

AN ASSESSMENT OF ELECTRICITY SECTOR REFORMS TO
ACHIEVE CALIFORNIA'S ENERGY GOALS

A Thesis

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by

Grant Austin Mack

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by

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Department of Public Policy and Administration

Abstract
of
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A wide range of factors, including emerging technologies, pioneering environmental policies, relatively high electricity rates in electric investor-owned utility territories and an inefficiently operated electric system are applying pressure to California's electricity sector and challenging the ability of the state to achieve its high-level energy goals for this sector. Addressing these issues and achieving the state's high-level energy goals will require the state's electricity sector to adapt. This means that there is a need to develop and enact new policy actions and structural reforms.

In this thesis, I examine three new structural reforms to California's electricity sector to address the issues stated above and achieve the state's high-level energy goals for this sector – affordable, efficient, reliable and environmentally responsible electric service. The structural reforms analyzed include strengthening the existing regulatory framework for the state's electric investor-owned utilities, creating and expanding the competitive wholesale and retail electric power markets, and a hybrid approach that combines elements of both structural reforms. I assessed each of these structural reforms against how well they met the state's high-level energy goals for its electricity sector and thereby addressing the issues stated above. This assessment is comprehensive and exploratory with the intent of helping frame policy discussions focused on improving California's electricity sector.

However, based on my assessment, the hybrid approach was the best structural reform to achieve the state’s electricity sector high-level energy goals and address the issues stated above. Recognizing the issues California’s electricity sector faces and the challenges they pose to the state to achieve its high-level energy goals for this sector, it is not a matter of if California’s electricity sector will evolve, but how and when.

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Chapter 1

INTRODUCTION

California's economy and the quality of life it provides hinges in part upon the state's ability to ensure reliable electricity to customers that is resilient to external factors, produced with little environmental impact, delivered efficiently and affordable. Over the last several decades, California has responded to issues that challenge these high-level energy goals by initiating various structural reforms - changes to how government affects and interacts with the economy - to its electricity sector. These reforms have created and disrupted governing institutions and the traditional electric utility business model. While some of these reforms have been successful, others have not. This thesis explains these structural reforms throughout the history of California's electricity sector that are primarily focused on the state's electric investor owned utilities (IOUs), the emergence of the state's high-level energy goals for this sector and current issues that challenge the state from achieving these same goals.

This thesis then presents three new electricity sector structural reforms that may assist the state in achieving these high-level goals for this sector. I developed and selected these three new structural reforms based on literature that influenced past reforms, existing practices, and initiatives currently underway to modify segments of California's electricity sector. I also selected the state's high-level energy goals based on the themes that emerged throughout the evolution and history of California's electricity sector. These goals are not specific policy goals but are the primary outcomes that government policy actions seek to achieve for the electricity sector. I then systematically assess how each of the three new structural reforms may help the state achieve its high-level energy goals. Though I do conclude with a recommendation, this thesis is meant to be comprehensive and exploratory with the intent of framing policy discussions focused on improving California's electricity sector.

California's electricity sector is very much a product of its history. This economic sector has undergone significant transformation since the early 1900's when electricity started to become the ubiquitous energy resource for modern society. The rapid growth of California's electricity sector in the early 1900's and the monopolistic market power electric IOUs exercised over their customers became the original impetus for government intervention. This first wave of structural reform came in the form of direct regulatory oversight by the state through the creation of the California' Public Utilities Commission (CPUC), which was responsible for ensuring that the state's electric IOUs (Pacific Gas and Electric, Southern California Edison and San Diego Gas and Electric) delivered electricity efficiently, at affordable prices and maintained reliable service. Achieving these three high-level energy goals became the primary focus of government intervention during this period.

The second wave of California's electricity sector structural reforms began in the 1970's in response to electricity supply shortages and price (rate) increases, tightened environmental standards and the projected unsustainable growth in demand for electricity (Joskow, 2000). These issues challenged the ability of the state to achieve three of its high-level energy goals - affordable, efficient and reliable electric service. A new high-level energy goal also emerged during this period, environmental responsibility. The reforms initiated during this period focused on solving these issues and achieving these high-level goals by creating new governing institutions, developing alternative sources of electricity and long-term planning (CEC, 1977). It was in 1974 that the California Legislature created the California Energy Resources Conservation and Development Commission (California Energy Commission) as the state's primary energy policy and planning agency. The California Energy Commission (CEC) was responsible for devising new approaches and strategies for achieving the state's growing electricity demand by encouraging the development of natural-gas fueled and renewable electric generation, such as

geothermal and wind, in combination with energy efficiency (CEC, 1977). The CEC's electricity demand forecasts also became the guiding framework for long-term electric system infrastructure planning and development for most of the state's electric utilities. California's structural reforms of the 1970's helped the state achieve efficient, reliable and environmentally responsible electric service, tempering many of the concerns associated with the rapid growth in electricity demand, supply shortages and the fear of rampant environmental degradation from overinvesting in electric system infrastructure. However, electricity rates continued to remain high relative to other states, compromising electric service affordability (Joskow, 2000).

These high electricity rates further encouraged the state's intervention in the business practices and affairs of its electric IOUs. This third wave of structural reform began in the early 1980's and was primarily focused on reducing these electricity rates to achieve the state's high-level energy goal of affordable electric service, by restructuring the roles and responsibilities of the state's electric IOUs (Weare, 2003). By the early 1990's, economic theorists proposed the creation of new governing institutions, management structures and mechanisms to encourage the proliferation of non-utility third-party electric generators (independent power producers) within California's electricity sector (Joskow, 2000). These proposed initiatives were aimed at transforming California's electricity supply chain (generation, transmission, distribution and sale) from a vertically integrated structure controlled by the electric IOUs, into a highly competitive structure with multiple market actors. Economists argued that full restructuring, both on the wholesale side of the electricity supply chain (generation and transmission) and the retail side (distribution and sale), and the introduction of competitive market forces would weed out economic inefficiencies and reduce electricity rates to California customers (Joskow, 2000). The CPUC and the state legislature embraced these proposals and initiated many of them throughout the late 1990's.

However, the implementation of these structural reforms compromised the electric IOU's ability to deliver affordable electricity reliably, leading to statewide rolling electric system outages and economic loss in 2001. The factors that caused California's electricity crisis were complex and interrelated and were debated amongst academics and policy analysts for years. These factors included the poor design of the competitive wholesale and retail electric power markets, regulatory inaction, undue market power of independent power producers, an overall shortage in electric generation and electric system infrastructure limitations and constraints (Weare, 2003). By the summer of 2001, numerous policy actions were enacted by then-Governor Grey Davis, the state legislature and the CPUC to realign electricity supply and demand. These reactive policy actions eventually stabilized California's electricity sector and reinstated electric service reliability. However, what emerged out of the crisis was an electricity sector with a more complex and decentralized structure - structure I call a hybrid-competitive market electricity supply chain (hybrid-market structure).

Today, California's electricity sector has semi-competitive wholesale electric power markets and a non-existent competitive retail electric power market. Despite its complications and complexity, the reactive policy actions of the early 2000's have maintained electric service reliability. However, California's electricity rates are still relatively high and the sector's electric system operates inefficiently and imposes sizeable environmental impacts.

These issues are challenging the state's ability to achieve its high-level energy goals of affordable, efficient, reliable and environmentally responsible electric service. In addition, emerging technological pressures and California's pioneering environmental policies, are applying pressure to the state's electricity sector and further challenging the ability of the state to meet its high-level energy goals for this sector. Addressing these issues and achieving the state's high-level energy goals will require the state's electricity sector to adapt. This means that new

policy actions and structural reforms will likely need to be created and enacted. This thesis will present and examine three new structural reforms for the state's electricity sector that are primarily specific to the state's electric IOUs. These structural reforms include, strengthening the existing regulatory framework, creating and expanding the competitive wholesale and retail electric power markets, and a hybrid approach that combines elements of both structural reforms. This thesis then systematically assesses how each of these three new structural reforms may help the state achieve its high-level energy goals - affordable, efficient, reliable and environmentally responsible electric service.

Before presenting the three new structural reforms, I explore in Chapter 2 the history of California's electricity sector and the emergence of its high-level energy goals. I also present background information about the theory of electricity sector structural reforms, the policy drivers behind these reforms, and the design flaws that contributed to California's electricity crisis in 2001 and creation of its current hybrid-market structure. In Chapter 3, I present information about California's current electricity sector and the issues it faces that are challenging the ability of the state to achieve its high-level energy goals. Then in Chapter 4, I explain my method of analysis and define the state's high-level energy goals for its electricity sector that I will use to assess the three new electricity sector structural reforms I present in Chapter 5. In Chapter 6, I present the results of my assessment. Finally, in Chapter 7 I conclude with the policy implications of my findings and a recommendation. However, the primary intent of my assessment is to help frame policy discussions focused on improving California's electricity sector. Note that I attempted to maintain consistent terminology throughout this thesis. However, many of the terms used in this thesis morph chapter-to-chapter, especially from Chapters 2 to 3. This is primarily due to the evolution of energy policy conversations from one decade to another.

Chapter 2

HISTORY AND BACKGROUND

Chapter 2 explores the history of California's electricity sector and the emergence of its high-level energy goals. Chapter 2 also presents background information about the theory of electricity sector structural reforms, the policy drivers behind these reforms, and the design flaws that contributed to California's electricity crisis in 2001 and creation of its current hybrid-market structure. The first section broadly discusses the basic concepts, historic reforms and structure of California's electricity sector as well as the emergence of the state's high-level energy goals - affordable, efficient, reliable and environmentally responsible electric service - from the early 1900's until the 1990's. The next section presents the theoretical concepts behind electricity sector structural reforms introduced in the 1990's. These reforms were aimed at restructuring this highly government regulated sector dominated by vertically integrated electric investor-owned utilities (IOUs), into a deregulated sector with competitive wholesale and retail electric power markets to help the state primarily achieve its high-level energy goals of affordable and efficient electric service. The following section discusses the policy drivers behind these structural reforms. Lastly, I summarize the literature that explains the design flaws of these reforms, how they contributed to the state's electricity crisis and the eventual creation of the sector's hybrid-market structure.

Affordable, Efficient and Reliable Electric Service -

The Formation of California's Electricity Sector: Pre-1970

The electric system is a key piece of modern infrastructure due to its versatility and ease of transmitting energy in the form of electricity. A constant recurrence in energy history from the late 1880's on is the advancement of electricity into new uses (Buchan, 2010). It has displaced older energy sources, such as gas and candles for lighting, created new communication

capabilities, replaced human muscle power for cleaning and drying clothes, for example, and is powering new and advanced electronic devices, such as computers. The foundation for these advancements can be traced back to the creation of the first electric bulb by Thomas Alva Edison in 1879.

Shortly after Edison's creation, he began to develop the United States' first electric generator in New York City through his newly formed Edison Electric Illuminating Company (Edison Electric Institute, 2014). The first electric generator was built in lower Manhattan and began producing electricity in 1882 (EEI, 2014). Edison's business model for providing electricity to customers was quickly adopted and modified by others interested in this emerging industry. By the late 1890's, private investors were funding the creation of electric utilities throughout the United States. These private electric utilities came to be known as electric IOUs.

Due to the monopolistic market power they exercised over electricity prices (rates), these entities became subjected to "cost of service" or "rate of return" regulation by state public utility commissions beginning in the 1920's. This was the first wave of government driven reform introduced into the electricity sector that helped California, and other states, achieve its high-level energy goals of affordable, efficient and reliable electric service for this sector. This regulatory structure granted electric IOUs exclusive rights to serve customers within defined territories. However, they were also obligated to serve each and every customer within their territories. In addition, the electricity rates they charged their customers were subject to review and approval by state public utility commissions. These commissions were responsible for ensuring that the electricity rates charged by electric IOUs justifiably reflected prudent investments in electric generators and electric system infrastructure to meet electricity demand. These commissions were also responsible to decide a fair "rate of return" to electric IOU private investors/shareholders that would be passed on and included in their electricity rates (Jamison, 2007). One of the main

reasons for allowing and deciding upon a “rate of return” for electric IOU investments is to attract private capital through bond financing for major electric system infrastructure capital investments (i.e., transmission and distribution electric system upgrades and/or expansions) and to satisfy shareholder investments in other related activities (Jamison, 2007).

