailing could rapidly expand the share of electric vehicles on the road, further increasing electricity demand.**
  - » The estimated share of total light-duty vehicle VMT from ride-hailing vehicles is growing rapidly nationwide - currently about 6 percent in the U.S. – and could double from 10 percent to 20 percent of total VMT between 2018 and 2020.
  - » If these companies move toward PEVs, critically important to decarbonize transportation, charging infrastructure needs and grid impacts would increase substantially. While ride-sharing companies are expected to complete 12 billion rides this year in the U.S., only one percent of the estimated 334 million total trip miles on the Uber and Lyft platforms in California were in an electric vehicle (in Q3 2017).
- **The growth of EVs in California will require upgrades to the energy system, but the long-run costs are likely to be low, when compared to the benefits.**
  - » As PEV adoption levels grow, there will be impacts to both the distribution system as well as the bulk power system. To date, the actual cost of distribution system upgrades as a result of added PEVs has been small: in 2017, PEVs caused only about 0.01 percent of total distribution system upgrade costs.
  - » A detailed analysis of the grid system and geographic distribution of future PEV sales found that the annual PEV-related distribution costs through 2030 are estimated to be only about one percent of the combined distribution revenue requirement of the three IOUs and SMUD (Sacramento Municipal Utility District).
  - » While upgrade costs to these systems as a result of added PEVs have been minimal thus far, that could change with greater adoption rates.

- New management strategies can help optimize the potential benefits and minimize the potential risks that added EV demand will present.
  - » Managed charging programs could alleviate stress on the distribution grid, lower wholesale operating costs, and serve as a resource to help integrate more intermittent renewable energy.
  - » Smart charging could deliver significant benefits: the authors' analysis found that when 2.5 million PEVs were added to the system, grid dispatch found that smart charging of all the vehicles could avoid 50 percent of incremental power system operating costs and reduce renewable energy curtailment by 27 percent annually, relative to when the charging of the same number of PEVs is left unmanaged.
  - » According to results from the CPUC's Integrated Resource Planning model, flexible PEV charging can yield total system resource cost savings of $100 - 200 million dollars per year and a reduction in renewable energy curtailment, compared to unmanaged PEV charging.
  - » EV batteries could provide a source of energy storage to the grid, and the CPUC should consider recognizing this value. In practice, due to the high value placed on mobility by PEV users, relying on EV batteries alone for grid storage is fraught with risk. The precipitous decline in battery prices makes it increasingly feasible for stationary battery storage to cost effectively provide distribution system support, load-shifting, and ancillary services, without the risks of managing a highly valuable mobile battery asset.

To ensure that California can meet its ZEV goals while maintaining an affordable and reliable electricity system, certain policy levers might be considered to optimize this transition. These include:

- Ensure that autonomous vehicles and mobility-on-demand services do not lead to increased GHG emissions while working to increase the overall level of electrification of the transportation sector.
- Increase the accessibility of charging infrastructure, which is paramount to increasing EV adoption rates.
  - » Focus financing and support to increase the deployment of fast chargers to support the electrification of medium-, heavy-duty and ridehailing vehicles.
  - » Focus incentives on lowering the installation and equipment costs for multifamily and public charging stations.
  - » Create a centralized, public database that tracks the cost, location, and utilization of home, multifamily, work, and public chargers by power level.
- Increase participation in existing and upcoming load management opportunities such as time-of-use (TOU) rates and smart charging programs.
  - » Design PEV-specific TOU rates with longer off-peak periods and bigger price differentials.
  - » Conduct more smart charging pilots.

This brief is intended to help provide background on how mobility, charging infrastructure, and energy management trends could influence the future management of PEVs on California's grid. The state's energy-related agencies and regulators, utilities, automakers, aggregators/demand response providers, and scheduling coordinators will need to work together to enable PEV grid services.

The Growth in COMMUNITY CHOICE AGGREGATION

Impacts to California's GRID

UCLA Luskin School of Public Affairs
Luskin Center FOR INNOVATION
NEXT 10

I.

Executive Summary

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

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

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

Key takeaways include:

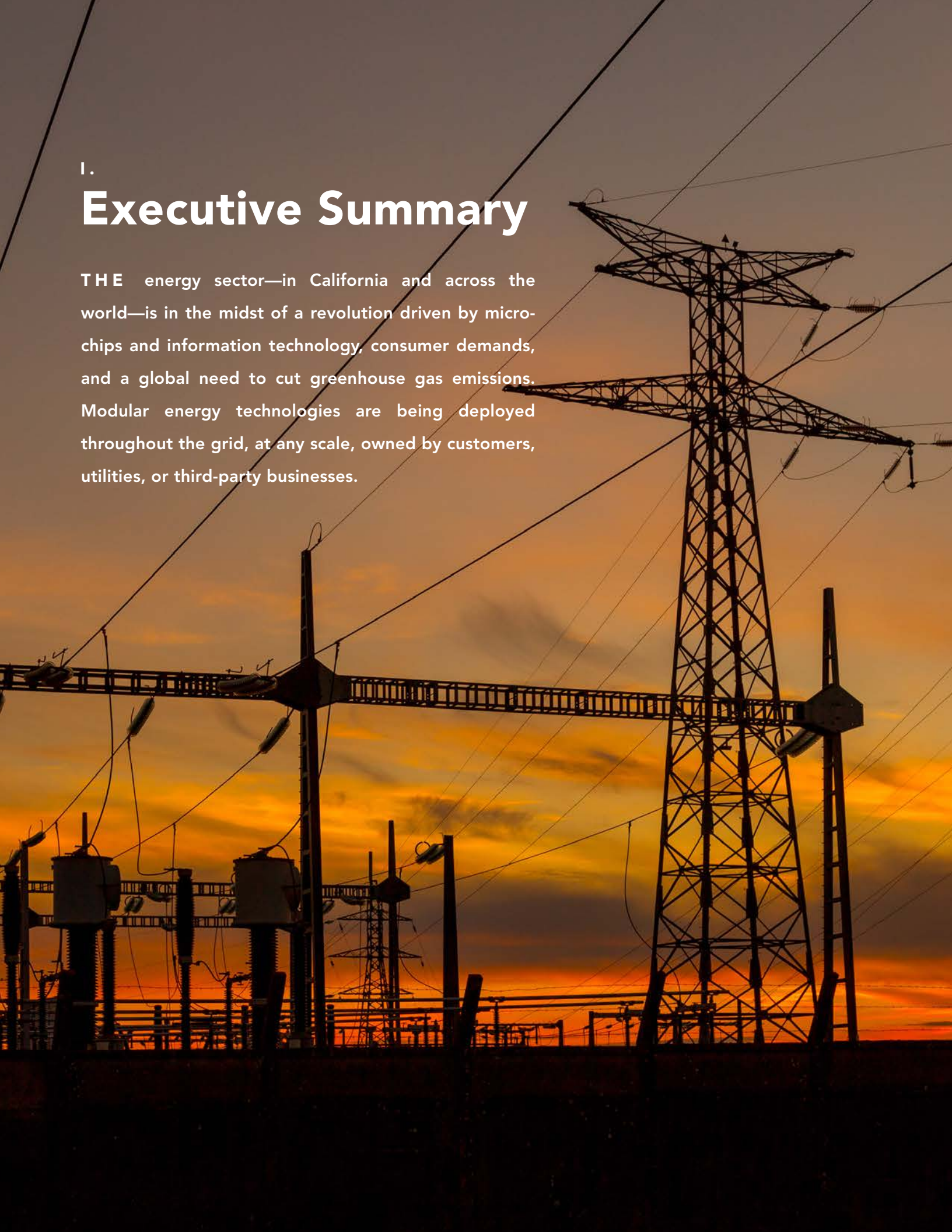
- **CCAs are relatively new, but on the rise**
  - » The cumulative share of CCA load in California is currently about 10 percent of the total state electricity consumption and should rise to 16 percent by 2020.
  - » Since the launch of the first CCA in 2010 (MCE), the number of CCAs launching per year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

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

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

THE GROWTH OF DISTRIBUTED ENERGY

Implications for California



I.

Executive Summary

THE energy sector—in California and across the world—is in the midst of a revolution driven by micro-chips and information technology, consumer demands, and a global need to cut greenhouse gas emissions. Modular energy technologies are being deployed throughout the grid, at any scale, owned by customers, utilities, or third-party businesses.

Enabled by software and wireless communications, these distributed energy resources (DERs) are able to serve both end-use customers and grid managers, often at the same time. Consumers are merging with producers to become "prosumers," replacing the old paradigm of one-way buyer-seller transactions.

With an increasing amount of variable renewable energy sources being added to the California grid, the growth of DERs offers the potential to increase reliability and efficiency and to reduce costs and emissions. But DERs also raise a number of challenges.

WHAT ARE DERS?

Distributed energy resources compose a suite of diverse technologies that have one thing in common: they are modular replacements for traditional "central station" energy technologies.

This brief look at six categories of DERs:

1. **Distributed generation:** Small electric generators, including solar panels, wind turbines, fuel cells, gas turbines, and internal combustion engines that can be sited on the customer side of the meter or tucked into the distribution grid where they are most needed. California has seen significant growth in distributed solar generation, with a total of over 800,000 customers with rooftop solar systems, providing over 6,500 MW of capacity. The state has been adding 100,000 systems annually and in May 2018, the California Energy Commission added rooftop solar as a building code requirement, which could lead to an additional 75,000 installations per year.

2. **Demand response and targeted energy efficiency:** Controlling electricity demand is another way to bring supply and demand into balance. Energy efficiency measures can be targeted to deliver specific grid benefits. California is a world leader on energy efficiency, with investor-owned utilities spending more than $700 million on efficiency programs and measures per year. But more needs to be done to target energy efficiency investment toward integrating renewables and on demand response. Recent research suggests California could save an additional $750 million a year from more sophisticated demand response programs.