In California, there are three primary electric IOUs, Pacific Gas and Electric (PG&E), Southern California Edison (SCE) and San Diego Gas and Electric (SDG&E). These electric IOUs were founded in the late 1890’s and early 1900’s (PG&E, SCE, SDG&E, 2014). All three of these electric utilities were regulated by the California Railroad Commission, established in 1911 by an amendment to California’s Constitution, with the primary authority to regulate the states private railroad industry (California Public Utilities Commission, 2014). However, by 1912 the California Railroad Commission’s authority expanded to include private natural gas, electric, telephone, water and marine transportation companies (CPUC, 2014). Its name was changed in 1946 to the California Public Utilities Commission (CPUC) (CPUC, 2014).

California’s three electric IOUs serve approximately 75 percent of California’s retail electricity demand (California Energy Commission, 2007). The remaining 25 percent of retail electricity demand in California is served mainly by electric publically-owned utilities (POUs) (CEC, 2007). Electric POUs are different than electric IOUs in that they are not accountable to private investors (shareholders) and are not subject to CPUC “rate of return” regulation. These utilities are essentially local public agencies that are held accountable by boards of locally elected officials who decide on electricity rates and investments in electric system infrastructure. These boards also oversee the management of the organization. In contrast, the electricity rates and investments of California’s three electric IOUs are determined by the CPUC through public regulatory proceedings. California’s largest electric POU is the Los Angeles Department of Water and Power (LADWP) followed by the Sacramento Municipal Utility District (SMUD). These two

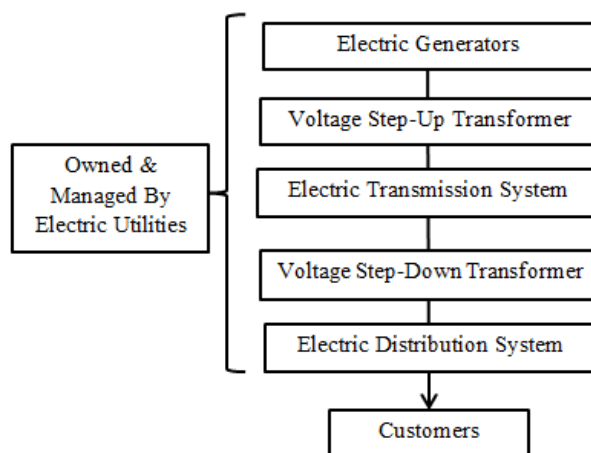
electric POUs serve about 15 percent out of the 25 percent of retail electricity demand served by electric POUs in California (California Municipal Utilities Association, 2007).

For most of their history electric utilities, both IOUs and POUs were vertically integrated, in that they owned, operated and managed electric generation, transmission, distribution and the sale of electricity with exclusive rights to serve customers in specific geographic territories.

Figure 1 presents a visual representation of a vertically integrated supply chain structure as it applies to the generation and delivery of electricity. This will be discussed later in this chapter and in chapter 3, as most of California's electric POUs still function within a vertically integrated structure, as opposed to the state's electric IOUs, which are no longer vertically integrated and currently function within a hybrid-market structure. The original rationale for electric utilities to engage in vertical integration was to:

1. Maintain electric service reliability through a centralized entity (aka electric utility) that balances supply and demand of electricity almost instantaneously,
2. Optimize the dispatch of electricity from electric generators at low-cost; and,
3. Achieve long-run efficiencies through economies of scale that require the coordination of investment decisions at all stages of the electricity supply chain (generation, transmission, distribution and sale; Michaels, 2004).

Figure 1- Electricity Sector: Vertically Integrated Supply Chain Structure



Affordable, Efficient, Reliable, and Environmentally Responsible Electric Service —

Creating New Institutions: Structural Reforms of the 1970's

Up until the 1970's, the state's involvement in its electricity sector was limited to the electric IOU "rate of return" regulatory framework of the CPUC to help achieve its high-level goals of affordable, efficient and reliable electric service. This began to change in the 1970's. Short- and long-term petroleum supply uncertainty brought on by foreign embargos imposed by the Organization for Petroleum Exporting Countries (OPEC) because of political instability in the Middle East became a major issue (Yergin, 2009). These embargoes coupled with what was deemed the rapid growth of total electricity demand (7 to 8 percent per year) and the environmental impacts of this growth in California became the state's first real incursion into developing and implementing electricity sector reforms (CEC, 1977). In the late 1960's, a growing number of electric generators in California were fueled by petroleum due to its low price and smog concerns from coal fueled electric generators (Energy Information Administration, 2014). But by the mid-1970's, petroleum shortages, petroleum's volatile price swings and

California's rapid growth in total electricity demand called for government intervention. These issues challenged the ability of the state to achieve its high-level energy goals that emerged during the formation of its electricity sector – affordable, efficient and reliable electric service. In addition, a new high-level energy goal emerged during the 1970's, environmentally responsible electric service.

To help address these issues and achieve the state's high-level energy goals, California policy-makers created the California Energy Resources Conservation and Development Commission (California Energy Commission, CEC) in 1974 as the state's primary energy policy and planning agency (CEC, 1977). The CEC was responsible for devising new approaches and strategies for supplying the state's growing electricity demand. By 1977, the CEC proposed a series of policies focused on phasing out petroleum as an electric generation fuel source, developing a coordinated and comprehensive state electric system infrastructure planning process and reducing electricity demand (CEC, 1977). Alternatively, the electric IOUs proposed to switch from petroleum fuel to coal and nuclear for electric generation, in addition to developing as many of these electric generators needed to meet the state's growing electricity demand. However, state policy-makers and regulators at the time ultimately decided to focus on three different energy resource pathways.

The first pathway the state pursued was energy efficiency, including the development of energy efficiency standards for appliances (1977) and new buildings (1978). It is important to note that since 1973, California's electricity consumption per capita has remained relatively flat compared to the rest of the United States (Kandel, A. et al, 2008). Specifically, electricity consumption per capita in California is 50 percent less when compared to the national average (Natural Resources Defense Council, 2013). There are many factors that have contributed to this, including California's temperate coastal climate, demographic changes, economic shifts, energy

efficiency incentive programs and the state's appliance and building energy efficiency standards first established by the CEC in 1977 and 1978 (Levinson, 2014). The second pathway proposed to decouple the electric IOUs revenue from their electricity retail sales (1978; CEC, 1977). Under traditional "cost of service" regulation, the CPUC would set electricity rates and let electric IOU revenues float up or down with electricity retail sales. Under decoupling, the CPUC would instead establish electric IOU revenues and then let electricity rates float up or down with consumption (Regulatory Assistance Project, 2011). Decoupling is similar to setting of a budget and removes the incentive for the electric IOUs to increase electricity retail sales to increase revenue. With revenue decoupling the electric IOUs would instead be incented to encourage customers to conserve and use electricity more efficiently. The last pathway was switching from petroleum fuel to natural-gas fuel for electric generation and investing in alternative forms of electric generation, such as renewable electric generation, namely wind and geothermal (CEC, 1977).

Electric system infrastructure planning also changed substantially in the 1970s. Historically, electric utilities operated in a relatively stable planning environment as their electricity retail sales and revenues grew with steady rates, costs of electric generation and fuel prices were stable and environmental policies and regulations were few (CEC, 1977). However, the uncertainty of future electricity demand, the growing risk of investing in potentially underutilized electric system infrastructure at a cost to customers, chronic inflation and new environmental policies and regulations (United States Clean Water and Air Acts), supported the creation of a more formal institutional long-range planning process that considered both electric service reliability and environmental impacts (CEC, 1977). This activity became one of the core responsibilities of the CEC.

The CEC was required to develop robust modeling methodologies to forecast electricity and natural gas demand in California independently from the forecasts developed by the state's electric utilities. These forecasts were used by the CPUC to justify and manage electric IOU proposed electric system infrastructure investments. The CEC also recommended a series of alternative approaches, as discussed above, to meet and reduce this demand through energy efficiency, alternative fuels and renewable electric generation. Finally, the CEC became the state's one-stop shop for permitting thermal electric generation 50 megawatts (MW) and above (primarily natural-gas fueled electric generators sized to produce 50 MW and above of electricity at any given moment). Thereby, streamlining what had previously been a complex and lengthy local permitting and environmental review process under the California Environmental Quality Act (CEQA) of 1970 (CEC. 1977). Consolidating the permitting and environmental review process for these electric generators at the state level provided the state's electric utilities with a single, clear process and certainty in the efficacy of the environmental reviews conducted under CEQA. It also established designated timeframes from when electric utilities applied for a permit and when they could expect a decision, rather than depending on varying local processes with disparate timeframes. This comprehensive and consolidated process would help ensure that electric generators were permitted expeditiously to meet growing electricity demand, while addressing the environmental impacts associated with these projects.

Focus on Affordable Electric Service –

Introducing Competition: Structural Reforms of the 1980's & 1990's

The 1970's electricity sector structural reforms in California and at the national level helped the state achieve three of its high-level energy goals - efficient, reliable and environmentally responsible electric service - tempering many of the concerns associated with the

rapid growth in electricity demand, supply shortages and the fear of rampant environmental degradation from overinvesting in electric system infrastructure.

Nevertheless, electricity rates did increase sharply from the mid-1970s until the mid-1980s in response to the increase in basic energy prices, high interest rates from electric system infrastructure financing, compliance with environmental policies and regulations and investments in the very few capital-intensive nuclear electric generators that were developed in California (Joskow, 2000). These issues challenged the state's ability to achieve its high-level energy goal of affordable electric service. In response, the CPUC in the early 1990's began exploring new electricity sector reforms aimed at restructuring the roles and responsibilities of the state's electric IOUs and opening up the sector to competitive market forces (Weare, 2003).

Academics and economists argued that by restructuring the entire electricity sector, medium and long-term cost savings could be realized (Joskow, 2000). These cost savings would come from:

1. Independent investments in the most economic electric generators driven by competition among developers;
2. A reduction in these electric generators operating costs motivated by competition;
3. Retirement of uneconomical electric generators (inefficient operations etc.);
4. Depoliticizing the planning processes for these electric generators;
5. Increase in labor productivity;
6. Better alignment between the cost of providing electric service and electricity rates charged to customers; and
7. Innovation of new technologies (Joskow, 2000).

These benefits depended heavily on the design and implementation of the restructuring reforms, most notably the creation and management of competitive wholesale and retail electric power markets and the mitigation of potential market failures.

The CPUC was well aware of the design and implementation challenges of restructuring California's electricity sector. In 1993, the CPUC published its report on electricity sector restructuring, initiating the state's first attempt at calling for a major overhaul of this sector (Weare, 2003). The CPUC's report, known as the yellow book, was regarded as the state's initial foray into electricity sector restructuring, but in reality the conversation had started over a decade before with the passage of the federal Public Utility Regulatory Policy Act (PURPA) by Congress in 1978. PURPA required electric utilities to purchase electricity from non-utility third-party electric generators (independent power producers) through long-term (20 year plus) contracts that built and operated Qualifying Facilities (QFs). QFs included combined heat and power and renewable electric generators. Deference was given to states to design their own methods for calculating the price that electric utilities would pay for these electric generators at their avoided cost and the length of their long-term contracts. There are multiple methods to estimate avoided cost and it is essentially the cost the utility would avoid by not having to generate or purchase the electricity itself (Parmesano et al, 1992). Each state's public utilities commissions, including California's, determined these methods. The avoided cost methodologies developed by the CPUC were quite favorable for QFs and resulted in a significant increase in independent electric generation. In addition, other actions were taken by the Federal Energy Regulatory Agency (FERC) throughout the 1980's and early 1990's that allowed independent power producers to gain access to electric IOU electric transmission system infrastructure. These actions, among others, increased electricity produced by independent power producers from less than five percent of California's electricity in 1985 to over 23 percent by 1995 (Weare, 2003).

By the time the CPUC instituted its public regulatory proceeding focused on electricity sector restructuring in 1994, independent power producers had emerged as a major proponent of restructuring the electric IOUs vertically integrated structure and creating new competitive wholesale and retail electric power markets (Michaels, 2004). Businesses and large energy intensive industries also joined the fray and were interested in taking advantage of new electric generation from independent power producers that could potentially provide them with electricity cheaper than the electric IOUs. Other stakeholders argued that the traditional vertically integrated structure of the electric IOUs was the source of high electricity rates, as California's average electricity rate was 30 percent greater than other nearby western states (Weare, 2003). This rate disparity was in fact a result of the few expensive investments California's electric IOUs made in nuclear electric generators and what became high-priced contracts with QFs (Weare, 2003). For several years, the CPUC held hearings to gather and analyze information from involved stakeholders that would be included in the agency's electricity sector restructuring proposal. However, the state Legislature became involved in 1996 and designed its own proposal with many elements pulled from the CPUC hearings. This proposal took the form of Assembly Bill 1890: The Electric Utility Industry Restructuring Act of 1996 (AB 1890) and became California's blueprint for electricity sector restructuring.

Following the CPUC's lead, AB 1890's intent was to sever the vertically integrated structure of the state's electric IOUs and create competitive wholesale and retail electric power markets for the generation and sale of electricity. Under this new structure, electric generation would be developed, owned and operated by independent power producers and electricity would be purchased through virtual auction-based competitive wholesale electric power markets by the electric IOUs and energy service providers (ESPs). These markets would be managed by the California Power Exchange (CPX), a new independent not-for-profit organization. Electricity

purchased would then be dispatched from the electric generators into the electric transmission system operated non-discriminatory by the California Independent System Operator (CAISO), another new independent not-for-profit organization, eventually making its way into local electric distribution systems and to customers. California's electric IOUs were to retain ownership and maintenance of both the electric transmission and distribution systems but the role of operating the electric transmission system shifted entirely to the CAISO. Electric POUs could also participate in the competitive wholesale electric power markets as means of procuring electricity that may be cheaper than producing their own, or to help balance real-time electricity supply and demand. To spur competition and ensure that the state's electric IOUs did not have undue market power in the newly created competitive wholesale electric power markets, they were forced to divest their fossil-fueled electric generation to independent power producers. They still however retained their large hydro-electric and nuclear electric generators, and their long-term contract agreements with QFs, but their share of total electric generation dropped to below 50 percent (Weare, 2003).

On the retail side, the electric IOUs would no longer be the sole provider of electricity, since ESPs would be allowed to enter the newly created competitive retail electric power market. ESPs could contract with customers directly and act on their behalf as intermediaries to purchase electricity through the competitive wholesale electric power markets at a potentially cheaper price than a customer's electric IOU. The CPUC and the state Legislature anticipated that most customers would eventually be served by ESPs with the electric IOUs acting as a backstop for customers that did not contract with an ESP. In addition, the electric IOUs would continue to be responsible for maintaining their electric transmission and distribution systems (Weare, 2003). Figure 2 visually illustrates this new electricity sector competitive market structure. On the wholesale side the electric IOUs, ESPs and electric POUs (optional) were to procure electricity

from independent power producers through the CPX competitive wholesale electric power markets. The electricity generated and fed into the electric transmission system would then be managed by the CAISO until it flowed into the electric distribution system and directly to customers (retail side).

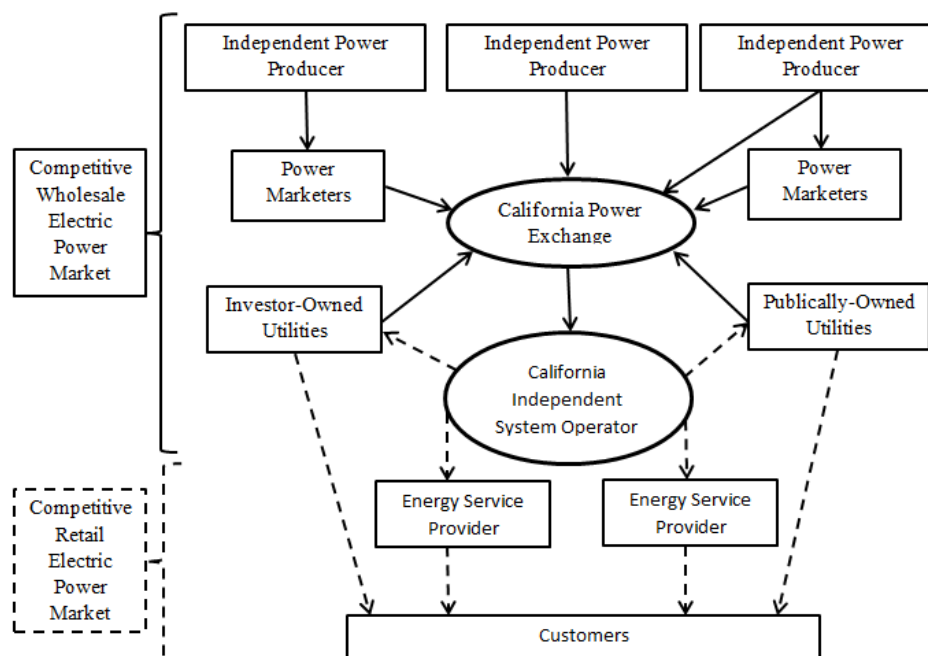
It is important to note that switching from a vertically integrated structure to a competitive market structure had a profound impact on the regulation of electricity rates. Under the vertically integrated structure of the electric IOUs, customer rates were regulated by the CPUC. In general, California's electric IOU electricity rates are a function of more than just the cost of generating electricity, which fluctuates depending on the electric generator, and includes:

1. Fixed infrastructure costs (electric transmission and distributions systems);
2. Administration costs (billing and customer services);
3. Long term contract costs with QFs, investment costs for nuclear electric generation;
and
4. Costs for various public benefit programs (energy research and development, low-income subsidies, energy efficiency programs and subsidies for renewable electric generation) (Joskow, 2000).

Under traditional regulated electricity rates, the electric IOUs fixed costs and electric generation costs were bundled. However, these would be unbundled with the creation of a competitive retail electric power market. This means that ESPs would be required to pass on to their customers a fixed charge to cover the non-electric generation costs described above, and then a volumetric charge to cover the costs of electric generation. The only portion of these unbundled rates that ESPs could manipulate would be the cost of electric generation, which would fluctuate depending on the price of electricity they purchased from independent power producers competing in the wholesale electric power markets. In theory, competition amongst

independent power producers and ESPs would provide customers with choice, and the ability to purchase electricity at prices lower than what they were currently paying to their electric IOU. However, these actual outcomes were highly dependent upon the implementation and functions of such arrangements.

Figure 2 - Electricity Sector: Competitive Market Supply Chain Structure



There were several major points of contention leading up to the passage of AB 1890 in 1996 and comprehensive electricity sector restructuring in California. The first was the issue of stranded costs. These costs are defined as the difference between the costs a utility paid and amortized for an electric generator (estimated to be higher) and the value it would receive in the new competitive wholesale electric power markets (estimated to be lower) (Michael, 2004). In California, stranded costs were estimated to be about \$25 billion and were divided among the investments electric IOUs made in nuclear electric generation and the long-term contracts with high electricity prices paid to QFs (Weare, 2003). If these costs were not recovered, the electric IOUs predicted that it could lead to financial disaster for them and significantly harm their ability

to accumulate capital from private investors. They vowed to resist restructuring if they would be forced to consider these costs as sunk investments.

To address these concerns from both the electric IOUs and advocates for customers, AB 1890 included a provision to allow the state to issue a bond and create a fee, known as the competitive transition charge (CTC), to cover the stranded costs (Weare, 2003). The bond and CTC would also pay for the costs associated with administering the restructuring reforms, including the creation of the CPX and CAISO (Weare, 2003). In addition, the state bond would reduce electricity rates for electric IOU customers immediately by 10 percent (AB 1890, 1996). These rates would also be frozen for four years (AB 1890, 1996). It is interesting to note that the political decisions reflected in AB 1890 of providing the potential benefit of electricity sector restructuring – lower electricity rates – would come immediately in the form of a bond. That is, borrowing against the future to reduce electricity costs in the near term only to pay back the bonds with interest later. Decisions such as this, and that of freezing electricity rates in what was supposed to be full wholesale and retail electric service competition, are but a few of the nuances in AB 1890 that would ultimately contribute to California's electricity crisis.

**Affordable, Efficient, Reliable and Environmentally Responsible Electric Service
Compromised – California's Electricity Crisis: Causes and Consequences**

The rolling electric system outages and crisis that followed California's attempt to restructure its electricity sector severely compromised the state's ability to achieve its high-level goals of affordable, efficient, reliable and environmentally responsible electric service. The outages and crisis were caused by complex and interrelated factors that have been debated amongst a few academics and policy analysts for years (Weare, 2003). These factors include the poor design of the competitive wholesale electric power markets, regulatory inaction, undue

market power of independent power producers, an overall shortage in electric generation and electric system infrastructure limitations and constraints (Weare, 2003).

Designing and implementing competitive wholesale and retail electric power markets is no small task and is naturally complex. Competitive wholesale electric power markets (day-ahead and real-time/spot markets) must constantly be managed and coordinated with electric transmission system operations to ensure the effective and economically efficient dispatch (export) of electricity from where it is generated to where it is needed, literally in real-time. This was made more challenging with the separation between the CPX and CAISO. The day-ahead competitive wholesale electric power market was managed by the CPX in which participating electric utilities, mainly the state's electric IOUs, would forecast electricity demand for the next day and both they and eventually ESPs would procure electricity from independent power producers from bids submitted into a virtual wholesale auction. However, in addition to operating the electric transmission system the CAISO also managed the real-time/spot competitive wholesale electric power market for the electric IOUs, ESPs and electric POUs to purchase electricity in real-time to make up for any error in the estimated electricity demand the day before and that of real-time electricity demand. Electricity prices in the real-time/spot competitive wholesale electric power market were naturally higher because electric IOUs, ESPs and electric POUs had immediate demand and would pay higher electricity prices to meet that demand.

Overtime, this encouraged independent power producers to bid into the real-time/spot competitive wholesale electric power market instead of the day-ahead competitive wholesale electric power market because they would have the opportunity, due to guaranteed demand, to offer higher prices for electricity and increase their revenue stream (Weare, 2003). This market design flaw contributed to extremely high wholesale electricity prices that the electric IOUs could not afford to purchase for their customers (Weare, 2003). Especially since electricity rates were

frozen for four years. This meant that the electric IOUs could not pass on these costs and instead had to absorb them, leading them down the path of insolvency and periodic electric system outages. Competitive wholesale electric power market design flaws, amongst other factors that will be explained later, was an example of what Cambridge Energy Research Associates called California's partial electricity sector restructuring, not true or full restructuring (Weare, 2003).

Regulatory complacency compounded the competitive wholesale electric power markets design flaws and the overreliance on the real-time/spot competitive wholesale electric power market. However, it was also regulatory inaction before and during the electricity crisis that contributed to its effect (Joskow, 2001). In the spirit of fostering competition in the wholesale electric power markets, long-term bilateral contracts (contracts negotiated between the electric IOUs and independent power producers outside of the CPX) for electric generation capacity (the amount of electricity an electric generator can produce) and electricity (actual energy produced) between the electric IOUs and independent power producers were discouraged. This is because mutually agreed upon electric generation capacity and electricity prices over a period of time could negate competition in the wholesale electric power markets (Joskow, 2001). However, forward or long-term contracts for capacity and electricity have the benefit of ensuring that independent power producers are around when needed to produce electricity to meet demand, and it would have allowed the electric IOUs to hedge their risks against volatile electricity prices in the competitive wholesale electric power markets (Bushnell, 2004). These contracts can also include payments for ancillary services, which are services that are necessary to support the movement of electricity and maintain electric system reliability. An example would be the ability of an electric generator to come on-line without an external source of electricity following an electric system outage. This is known as black start. Other ancillary services include voltage regulation, frequency control and load following. By 1999, the CPUC did allow the electric IOUs

to use bilateral contracts for electricity but only up to a third of their minimum estimated demand through the CPX (Weare, 2003). The amount of electricity that could be procured through these contracts was expanded in 2000, but the CPUC still retained its authority to review and approve contracts entered into by the electric IOUs (Weare, 2003).

The changing restrictions on bilateral long-term contracts and the CPUC's inability to fully understand its role in a time in which retail competition was supposed to be a check on electric IOU investments, created uncertainty for the electric IOUs. This alludes to the misalignment in implementation between the competitive wholesale electric power markets, which were in full implementation, and the competitive retail electric power market, which was stalled and almost non-existent around 2000. Part of the reasoning was that AB 1890 prescribed a slow transition toward a competitive retail electric power market and provisions, such as the 10 percent electricity rate reduction and four year frozen electricity rates. These elements essentially nullified the ability of ESPs to gain traction in the residential and non-residential electricity retail space, since their rates could not compete with the artificial electric IOU electricity rates. In fact, the entire rollout of a competitive retail electric power market was a major issue. Regulators did not actively pursue actions to create this market and instead remained more or less agnostic to its implementation. Part of the reasoning could have been the sheer amount of time and resources consumed just creating the competitive wholesale electric power markets with the retail side becoming more of an afterthought. However, the benefits of electricity sector restructuring, such as potentially lower electricity rates and innovative energy services provided by ESPs, could only have been achieved by established and functional competitive wholesale and retail electric power markets operating in parallel with one another. The separate implementation of both markets at different times, instead of a comprehensive simultaneous rollout by regulators added another

dimension of complication and further contributed to the impending electricity crises (Weare, 2003).