3. **Energy storage:** Energy can be stored as electricity, heat, ice, and other forms. This paper focuses on batteries, which are emerging rapidly for use in electric vehicles, but can also be used in stationary applications. Ninety percent of the nation's small-scale energy storage is in California, and almost half of the large-scale installations. But this will change soon: in June 2018, PG&E announced the world's largest battery project, to be installed near Monterey Bay in place of three natural gas power plants.

4. **Electric vehicles as grid tools:** When electric vehicles (EVs) are parked and plugged in, their batteries can serve as both demand response and energy storage. With California aiming for five million EVs on the road by 2030, there will be a huge opportunity to tap them for grid services. As EV batteries wear out they can live a "second life" as stationary batteries.

5. **Communication and control technologies:** Smart grid technologies enable better visibility and control into the transmission and distribution systems, as well as into customer's buildings and appliances. What can be seen and controlled can be used to save energy and money, and provide grid services. The biggest current trend in smart grid investment is to automate distribution system controls, with nearly $2 billion invested nationally last year, including nearly $250 million in California.

6. **Microgrids:** DERs can be bundled together, creating small grids within the big grid. Microgrids can improve reliability, save money and energy, help incorporate more renewables, and provide grid services. As of early 2017, there were 36 operating microgrids in California, with an additional 80 under construction or planned. Altogether the systems will have over 650 MW of peak capacity, less than one percent of the total in-state generation capacity, but an important resource to help manage grid reliability.

While DERs can work together, they can also compete with each other. Demand response and storage, for example, can both provide services to a utility or grid operator by reducing demand for generation at key times. Stationary batteries compete with batteries on wheels, in electric cars.

They also compete with large-scale generation, transmission and distribution lines, transformers and meters, and all the rest of the traditional "central station" infrastructure. At the same time, they can supplement and benefit from the traditional grid. While DER enthusiasts see a future with no transmission lines and big power plants, others see a hybrid approach that taps the best of both worlds.

CHALLENGES

The growth of distributed energy is creating many opportunities, but also many challenges. For example:

- It can be hard to do electric system planning since so many decisions are made by customers rather than planners, utilities, or regulators, and customer decisions can be hard to predict. While transmission and generation planning is a highly refined art after many years of experience, distribution system planning (DSP) is in its infancy.
- One difficulty with distribution system planning is that traditionally there has been little visibility into the distribution system. If DERs are going to be a distribution resource, there is a need for greater monitoring and communications to know what is happening at the distribution level, and new methods to place a value on DER deployment.
- For DERs to be deployed, their value must be monetized. Many DERs can create a stack of values that cut across different markets and jurisdictions, from the customer to the distribution grid to the wholesale market. DERs need access to these different levels in order to be monetized.
- The value of DERs can change with deployment. If storage is used to alleviate grid congestion in a pocket of the grid, then subsequent DERs in that area are worth less. The growth of solar is driving down the value of more solar, since the panels all produce power at the same time.
- DERs cause a shift in revenues away from traditional energy companies and technologies, who will fight to protect their market share. Utilities are promoting changes to rate designs across the country to counter the financial effect of DERs.
- Energy incumbents have an incentive to minimize the value of DERs to customers, as DERs compete with utility-owned investments. Yet incumbent utilities hold powerful sway over the regulatory process, with access to more information about the grid and their customers than any other parties involved in a regulatory proceeding. They can use this "information asymmetry" to win outcomes that suppress DERs in favor of utility solutions.

These challenges are being addressed in a multitude of utility commission and federal proceedings, legislation, and court cases, as well as in the marketplace, every day, by startups, tech giants, utilities, and customers.

RESPONSES

In this brief, the discussion of each category of DERs includes an overview of the technologies, a quick look at their deployment in the U.S. and in California, and a summary of California state policies.

Some policies affect all DERs, such as the design of retail electricity rates, interconnection rules, access to wholesale markets, and planning. Other policies are tailored to help specific technologies, such as mandates, procurement dockets, and valuation policies.

Because DERs are a diverse and growing set of technologies, with entrepreneurs developing new business cases every day, the policy landscape is also diverse and rapidly evolving. In the interest of readability and comprehension, this paper is nowhere near comprehensive. California alone currently has 15 dockets open at the state utility commission to deal with various aspects of DER deployment and regulation.

DERs have been the primary topic of discussion at industry conferences, at commission hearings, and in the trade press and academic literature for the past decade. They have been called a "disruptive challenge" and "restructuring 2.0," as momentous as the switch to competitive electricity markets that began in the 1990s.

Therefore, consider this paper a brief introduction to the growing world of distributed energy.

To view the full text of each of the briefs in this series, please visit www.next10.org/ca-grid