When electricity prices spiked in the competitive wholesale electric power markets in 2000 due to supply issues, the electric IOUs were forced into a situation of purchasing electricity at high prices and selling it to their customers at frozen electricity rates. The level of debt the electric IOUs accumulated amounted to as much as \$50 million a day (Weare, 2003). The electric IOUs eventually reached a point where they were unable to purchase electricity from the competitive wholesale electric power markets and rolling electric system outages became a reality. State efforts to curb the electric IOUs road to insolvency, such as permitting an ever greater number of natural-gas fueled electric generators and implementing voluntary electricity demand reduction programs held off the crisis but ultimately did not avert it (Weare, 2003). Avoiding the financial collapse of the electric IOUs would have required a cap on wholesale electricity prices combined with the raising of electricity rates reflecting the costs signaled in the competitive wholesale electric power markets (Bushnell, 2004). However, increasing electricity rates was politically unacceptable. This, plus misinformation about the situation and uncertainty about the causes of the electricity crises paralyzed regulators and policy-makers who were unable to develop and act upon solutions. Weare (2003) asserts that electricity rate increases would have encouraged strong conservation actions by customers and a price cap on the wholesale electric power markets would have helped stymie the electricity supply issues.

The electricity supply issue leads to the next set of factors that contributed to California's electricity crisis. Market manipulation by independent power producers was one such factor. This factor received the most public attention and scrutiny. The public, policy-makers, regulators and the media looked for someone or something to blame for the electricity crisis. Independent power producers became that target. The premise behind market manipulation was that independent

power producers tried to maximize their profit stream by colluding with one another and artificially raising the electricity prices they bid into the competitive wholesale electric power markets at times when electricity demand was high and supply low. This type of market manipulation can only be achieved if few suppliers are engaged in a market with nearly inelastic demand. This is exactly what happened. In the early days of electricity sector restructuring, the electric IOUs divested most of their electric generators to independent power producers. However, there were only a few independent power producers acting as electricity suppliers that, whether it was direct or indirect collusion, could withhold the supply of electricity during high demand, raising electricity prices. More and new electricity suppliers would have diluted this form of market power but planning, financing and building, for example natural-gas fueled electric generators, can take years. As discussed by many academics, market power has been a major problem in competitive wholesale electric power markets (Wolfram, 1999, Borenstein et al, 2001, Weare 2003). Though there is evidence that market manipulation by independent power producers and their intermediaries, such as Enron, did occur, the extent of this behavior is still unresolved (Weare, 2003).

The next electricity supply issue was the lack of physical electric generation capacity. Basic economics states that more supply than demand is a prerequisite to help foster competition. Under a traditional electric utility vertically integrated structure, extra electric generation capacity is uneconomical, inefficient and only leads to high electricity rates for customers. But, as theoretically envisioned, multiple suppliers and many electric generators are necessary to foster competitive behavior in wholesale electric power markets. However, constructing and operating natural-gas fueled electric generators has for example, environmental consequences. But since the primary high-level energy goal of electricity sector restructuring was to achieve affordable electric service by stimulating customer choice and competition to reduce electricity rates, these

consequences were considered secondary. What ultimately occurred was that though electricity demand was growing at a steady rate of one percent per year in the late 1990's early 2000s, electric generation capacity was not being developed to keep up with demand (CEC, 2001). A potential cause for this could have been the uncertainties surrounding the implementation of electricity sector restructuring. These uncertainties in turn could have led to the perception of high risk and distaste by market actors to finance, build and operate any new electric generators.

Under a more traditional electric utility vertically integrated structure, its common practice for electric utilities to maintain a reserve margin of electric generation capacity. That is, extra electric generators that would be available, for the purposes of supplying the highest point of demand in any given day (peak). As alluded to above, too much of this extra capacity is economically inefficient. That is why electric system planning and forward projections of total and peak electricity demand over time are extremely important, as it helps justify investments and review of electric utility decisions by their regulators (CEC, 1977). This type of electric system planning that existed under the vertically integrated structure had diminished significantly with electricity sector restructuring. This was but another design flaw and mishap by regulators. According to James Bushnell, market signals such as bilateral long-term contracts between independent power producers and the electric IOUs would have alleviated some if not all of the uncertainty surrounding the need for new electric generation capacity (Bushnell, 2004).

Finally, the last electricity supply issue and factor that contributed to the electricity crisis is the inherent electric system infrastructure limitations including constraints on natural gas pipelines (primary California fuel for electric generators), the market for air pollution permits and the electric transmission system. By 2000, 38 percent of California's in-state electricity supply was met by natural-gas fueled electric generators (Weare, 2003). The price of natural gas has a major impact on the costs and price of electric generation. Balancing natural gas supply with

electric generation is complex and in 2000 natural gas prices were highly volatile due to unexpected events and demand growth (Weare, 2003). This price spike had a tremendous influence on electric generation costs and therefore electricity prices. In addition, air pollution permit prices rose within the South Coast Air Quality Management District (SCAQMD) due to changes in the market for these permits (Weare, 2003). Furthermore, the electric transmission system in California has limited capacity, in that there are only so many electric transmission lines that can transport only so much electricity (transmission capacity) from one part of the state to another. The physical constraints of this system make it difficult to move electricity; sometimes where it is more abundant and more economical to produce, to places where there is demand. Congestion on California's electric transmission system was managed by the CAISO through their wholesale electric power markets and by rules that dictated which types of electric generators receive higher scheduling priority to dispatch their electricity into the electric transmission system. It is important to note that the transportability of electricity is one of three features that contribute to the difference in electricity prices within competitive wholesale electric power markets. The other features are the marginalized cost of actually producing electricity (as noted above, natural gas being a major factor) and the speeds at which independent power producers can control and manage their electric generation (Joskow, 2000). Expansive electric transmission system infrastructure becomes a necessity to foster competition amongst independent power producers as the location of these electric generators, especially if they are located in areas with high demand and constrained electric transmission system infrastructure, influences their value.

Poor design of the markets, regulatory inaction, undue market power of independent power producers, an overall shortage in electric generation capacity and electric transmission system infrastructure limitations were significant factors that contributed to California's

electricity crisis in 2001. The details and nuances of these interrelated and compounding factors are highly complex but a basic understanding, as presented in the preceding literature, is necessary to grasp the concepts that will be presented later in this paper, especially Chapters 5 and 6. Having this knowledge also provides the background necessary to fully comprehend what was to come in the aftermath of California's electricity crisis.

**Affordable, Efficient and Reliable Electric Service Re-examined –
California's Electricity Crisis: Aftermath**

Perhaps the most important lesson to be learned from California's electricity crisis is that the state's electricity sector is far more complex and interdependent than those who sought to change it ever imagined. Decisions concerning the supply of electricity must be coordinated in real time with many actors that operate within an environment of complex market rules and regulatory oversight split between multiple governing institutions (Weare, 2003). This simple truth highlights the fact that changing any piece of California's electricity sector can have consequential effects on other pieces. Thus, any structural reform that seeks to significantly change California's electricity sector to achieve its high-level energy goals must always be viewed with caution by policy-makers and regulators.

By the summer of 2001, the electricity crisis began to fade after numerous policy actions were implemented to realign electricity supply and demand. On the supply side, new natural gas-fueled electric generators were eventually permitted and developed through a new fast-track regulatory process established by Governor Gray Davis. FERC also established price caps for the competitive wholesale electric power markets. Finally, the California Department of Water Resources (CDWR), which was the only state agency with electricity contracting experience, was granted the authority to borrow advanced funds from the state's General Fund. These funds were used to sign bilateral long-term electricity and electric generation capacity contracts with

independent power producers in order to reduce overreliance on the states real-time/spot competitive wholesale electric power market (Weare, 2003). On the demand side, targeted energy efficiency, demand response and conservation programs, along with the public's awareness of the crisis and the CPUCs eventual decision to increase electricity rates, reduced electricity consumption/demand considerably (Weare, 2003).

Conclusion

When smoke from the electricity crises cleared, policy-makers, regulators and stakeholders focused most of their immediate attention on its financial dimensions. This included paying for the high competitive wholesale electric power market electricity prices, saving the electric IOUs from insolvency, seeking reparations from independent power producers who contributed to the crisis, and repaying the \$10 billion that the CDWR incurred on behalf of the electric IOUs to procure electricity through bilateral long-term electricity and electric generation capacity contracts (Weare, 2003). These decisions would influence the future of California's electricity sector. In addition, decisions were made to dismantle elements of California's electricity sector restructuring efforts including the dissolution of the CPX whose responsibilities of managing the competitive day-ahead wholesale electric power market transferred to the CAISO. In addition, the CPUC decided to allow the electric IOUs to become the main purchaser of wholesale electricity and froze the competitive retail electric power market, allowing the electric IOUs to continue to serve as the primary providers of electricity within their territories. The years following California's electricity crisis were defined by policy-makers, regulators and stakeholders trying to piece together what remained of the structures and institutions created from the restructuring reforms. They reinstated many of the older public regulatory processes, portions of the electric IOUs vertically integrated structure that preceded restructuring and began to develop new electricity sector policies aimed at addressing issues challenging the state's ability to

achieve its high-level energy goals. These proceeding years created what I call California's hybrid-market structure for its electricity sector.

Chapter 3

DEFINING THE PROBLEM

Chapter 3 presents information about California's current electricity sector hybrid-market structure and the emerging issues that are challenging the state's ability to achieve its high-level energy goals – affordable, efficient, reliable and environmentally responsible electric service. I begin by discussing the decisions policy-makers and regulators made after the 2001 electricity crisis to ensure a functional electricity sector. In the second section, I explain how California's electricity sector functions today. The last section discusses emerging issues and policies confronting California's electricity sector.

Affordable, Efficient, Reliable and Environmentally Responsible Electric Service

Re-instated – California's Electricity Sector: Post Electricity Crisis

In the first couple of years after California's electricity crisis in 2001, regulators and policy-makers had to decide on the long-term institutional structures and framework that would define the state's electricity sector. Since the reliable delivery of electricity was significantly compromised during the electricity crisis, reliable electric service became the primary focus for policy-makers and regulators immediately after the crisis. They deemed the electricity crisis as unacceptable, as it harmed Californian's through substantial electricity rate increases, threw the electric investor owned utilities (IOUs) into financial turmoil and forced the state, through California Department of Water Resources (CDWR), to assume the procurement responsibilities of the electric IOUs from January 2001 to December 2002 (CPUC, 2004). To prevent these issues from occurring again, the state Legislature created, and then Governor Gray Davis approved, Assembly Bill 57 (AB 57, 2002) and Senate Bill 1976 (SB 1976, 2002). These pieces of legislation authorized the California Public Utilities Commission (CPUC) to develop a regulated

electricity procurement framework similar to what existed before California's electricity sector restructuring attempt.

This framework once again required each electric IOU to file electricity procurement plans and associated costs, reflected in electricity rates, to the CPUC for review and approval. The state Legislature also created, through Senate Bill 6 (SB 6, 2001), the California Consumer Power and Conservation Financing Authority (California Power Authority, CPA) to ensure a reliable supply of electricity to Californians at just and reasonable electricity rates, including planning for a prudent electricity planning reserve. The CPA was also responsible for encouraging energy efficiency, conservation, and the use of renewable electric generation. SB 6 directed that the operation of the CPA to sunset on January 1, 2007 (Legislative Analyst Office, 2004). Finally, the CPUC suspended all efforts to create a competitive retail electric power market (CPUC, 2004) resuming the electric IOUs as the sole providers of electricity to customers within their territories. At this time the CPUC estimated that about five percent of the state's peak electricity demand of 46,000 MW was then under energy service provider (ESP) contracts, mostly with large industrial customers (Energy Information Administration, 2010).

In 2003, the Energy Resources Conservation and Development Commission (California Energy Commission, CEC), CPUC and the newly created CPA developed and adopted the state's *Energy Action Plan* that was, in essence, a post-electricity crisis call to action. It articulated a single, unified approach to meeting California's electricity needs (Energy Action Plan, 2008). The plan had an enormous impact, as it represented for the first time that California's energy agencies shared a common approach to further the state's high-level energy goals (Energy Action Plan, 2008). This approach was the "loading order". The "loading order" established that the state would meet its electricity needs/demand by first investing in energy efficiency and demand response, followed by renewable electric generation and distributed electric generation (electric

generation located within the electric distribution system) and then clean natural-gas fueled electric generation and electric transmission and distribution system infrastructure (Energy Action Plan, 2008). The plan also served as a guiding document for the development of the CPUC's regulated electricity procurement framework.

The major policy issues addressed within this framework were the adoption of an electricity planning reserve, a requirement that the electric IOUs procure adequate electric generation capacity (known as resource adequacy), and a long-term electricity procurement market for the electric IOUs. An electricity planning reserve is a marginal reserve of electricity above the annual forecasted peak electricity demand within an electric utility territory. The CPUC determined that this reserve should be 15 percent (CPUC, 2004). This means that if the annual forecasted peak electricity demand within in an electric IOU territory is 25,000 megawatts (MW) its reserve margin would be 15 percent of this amount and together add up to 28,750 MW. An electricity planning reserve is essentially a contingent or back-up amount of electric generation that is available to an electric utility to ensure that it can meet its annual peak demand in case their peak is above the forecasted amount. Essentially the 15 percent electricity planning reserve translates into the electric IOUs procuring electric generation capacity 115 percent above their forecasted peak electricity demand 30 days prior to the start of a calendar month (CPUC, 2004). 90 percent of this electric generation capacity must be procured through forward contracts by November 1st of the previous calendar year (CPUC, 2004). Note that these resource adequacy requirements are contract obligations for electric generation capacity only, not electricity.

Currently, the electric IOUs procure electricity either through contracts they have with independent power producers, who they may also have an electric generation capacity contract with, and/or through the California Independent System Operators (CAISO) competitive wholesale electric power markets (day-ahead and real-time/spot-market), depending on the price

of electricity. In 2002, close to 90 percent of the electricity procured and produced by the electric IOUs was through contracts with independent power producers and by their own electric generation (CAISO, 2003). Whereas, in 2013, roughly 56 percent of the electricity procured and produced by the electric IOUs was through contracts with independent power producers and by their own electric generation (CAISO, 2013). When comparing these numbers, the amount of electricity procured and produced by the electric IOUs through contracts and their own electric generation, instead of through the CAISO's competitive wholesale electric power markets, has decreased substantially over the last 10 years. This is a positive trend because extremely high levels of electricity supply that is contracted outside of the CAISO competitive wholesale electric power markets can decrease market efficiency by reducing the degree to which the CAISO's virtual wholesale auction is free to optimize electric generation based on their actual costs (CAISO, 2013).

The electric IOUs procure electric generation capacity and electricity through contracts under the guise of the CPUC's Long Term Procurement Planning Proceeding (LTPPP). This planning process has occurred every two years since 2002 to evaluate the electric systems need for new electric generation and to serve as the "umbrella" proceeding to consider, in an integrated fashion, all of the CPUC's approaches to meet its electricity needs/demand as specified in the *Energy Action Plan* (CPUC, 2010). Each electric IOU submits plans to meet customer electricity demand with preferred electricity resources (energy efficiency, demand-response, renewable electric generation and distributed electric generation) and the CPUC then evaluates these plans taking into consideration current electric generators and the retirement of these generators. The CPUC also compares overall electricity supply with the CEC's electricity demand forecast over the next 10 years. If electricity demand exceeds supply and preferred electricity resources cannot meet expected electricity demand the CPUC then authorizes the electric IOUs to solicit contracts

with independent power producers to build new natural-gas fueled electric generators (CPUC, 2010). These new electric generators are also built to offset inefficient and potentially more environmentally impactful natural-gas fueled electric generators entering retirement. Contracts with these generators can last anywhere from less than five years to 10 years (CPUC, 2013).

The CPUC currently estimates that there is more electric generation capacity than currently needed over the 10-year LTPPP planning horizon, depressing electric generation capacity prices (CPUC, 2013). Independent power producers with electric generation capacity only contracts have noted that the current short term (less than five years) resource adequacy contracts do not provide them with enough revenue to cover long-term costs (CPUC, 2013). However, this electric generation capacity is not necessarily located in areas where the capacity and electric generation is needed, which means there may be a need to build additional electric generators in these areas. The issue really comes down to the short-term versus long-term need for these electric generators. Allowing the electric IOUs to enter into long-term (10 year plus) electric generation capacity contracts would keep these electric generators open , but it does not mean they would be generating electricity, only that they would be available to do so if or when called upon. The costs for these long-term contracts would then be passed down to electric IOU customers in higher electricity rates but would likely ensure higher electric service reliability. In contrast, if the electric IOUs continue to only enter into short-term contracts with these electric generators they could shut down permanently citing the lack of adequate revenue to stay open. This may be the most financially prudent decision in the short-term for the CPUC, but long-term it could mean that more, newer and more expensive electric generators would need to be built to meet demand and ensure electric service reliability. These costs would also be passed down to electric IOU customers in higher electricity rates compromising electric service affordability. The

CPUCs regulated electricity procurement framework was never intended to be a panacea for all of the electric IOUs procurement issues, and over time, new issues are bound to emerge.

After 2002, the CPUCs new regulated electricity procurement framework also needed to address the state Legislatures' desire to encourage the development of renewable electric generation to achieve the state's high-level energy goal of environmentally responsible electric service. In 2002, the state Legislature enacted Senate Bill 1078 (SB 1078) establishing the states Renewables Procurement Standard (RPS) (SB 1078, 2002). The legislation required that the electric IOUs eventually procure 20 percent of their total electricity retail sales from renewable electric generation by increasing their procurement of these resources one percent each year (SB 1078, 2002). The electric POUs were required under SB 1078 to establish their own local RPS target (SB 1078, 2002). The Legislatures intent for establishing the RPS was to increase the diversity, reliability, public health and environmental benefits of the state's electricity supply (SB 1078, 2002). In 2006, the RPS was amended by Senate Bill 107 (SB 107) mandating that the electric IOUs reach their 20 percent target by 2010 (CEC, 2014).

With the *Energy Action Plan* serving as the state's leading energy policy document and the CPUC's regulated electricity procurement framework established, including mechanisms for the electric IOUs to achieve their RPS target and the agency's desire to develop a comprehensive framework for the electric IOUs to administer energy efficiency programs, then Governor Arnold Schwarzenegger defunded the CPA in 2004. The administration claimed that the agency was no longer needed, since many of its programs had spun off to other agencies and electric utilities (Vogel, 2004). In the end, the agency's most prominent accomplishment was its role serving as a mediator between the historically hostile CEC and CPUC and the development of coordination processes between the two agencies (Vogel, 2004).

Citing the CPUC's desire to aggressively pursue energy efficiency, as articulated in the *Energy Action Plan*, the agency in 2005 adopted an administrative structure for post-2005 electric IOU energy efficiency programs (CPUC, 2010). The aim of these programs were to reduce electricity demand, as investments in energy efficiency were determined to be more cost-effective, more reliable and have less of an environmental impact than natural-gas fueled electric generators. The programs were to be developed in three-year cycles to assist the electric IOUs with long-term program planning. The CPUC became the primary overseer of these programs and was responsible for managing the evaluation, measurement and verification studies used to ensure that energy savings were achieved and outweighed the costs of the investments (CPUC, 2010).

Beginning in the 2006-2008 program cycle the CPUC adopted a reward mechanism that was intended to reward electric IOU shareholders for the successful implementation of cost-effective energy efficiency programs and to address the inherent bias of electric IOUs favoring investments in supply-side electric generators (CPUC, 2010). This bias stems from the fact that electric IOUs investments in electric generation, but mainly electric transmission and distribution system infrastructure due to electricity sector restructuring, could be incorporated into the costs of providing electric service, which the electric IOUs could recover through electricity rates approved by the CPUC. In addition to recovering these costs, the electric IOUs would receive a "rate of return" to their shareholders. This "rate of return" is a function of their total cost of service or rate base. The larger the rate base then the larger the electric IOU shareholder "rate of return" (CPUC, 2010). The energy efficiency reward mechanism developed by the CPUC directed the agency to establish minimum levels of energy savings for the electric IOUs entire energy efficiency program portfolio to achieve. The CPUC would then reward the electric IOU shareholders with rising performance incentives if they achieved over 80 percent of their energy savings targets (CPUC, 2010). Conversely, the CPUC would exact financial penalties if the

electric IOUs achieved only 65 percent and below of their established energy savings targets (CPUC, 2010). The evaluation, measurement and verification studies thus became that much more important because it allowed the CPUC to ensure that the electric IOUs were achieving their targets and justified their shareholder performance incentives.

The actions and initiatives that were decided upon and implemented in the aftermath of the 2001 electricity crisis and throughout the mid-2000's achieved an important high-level energy goal for the electricity sector; reliability. The 2001 electricity crisis had compromised the ability of policy-makers, regulators and the electric IOUs to provide reliable electric service to most Californians. Achieving this high-level energy goal was of great importance to policy-makers and regulators, and their decisions reflected that priority. Once reliable electric service was established for most Californians, policy-makers and regulators began to focus their efforts toward achieving other high-level energy goals for California's electricity sector. These other goals are easy to state and promote but almost always involve trade-offs.

California's Electricity Sector - Today

California's electricity sector is complex and difficult to change despite the many reforms and policies implemented over the decades that have sought to address its issues and achieve its high-level energy goals. The most significant reform California's electricity sector has ever faced was its complete restructuring and creation of competitive wholesale and retail electric power markets in the late 1990's and early 2000's. As discussed in the preceding sections, these structural reforms had unintended consequences and were not fully implemented. The result has been the creation of a hybrid-market structure. This structure is defined as having semi-competitive wholesale electric power markets (day-ahead, and real-time/spot market) coupled with resource adequacy (electric generation capacity) requirements, a spattering of long-term electric generation contracts, most electric generators divested from electric IOUs (excluding

large hydro-electric and nuclear generators) and the majority of electricity provided to customers under the control of the electric IOUs. Essentially, this structure is half of what electricity sector restructuring in the late 1990's sought to accomplish; full wholesale and retail electricity supply chain competition.

Looking back, the impetus that started electricity sector restructuring was a desire to reduce costs through competition and help the state achieve its high-level energy goal of affordable electric service. However, in California, the policy-makers and regulators were forced to confront the uncomfortable fact that much of the customer appeal of electricity sector restructuring was rooted not in cost savings through competition, but rather in the opportunity to shift fixed costs between different classes of residential and non-residential customers (Borenstein et al, 2014). This complicated the restructuring of the retail side of California's electricity sector, as electricity rates have historically been driven more by political concerns between different classes of residential and non-residential customers than by economic efficiency (Borenstein et al, 2014). However, this is starting to change with the CPUC slowly starting to re-open retail competition for third parties, such as ESPs and community choice aggregators (CCAs), to provide electricity to customers. This change coupled with emerging issues are challenging the state's ability to achieve its high-level energy goals and are thus forcing policy-makers and regulators to seriously consider new electricity sector reforms.

California's Electricity Sector – Emerging Challenges

As a result of Senate Bill 695 (SB 695), non-residential (i.e. commercial and industrial) customers can currently purchase electricity from ESPs but only up to an overall historical demand amount in each electric IOU territory (CPUC, 2010). This capped the amount of electricity ESPs could serve to non-residential customers. Currently, it is roughly 13 percent of the total electricity retail sales of the electric IOUs (CPUC, 2010). As of July 2014, roughly 12.9

percent of the electric IOUs total electricity retail sales was provided by ESPs (CPUC, 2010). Most of the non-residential customers served by ESPs are industrial facilities (CPUC, 2014). In addition, a couple of cities have become CCAs, as authorized under Assembly Bill 117, which was passed in 2002 in the waning days of California's electricity crisis (CPUC, 2014). CCAs are cities and counties that aggregate the buying power of individual customers within a defined jurisdiction in order to purchase wholesale electricity through contracts or the CAISO's competitive wholesale electric power markets. CCAs essentially serve the same role as ESPs. There are currently only two CCAs in California, the Marine Energy Authority and the Sonoma Clean Power Authority, though there is interest from other cities and counties as well (CPUC, 2014). Both CCAs and ESPs are required to follow the same electricity planning reserve and resource adequacy obligations as the electric IOUs. However, their electricity contracts are not reviewed nor approved by the CPUC like the electric IOUs (CPUC, 2004).

The growth of third-party electricity providers over the last five years within the electric IOU territories has begun to raise questions about the future of California's electricity sector. However, these questions are mainly being driven by California's clean energy policies and recent technological advancements. These in turn are being guided by California's desire to address global climate change. In 2006, the state legislature enacted Assembly Bill 32: The California Global Warming Solutions Act (AB 32), mandating that California reduce its greenhouse gas emissions (GHG) to 1990 levels by 2020 (AB 32, 2006). In 2008, the California Air Resources Board (CARB), the primary agency responsible for implementing AB 32, developed California's *Climate Change Scoping Plan* outlining various GHG reduction actions in all of California's economic sectors (CARB, 2008). These actions include direct regulation, market-based mechanisms, incentives and voluntary efforts (CARB, 2008).

Not surprisingly, California's electricity sector is a major contributor to the states GHG emissions and in 2011 electric generation contributed 20 percent of California's total gross GHG emissions (CEC, 2013). Of this amount, 11 percent comes from out-of-state electricity imports (CEC, 2013). To reduce GHG emissions from California's electricity sector, California's *Climate Change Scoping Plan* of 2008 recommended that an increase in electricity be supplied from renewable electric generation and that the state aggressively pursue increasing energy efficiency in new and existing residential and non-residential buildings (CARB, 2008).

Following these recommendations, in 2011 Senate Bill X1-2 (SB X1-2) officially codified California's new RPS target requiring that all electricity providers in California, including the electric IOUs, POUs, ESPs and CCAs, procure 33 percent of their annual electricity sales from eligible renewable electric generation by 2020 (CEC, 2014). Also, to encourage all of California's electricity providers to achieve this target, interim RPS targets were established, including 20 percent by the end of 2013 and 25 percent by the end of 2016 (CEC, 2014). For California's electric IOUs, eligible renewable electric generation that count toward their targets are mainly large-scale, independent power producer owned, have long-term (20 year) contracts, are connected to California's electric transmission system, and are scheduled to dispatch electricity through the CAISO (CPUC, 2014).

The new, more aggressive RPS target is driving the large-scale deployment of renewable electric generation in California. Complimentary policies and programs in recent years are also driving the deployment of the preferred electricity resources within the electric distribution system. In 2006, Senate Bill 1 (SB 1) created the Go Solar California program, a \$3.3 billion incentive program within the electric IOU territories for residential and commercial building owners interested in installing solar photovoltaic systems on or near their new or existing building with the goal of installing 3,000 MW by the end 2016 (Go Solar California, 2014). This, plus the

Net-Energy Metering (NEM) tariff, which allows customers within the electric IOU territories to receive electricity bill credit for the electricity they produce and export to the electric distribution system, has significantly helped increase the penetration of solar photovoltaic systems within the electric IOUs electric distribution systems (Go Solar California, 2014). In addition, the states creation and continued commitment to the Self-Generation Incentive Program (SGIP), within electric IOU territories, has further encouraged the development of electric generation (also known as distributed electric generation or distributed generation) within the electric distribution system. SGIP, in its many iterations since 2001, has and continues to offer up-front and performance based incentives to customers interested in developing on-site non-electricity exporting distributed electric generation, including wind turbines, waste heat-to-power technologies, pressure reduction turbines, internal combustion engines, micro-turbines, gas turbines and fuel cells (CPUC, 2014). SGIP also offers incentives for advanced energy storage systems. Senate Bill 861 (SB 861) recently extended funding for SGIP until December 31, 2019 (SB 861, 2014). For other types of distributed generation connected to the electric distribution system and that export all or excess electricity, the electric IOUs have administered a variety of renewable Feed-in Tariff (FiT) procurement mechanisms. FiTs are long-term standard priced contracts available to developers for their renewable distributed electric generation (for example, solar photovoltaic systems), sized between one and 20 MW and located within an electric IOUs electric distribution system. The availability of these contracts has fluctuated in recent years and are usually associated with a program cap on how many MW can be developed within each electric IOU territory (CPUC, 2014).

To complement these actions to reduce GHG emissions from electric generation and to meet California's electricity demand with preferred electricity resources, per the "loading order", the CPUC developed *California's Long Term Energy Efficiency Strategic Plan* (Plan) in 2008.

The Plan outlined a series of strategies and actions to maximize investments in energy efficiency upgrades through the electric IOUs energy efficiency programs for existing residential and non-residential buildings. The Plan also established two key energy efficiency goals for new buildings; all newly constructed low-rise residential building are to be zero-net energy (ZNE) by 2020 and all new commercial buildings by 2030 (CPUC, 2008). According to the Plan, ZNE is defined as the amount of energy (electricity and natural gas) provided by on-site renewable distributed electric generation is equal to the amount of energy used by the building (CPUC, 2008). There are many complexities and nuances to this definition, but the intent of constructing ZNE buildings is to maximize building energy efficiency (design, equipment and operational efficiency) and couple it with on-site renewable distributed electric generation (Trocellini et al, 2006). The result is an energy self-sufficient building that has low to no GHG emissions and saves the building owner energy costs over the life of the building.

Another preferred electricity resource that builds off of building energy efficiency upgrades that has not been significantly deployed in California, is demand response. Demand response is a change (usually a reduction) in electricity consumption by customers from their normal consumption patterns in response to changes in the price of electricity, or to incentivize payments designed to induce lower electricity use during peak electricity demand when electricity costs are highest and/or when electric service reliability is jeopardized (FERC, 2014). For customers that are on time-of-use (TOU) electricity rates, mainly commercial and industrial customers in electric IOU territories, demand response can help save them from high electricity costs. TOU rates are electricity rates that reflect the variable/marginal cost of electricity generation throughout predictable periods of the day in contrast to a flat or tiered rate for electricity that apply mainly to residential customers in electric IOU territories. Demand response also has the added benefit of helping to reduce GHG emissions by avoiding the need to operate

typically inefficient (peaker) natural-gas fueled electric generators that only operate during peak electricity demand. Finally, demand response can help the CAISO better integrate large-scale renewable electric generation, such as wind and solar photovoltaic, into the electric transmission system, as these facilities have variable and intermittent electric generation (output changes daily and they only produce electricity, for example, when the wind is blowing or when the sun is shining).

Unfortunately, there has been little progress toward increasing the amount of demand response used in California according to the CEC's 2013 *Integrated Energy Policy Report* (CEC, 2013). The electric IOUs currently spend close to \$500 million a year on demand response programs (CEC, 2013). The electric IOUs currently contract with demand response aggregators who then voluntarily sign agreements with non-residential customers on TOU rates, and who are willing to reduce their electricity consumption by curtailing their operations in return for a payment that is communicated to them by the aggregator (CEC, 2013). The theory is that if the payment from the electric IOUs to these customers is greater than the electricity costs these customers would have incurred without reducing consumption, then they are encouraged to reduce electricity consumption. However, these customers also factor in the lost value of producing less of whatever product or service they are providing due to a reduction in electricity consumption. These costs could be large in terms of lost production, ruined product, restart costs, and other effects (CEC, 2013). There is great potential for demand response to act as a viable preferred electricity resource in which negawatts (absence of producing electricity measured in megawatts) are sold and procured similarly to electric generation. The electric IOUs, with CPUC approval, have begun signing multi-year contracts with demand response aggregators and are working with them to modify the programs so that they are more focused on price-signals than

emergency-signals (CEC, 2013). The CAISO is also developing mechanisms to allow demand response megawatts to bid into their competitive wholesale electric power markets (CEC, 2013).

The fundamental issue preventing residential customers from participating in demand response programs is the electricity rate structure established for the electric IOUs during and after the electricity crisis in the early 2000's. To protect residential customers from dramatic electricity rate increases during the crisis, the Legislature enacted Assembly Bill 1X (AB 1x) in 2001 which contained a provision that, as interpreted by the CPUC, froze electricity rates into a tiered structure for residential customers (CEC, 2013). This tiered structure assigns a specific electricity rate up to a given consumption level, and once a residential customer exceeds that consumption level they enter into a new tier with a higher electricity rate. The more the residential customer consumes the higher the electricity rate. However, these tiers do not reflect the actual costs of electric service nor do they align with the cost of electric generation that fluctuates throughout the day, week, month, season and year. Note that these tiered electricity rates are bundled, in which fixed costs and variable costs of electric service are coupled. There is a major disconnect between variable electricity prices within the CAISOs competitive wholesale electric power markets and the electric IOU residential electricity rates because they are not directly and dynamically reflective of actual electric generation and delivery costs (the cost of electric service). Also, the electric IOUs retrieve their fixed costs volumetrically through these tiers, which means residential customers that consume more electricity are paying more for the fixed costs than customers that consume less electricity, even though they use the electric transmission and distribution system infrastructure equally.

Enacted in 2009, Senate Bill 695 (SB 695) attempted to address these residential tiered electricity rates and allowed TOU and/or dynamic pricing (electricity rates that align with the costs of electric service on an hourly or sub-hourly basis) after 2013 under specific conditions

(CEC, 2013). However, Assembly Bill 327 (AB 327) enacted in 2013, currently prohibits the CPUC from requiring the electric IOUs to implement mandatory or default TOU or dynamic pricing for residential customers until 2018, when the restriction would be lifted for default TOU electricity rates; dynamic electricity rates would still be prohibited except on an opt-in basis (CEC, 2013). The current electric IOU rate structure for non-residential and residential customers and its misalignment with the cost of electric service is a major issue that not only impacts the viability of demand response but also the cost-effectiveness of energy efficiency upgrades and distributed generation, long-term electric transmission and distribution system infrastructure investments, and contracts with large-scale renewable and natural-gas fueled electric generators.

Regardless, California's numerous policies and programs are still driving the development of distributed and large-scale renewable electric generation as well as the mobilization of energy efficiency upgrades and demand response. All of which are being enabled more than ever by technological advancements in two-way digital communication, data analytics and automation and control systems. For example, advanced metering systems which are comprised of state-of-the-art electronic/digital hardware (meters) and software that combine interval energy consumption data measurement with continuously available remote communications, enable time-based information and frequent collection and transmittal of such information to customers, electric utilities and electric transmission system operators (FERC, 2007). These new enabling technologies are creating more options and pathways for these entities to better manage electricity supply and demand. These technologies are also creating opportunities to modernize the entire electric system, particularly the electric distribution system where distributed energy resources (DER) - energy efficiency, demand response, distributed generation and electricity storage - can be coordinated and managed at a micro-level, balancing electricity demand more effectively with local electricity supply. These micro-level electric

distribution systems are known as micro-grids. The benefits of micro-grids are stated as improving electric service reliability, the ability to efficiently and effectively integrate intermittent renewable distributed generation that emit no GHG emissions and potentially reduce electricity costs to customers (CPUC, 2014).

A major technology component of micro-grids and an emerging DER that has yet to be discussed is electricity storage. Electricity storage is a real game changer due to the fact that these technologies can assist in integrating intermittent renewable electric generation of all sizes and applications because it can store excess electricity that is generated, and dispatch it at times when these resources are not generating. Up until recently, electricity storage technologies have been the one technology area viewed as being too costly to be seen as viable (CEC, 2011). This is changing, as battery electricity storage for example, is becoming more prevalent for mobile purposes, such as hybrid and battery electric vehicles, and for stationary purposes. Stationary electricity storage other than pumped hydro-electric - battery, flywheel and compressed air – received a major financial boost through the American Reinvestment and Recovery Act (ARRA) which leveraged \$585 million of industry cost-share funding by providing \$185 million for the demonstration and deployment of these technologies interconnected at different points within the country's electric system (Wesoff, 2012).

Many of these demonstration projects are located in California and are just now starting to operate. These technology demonstration projects will likely assist the electric IOUs and the CAISO get a better understanding of how to properly value electricity storage and how to operate them. Also, in response to Assembly Bill 2514 (AB 2514) enacted in 2013, the CPUC adopted 1,325 MW as the electric IOUs electricity storage procurement target to be achieved by December 31, 2020 (CPUC, 2014). This mandatory procurement target is driving the market for electricity storage deployment in California and may help reduce the costs of these technologies

overtime through economies of scale. Unfortunately, the CPUCs regulatory framework that governs the electric IOUs recovery of costs for investments and electricity procurement, their monopoly of electricity sales and the interconnection of DERs, specifically electricity storage and distributed generation, to an electric IOUs electric distribution system complicates the deployment of these technologies (CPUC, 2014).

Conclusion

Most of California's energy policies and programs since the electricity crisis of 2001, and new and emerging technologies, as discussed in the preceding section, pose challenges to the state to achieve all of its high-level energy goals – affordable, efficient, reliable and environmentally responsible electric service - for its electricity sector. To address these issues and achieve it high-level energy goals, California's electricity sector hybrid-market structure will need to change. Some of these changes may stem from provisions within AB 327, such as the new requirement that mandates the electric IOUs to submit to the CPUC a distribution resources plan by July 1, 2015. These plans require the electric IOUs to identify optimal locations for the deployment of DERs and for the CPUC to review these plans and approve spending on electric distribution system infrastructure upgrades necessary to accommodate DERS. These plans also represent an opportunity to reexamine California's electric system hybrid-market structure, specifically the electric IOUs electric distribution systems. However, it is likely that new structural reforms well beyond the electric IOUs distribution resources plans are needed to address these new and emerging technologies, policies and programs, and help the state achieve its high-level energy goals for this sector – affordable, efficient, reliable and environmental responsible electric service.

Chapter 4

METHOD OF ANALYSIS AND CALIFORNIA'S ENERGY GOALS

Chapter 2 presented background of historic decisions, events, trends and structural reforms that affected California's electricity sector up until the state's electricity crisis in 2001 and the emergence of its high-level energy goals. Chapter 3 then discussed the aftermath of California's electricity crisis, the current hybrid-market structure of the state's electricity sector, and emerging issues that are challenging the state's ability to achieve its high-level energy goals for this sector – affordable, efficient, reliable and environmental responsible electric service. This chapter explains my method of analysis and how I have defined the state's high-level energy goals. I will use these goals to assess the three new electricity sector structural reforms I present in Chapter 5.

Method of Analysis

Policy analysis extends beyond individual decision-making and individual impacts. The choices that policy-makers and regulators decide upon are often very complex and can have both positive and negative impacts for a large number of citizens. These choices can help achieve some goals while ignoring others, and there are always costs to one party or another. Trade-offs are almost always involved. There are many methods and tools to choose from to analyze public problems, and choosing between them is an important step in that process. In this thesis, I elected to use a modified version of a Criteria-Alternatives Matrix (CAM). A CAM is a tool often used to aid in decision-making in which specified alternatives are evaluated against their ability to meet certain criteria that are important to the problem being considered within a matrix or table. These tables allow analysts to quickly summarize extensive analysis in a simple and organized manner (Mintron, 2012).

This approach is built upon decision-making theory (Department for Communities and Local Governments, 2009). The main assumption of decision-making theory is that decision makers have a desire to make thoughtful, coherent decisions (Department for Communities and Local Governments, 2009). Essentially, this means that decision makers deliberately try to make decisions that do not contradict one another (Department for Communities and Local Governments, 2009). Individuals use this approach almost every day. For example, when deciding to buy a vehicle, an individual may consider multiple factors:

1. The cost of the vehicle
2. The fuel efficiency of the vehicle
3. The style of the vehicle
4. The size of the vehicle

For a prospective vehicle buyer, these factors often conflict. For instance, a large vehicle may not be very fuel-efficient. Using this approach allows an individual to assess and confront these trade-offs in order to make an informed decision. It essentially provides a framework for an individual to clearly outline a decision-making process so that trade-offs between alternatives are evaluated against a set of criteria.

My modified version of a CAM includes summary tables of scores I have assigned to each of the three new electricity sector structural reforms based on my qualitative assessment of their ability to achieve the state's high-level energy goals and thereby address the emerging issues confronting this sector. I derived these goals from themes that emerged throughout the evolution and history of California's electricity sector as discussed in Chapters 2 and 3. In the next section, I define each one of these goals broadly, since I am using them for a comprehensive and systematic assessment, and because some of the goals are not clearly and measurably defined within existing literature. This is an area worth exploring further as a broad definition limits the

usefulness of these goals at assessing policy actions, which in this case are three new electricity sector structural reforms. However, as stated in Chapter 1, the primary intent of my assessment is to help frame policy discussions focused on improving California's electricity sector.

After I define California's high-level energy goals for its electricity sector in the next section, I then present and explain three new electricity sector structural reforms in Chapter 5. These three new structural reforms are aimed at achieving the state's high-level energy goals, thereby addressing the emerging issues within California's electricity sector that are challenging the state from achieving these goals. I developed these three structural reforms based on literature that influenced past reforms, existing practices and initiatives currently underway to modify segments of California's electricity sector. In Chapter 6, I assess each one of these structural reforms against each high-level energy goal for the state's electricity sector and assign scores. I also provide an explanation why I chose to assign certain scores to each structural reform. A positive score is represented by a "+" which means that the structural reform would likely help achieve the specified goal. A neutral score represented by an "O" means that it is uncertain if the structural reform would help achieve the specified goal. A negative score represented by a "-" means that the structural reform would likely not help achieve the specified goal. Summary charts of the assigned scores are included within Chapter 6 to visualize this assessment.

California's Electricity Sector - Energy Goals

California has led the nation and the world in implementing progressive policy actions to address issues that challenge the state's ability to achieve its high-level energy goals. These policy actions, which include structural reforms, were explained in Chapter 2 and 3 and are specifically aimed at achieving four high-level energy goals – affordable (affordability), efficient (efficient resource use), reliable (reliability) and environmentally responsible electric service - that, if achieved, define a well-functioning electricity sector (Weare, 2003). These goals are described in

the proceeding section and will be used assess the three new electricity sector structural reforms presented and explained in the next chapter.

Goal 1 – Affordability: Electric service affordability for the purposes of this assessment is defined broadly as the cost of electric service, reflected in electricity in rates and its sum reflected in monthly electricity consumption bills being within the financial means of customers. A structural reform that is assigned a “+” score under this goal is one that likely does not significantly increase electricity rates and its sum reflected in monthly electricity consumption bills, which differs between customers and thereby is remains within the financial means of customers. A structural reform that is assigned a “O” under this goal is one where it is uncertain if current electricity rates and its sum reflected in monthly electricity consumption bills, which differs between customers, would significantly increase or not. Finally, a structural reform that is assigned a “-” under this goal is one that would likely significantly increase current electricity rates and its sum reflected in monthly electricity consumption bills, which differs between customers.

Goal 2 - Efficient Resource Use: Economic efficiency is generally defined as a state in which resources are optimally allocated to serve each person in the best way while minimizing waste and inefficiencies (Business Dictionary, 2015). For the electricity sector I have chosen to define this in the context of electric generation. Electric generation efficiency means that all electric generation is run optimally from the lowest cost generators before higher cost generators are utilized (Weare, 2003). A structural reform that is assigned a “+” score under this goal is one that would likely optimize the lowest cost electric generators before higher cost generators. A structural reform that is assigned an “O” under goal is one where it is uncertain if electric generators would be optimized. Finally, a structural reform that assigned a “-” under this goal is one that likely does not optimize the lowest cost electric generators before higher cost generators.

Goal 3 - Reliability: There are two fundamental concepts that define electric service reliability: adequacy and operation. For the purpose of this assessment, I have merged these two concepts together. Thus, I define reliability as the ability of the electric system to supply electricity to customers at all times, taking into account scheduled and reasonably expected unscheduled electricity outages of system components and the ability of the electric system to withstand sudden disturbances such as electric short circuits or unanticipated loss of system components (North American Electric Reliability Corporation, 2007). A structural reform that is assigned a “+” score under this goal is one that likely improves electric service reliability as defined above. A structural reform that is assigned an “O” under this goal is one where it is uncertain if electric service reliability would improve or become compromised. Finally, a structural reform that is assigned a “-” under this goal is one that likely compromises electric service reliability.

Goals 4 - Environmentally Responsible: For the purposes of this assessment, I define environmentally responsible electric service as the generation and consumption of electricity having minimal impacts on the natural environment, preserving clean air and water, and protecting environmental resources. This includes minimizing and reducing greenhouse gas (GHG) emissions that contribute to global climate change as specified in statute through the enactment of Assembly Bill 32: The California Global Warming Solutions Act (AB 32). A structural reform that is assigned a “+” score under this goal is one that would likely minimize and reduce any adverse impacts on the natural environment, including GHG emissions. A structural reform that is assigned an “O” under this goal is one where it is uncertain if adverse impacts on the natural environment would increase or be minimized. Finally, a structural reform that is assigned a “-” under this goal is one that likely increases adverse impacts on the natural environment, including an increase in GHG emissions.

Achieving these goals, represented by a “+” score, described above, involves varying degrees of trade-offs. Maintaining affordable electric service may decrease the amount of capital needed to fund electric system expansions and/or improvements that ensure electric service reliability. Policy actions aimed at reducing and avoiding the environmental impacts associated with the generation of electricity may in turn increase electricity rates and bills to a point where they may no longer be considered affordable. Ensuring electric service reliability could in turn require the construction of additional electric system infrastructure that could cause environmental damage, such as habitat destruction and water and air pollution. The three new electricity sector reforms I discuss in Chapter 5 differ not only in how well they achieve these four high-level electricity sector energy goals but also in the trade-offs between the goals.

Conclusion

This chapter explained my method of analysis and defined the state’s high-level energy goals for its electricity sector. My method of analysis is a modified version of a CAM, whereby I assign scores, summarized in tables, based on my qualitative assessment of three new electricity sector structural reforms against the state’s high-level energy goals for this sector. I defined the state’s high-level goals broadly since I am using them for a comprehensive and systematic assessment, and because some of the goals are not clearly and measurably defined within existing literature. The next chapter explains three new electricity sector structural reforms to address this sectors emerging issues and help the state achieve its high-level energy goals for this sector – affordable, efficient, reliable and environmental responsible electric service.

Chapter 5

STRUCTURAL REFORMS FOR ANALYSIS

Chapter 4 explained my method of analysis and defined the state's high-level energy goals that I will use to assess three new structural reforms to California's electricity sector. This chapter discusses these structural reforms that are aimed at structurally modifying California's wholesale and retail electric power markets, the regulatory framework of the California Public Utilities Commission (CPUC), Energy Resources Conservation and Development Commission (California Energy Commission, CEC), California Independent System Operator (CAISO) and the state's electric investor owned utilities (IOUs). These reforms have similarities, in addition to key differences, that involve trade-offs and varying degrees of political sensitivity. All of these reforms are aimed at addressing this sectors emerging issues and help the state achieve its high-level energy goals for this sector – affordable, efficient, reliable and environmental responsible electric service. Though there are a multitude of structural reforms that could be explored and assessed, I have chosen only three that were each derived from the history and background presented in Chapters 2 and 3.

The first structural reform proposes strengthening the current regulatory framework of California's electricity sector, both the current semi-competitive wholesale electric power market and the monopolized retail electric power market. The second structural reform proposes full and deeper restructuring of California's wholesale and retail electric power markets to functional and manageable competition. The last reform proposes a hybrid approach, combining a stronger regulatory framework with initiatives that increase competition.

Strengthening the Existing Regulatory Framework

Enhancing the existing regulatory framework of California's electric IOUs is a structural reform worth exploring. Before the restructuring reforms of the 1990's that were aimed at

creating competitive wholesale and retail electric power markets, California's electricity sector enjoyed relatively stable electric system planning and a high degree of electric service reliability. These characteristics were attributed to the traditional "cost-of-service" or "rate-of-return" regulation by the CPUC. Under this regulatory regime, the electric IOUs would propose investments in electric generation and electric transmission and distribution system infrastructure and the CPUC would determine, through various public regulatory proceedings, which investments were prudent and necessary to meet growing electricity demand. The CPUC would then establish electricity rates that reflected these costs and would spread these costs amongst customers within electric IOU territories. The CPUC would also decide on a fair "rate of return" to electric IOU private investors/shareholders that would be passed on and included in their electricity rates. This type of regulation had existed for decades and provided clear signals to investors to develop enough electric generation capacity to ensure that electricity demand was met.

Some of these regulatory elements already exist within California's current electricity sector hybrid-market structure; however, there are actions that can be taken to capture more of the benefits from this regulatory framework. These actions focus on modifying and strengthening parts of the wholesale and retail electric power markets, electricity rates and the roles of the CPUC, CEC and CAISO. I will present these actions for each of the elements mentioned in the previous sentence throughout the rest of this section.

As described in Chapter 3, the electric IOUs currently procure electric generation capacity and electricity through the LTPPP, which is a regulated procurement framework overseen by the CPUC and mimics elements of traditional "cost-of-service" regulation. However, the electric IOUs do not own most of their electric generation and either engage in contracts with independent power producers for electric generation capacity and/or electricity, or purchase

electricity through the CAISO's competitive wholesale electric power markets (day-ahead and real-time/spot markets) from independent power producers. To enhance electric service reliability and improve long-term electric system planning the CPUC could require the electric IOUs to engage in long-term contracts with independent power producers to meet 100 percent plus a modest planning reserve, of their electricity demand, instead what they receive now from these contracts (a little over half) (CAISO, 2013). This would be similar to the resource adequacy framework the electric IOUs currently follow to procure electric generation capacity. Under this framework, they currently procure 115 percent of electric generation capacity above their forecasted peak electricity demand 30 days prior to the start of a calendar month (CPUC, 2004). 90 percent of this electric generation capacity is procured through forward contracts by November 1st of the previous calendar year (CPUC, 2004).

Employing a similar framework for electricity procurement would effectively diminish the need for the CAISO's competitive wholesale electric power markets and restrict the CAISO's purpose to a just an electric transmission system operator. This means that the CAISO would either facilitate much smaller competitive wholesale electric power markets for other non-electric IOU participants, such as the electric publically owned utilities (POU), energy service providers (ESPs), community choice aggregators (CCAs), or none at all. The CAISO would focus its attention instead on operating the electric transmission system; dispatching electricity from electric generators contracted with the electric IOUs based on electricity demand (factoring in the location of electric generators), contracted electricity price, time and electric generation capacity. Essentially, none of the wholesale electricity prices would be determined by day-ahead and real-time/spot competitive wholesale electric markets but through long-term contracts under the watchful eye of the CPUC.

In addition, the CPUC could allow the electric IOUs to engage in long-term electric generation capacity contracts longer than a couple of years and potentially more than 10 years. The costs for these long-term contracts for both electricity and electric generation capacity would be passed down to electric IOU customers in electricity rates. This means that electricity rates would likely increase, but it could ensure improved electric service reliability and longer term electricity rate stability since wholesale prices would be fixed for long periods of time.

Given the recent enactment of Assembly Bill 327 (AB 327) in 2013, maintaining the current monopolized retail electric power market and electric distribution system by the electric IOUs is possible, even with the statutes mandates. Not only does AB 327 prohibit the CPUC from requiring the electric IOUs to implement default time-of-use (TOU) or dynamic pricing for residential customers until 2018, it also requires the electric IOUs to submit distribution resource plans (DRPs) by July 1, 2015 to the CPUC. These DRPs are to recognize, among other things, the need for investment to integrate cost-effective distributed energy resources (DER) - energy efficiency, demand response, distributed generation and electricity storage - and for actively identifying barriers to the deployment of DERs, such as safety standards related to technology or operation of the electric distribution system (CPUC, 2014). These DRPs will likely force the electric IOUs to better identify locations on their electric distribution systems where DERs could provide the most benefit for the electric distribution system and to electric IOU customers. Given the significant change this will represent to traditional electric distribution system planning processes, which have mainly focused on meeting expected electricity demand growth and potential peak demand without much regard to customer-side interactions, this relatively narrow focus may be considered revolutionary (CPUC, 2014).

The CPUC's draft DRP guidance document directs the electric IOUs to develop three analytical planning frameworks. The first is an analysis of electric distribution system capacity to

assess the capabilities of its existing infrastructure to integrate varying degrees of DERs, The second is an analysis of optimal locations to deploy DERs based on the quantified value they provide to the electric distribution system (i.e. avoided electric distribution and transmission system upgrades, avoided wholesale electricity procurement costs etc.). The third is an analysis that incorporates DER deployment scenarios that project the growth of DERs on the IOUs electric distribution systems over a 10 year period (CPUC, 2014). The guidance document further directs the electric IOUs to use their existing resources to demonstrate different DERs, analyze their impacts on the electric distribution system and better quantify their benefits. Furthermore, the guidance document directs the electric IOUs to include mechanisms to acquire, generate and share data with third parties about their electric distribution system, as well as identify mechanisms to encourage the deployment of DERs and the barriers they confront (CPUC, 2014).

The development of the electric IOUs DRPs can enhance their primacy as an electric distribution system operator and monopolized provider of electricity within their territories. In fact, the CPUC DRP guidance document explicitly states that though the DRPs may serve as a foundation to reinvent the existing monopolized retail electric power market and the role of the electric IOUs, it is not the focus of the CPUCs DRPs regulatory proceeding or its guidance document (CPUC, 2014). The CPUC could in effect designate the electric IOUs as the sole providers and integrators of DER services. This means that each electric IOU could bolster, create and provide new services and products to their customers in the form of customer DERs or contract with third-party DER providers that would provide these services but are managed through the electric IOUs. To encourage the electric IOUs to actively deploy DERs, the CPUC could build off of the energy efficiency reward mechanism model that establishes performance goals for the electric IOUs energy efficiency program portfolio, and rewards them based on the amount of energy they save through this portfolio of programs that they and third-party providers

administer. The CPUC could also modify and expand this model to offer rewards to the electric IOUs based on the value DERs provide at specific locations. In addition, the CPUC could modify its regulated procurement framework (includes electricity procurement and resource adequacy requirements to procure electric generation capacity) to allow DERs to participate and offer into the electric IOUs procurement processes. This would further encourage the electric IOUs to deploy DERs. For example, in response to the closure of the San Onofre Nuclear Generation Station (SONGS) in southern California in 2012, SCE issued solicitation in October, 2014 allowing all electricity resources (natural-gas fueled electric generators and DERs) to bid and compete in their procurement process for the west Los Angeles basin. Of the 1,892 megawatts (MW) in need of procurement, roughly 27 percent was awarded to DER providers (Golden, 2014).

Though the DRPs could transform the electric IOUs into better planners and more than just providers of electricity, whatever modifications are made to the retail electric power market and to electric distribution system operations they must integrate and compliment the wholesale electric power markets and electric transmission system operations. This means that electric distribution system operations with DERs, such as the dispatch of electricity from distributed generators and electricity storage, and the reduction or shift in electricity demand from demand response, needs to be well coordinated with the CAISO's electric transmission system operations. With recent advancements in information and communication technologies, such as advanced metering systems, there is a tremendous amount of granular energy data being collected (i.e. building/site-specific electricity demand and DER operational characteristics) that are providing the electric IOUs and the CAISO with greater insight and near to real-time information about how the electric distribution and transmission system is operating within their territories. The development of clear data sharing protocols and processes could go a long way in assuring the

CAISO that DERs are providing services when and where needed, so that large-scale wholesale electric generators do not need to operate or are coordinated with electric distribution system needs and electricity demand (Resnick Institute, 2014).

A fundamental factor that impacts strengthening the existing regulatory framework or any other electricity sector reform, is electricity rate design – essentially, who pays, how much and why for electric service. As described in chapters 2 and 3, electricity rate design is complex and differs among customers. For example, non-residential (i.e. commercial and industrial customers) within electric IOU territories are on TOU electricity rates, which are electricity rates that reflect the variable/marginal cost of electricity production throughout predictable periods of the day, in contrast to a flat or tiered electricity rate that apply mainly to residential customers. There is a slow movement towards changing residential customer electricity rates, especially with the enactment of AB 327, which authorized the CPUC to establish a fixed charge on residential customers not to exceed \$10 per month beginning January, 2015 and may be adjusted by no more than the percentage increase in the Consumer Price Index for the prior calendar year (CPUC, 2014). This fixed charge in essence would cover the fixed costs of electric service such as electric transmission and distribution system infrastructure coupled with a volumetric electricity charge which would be based on the amount of electricity residential customers consume. This volumetric charge would be TOU based. Having a fixed charge and a volumetric electricity charge would unbundle electricity rates for customers and better align them with the costs of electric service. However, in a recent decision made by the CPUC through a public regulatory proceeding focused on residential electricity rate design, the electric IOUs were directed to not collect a fixed charge and instead modify the current residential electricity rate structure so that the lower tiers have higher electricity rates and the upper tiers have lower electricity rates (CPUC, 2014). This reduces the rate disparity between the lower and upper tiers, and prevents the upper

tier residential customers (high-electricity users) from paying a disproportional higher share of electric service costs which, historically, has subsidized lower tier residential electricity customers and those on low-income residential electricity rates (CPUC, 2014). Unfortunately, the CPUC's decision is only an incremental change to better align residential electricity rates with the actual costs of electric service. Given the CPUC's authority under AB 327 it should actively explore pursuing a fixed charge on residential customers to cover the fixed costs of electric service, coupled with a TOU volumetric electricity charge to fully reflect the actual costs of electric service that the electric IOUs provide. This type of residential electricity rate structure would likely be more financially prudent for the CPUC to oversee and manage. However, there are equity concerns that should be considered between low-income electricity customers and high-electricity users that are typically wealthier (CPUC, 2012). Also, many stakeholders that participated in the CPUC's residential electricity rate design public regulatory proceeding; voiced concerns about the disincentive a fixed charge would impose on residential customers to reduce their electricity consumption through conservation and investments in energy efficiency upgrades (CPUC, 2014).

Finally, strengthening the existing regulatory framework for California's electricity sector, specific to its electric IOUs, may not require any major changes to the current roles and responsibilities of the CPUC, CEC and CAISO. Under this framework, the CPUC would have more oversight and control over the electric IOUs procurement of electric generation capacity and electricity, electricity rates, the deployment of DERs and the administration of the electric IOUs various DER incentive programs and tariffs (for example, the electric IOUs energy efficiency program portfolio, Self-Generation Incentive Program (SGIP) and Net-Energy Metering (NEM) tariff). The CAISO under this framework would focus more on electric transmission system operation in close coordination with the electric IOUs, and would no longer facilitate the

competitive wholesale electric power markets or potentially to a lesser extent for non-electric IOU participants. The CEC would remain as the state's primary energy policy and planning agency and retain its core responsibilities, such as developing their electricity demand forecasts to feed into the CPUC's regulatory electricity procurement framework, creating the state's building and appliance energy efficiency standards, and administering a multitude of clean energy incentive programs (for example, New Solar Homes Partnership, and Proposition 39 – Clean Energy Jobs Act) that complement the CPUC's DER incentive programs.

Expanding and Creating Competitive Electric Power Markets

The second proposed structural reform focuses on expanding the competitive wholesale electric power markets and creating a competitive retail electric power market within the electric IOU territories. The restructuring reforms championed in the 1990s were aimed at creating both competitive wholesale and retail electric power markets. However, as described in chapter 2, the advent of California's electricity crisis brought on by complex and interrelated factors prevented these outcomes from coming to fruition. The decisions made after the crisis created a hybrid-market structure for California's electricity sector with semi-competitive wholesale electric power markets and a monopolized retail electric power market within electric IOU territories. The electric IOUs have begun to face some retail competition with the implementation of AB 695, which allowed non-residential (i.e. commercial and industrial) customers to purchase electricity from ESPs up to an overall historical electricity demand amount in each electric IOU territory (CPUC, 2010). There are also the two CCA's in California, Marine Energy Authority and the Sonoma Clean Power Authority that have entered the retail electric power market within electric IOU territories. However, private providers of distributed generation (i.e. solar photovoltaic systems and fuel cell technologies sometimes coupled with electricity storage technologies) are challenging the electric IOUs dominance of the retail electric power market more so than any

other entity. Currently, residential and non-residential customers within electric IOU territories are entering into agreements with these private providers, thereby reducing their reliance on the electric IOUs to provide electric service. These technologies coupled with tariffs, such as NEM, are encouraging rapid adoption by customers, raising questions about the role of the electric IOUs and who pays the costs of electric distribution and transmission system infrastructure and associated debts. However, a more distributed network of electric generators provided by non-utility third-party private entities integrated with other types of DERs and coordinated with more robust competitive wholesale electric power markets could increase electric service reliability, reduce reliance on natural-gas fueled electric generators, and provide economic benefits to customers in the form of reduced electricity bills.

Fostering greater competition within California's electricity sector presents opportunities for the state to capitalize upon, along with some additional challenges. The actions required to foster greater competition are numerous, and includes making significant changes to both the wholesale and retail electric power markets, electricity rates and the roles of the CPUC, CEC and CAISO. I will present these actions for each of the elements mentioned in the previous sentence throughout the rest of this section.

To encourage greater competition in the wholesale electric power markets, the CPUC could prevent or limit the number of contracts the electric IOUs enter into to procure electricity from independent power producers as they had done during restructuring in the 1990's. To control market power, which was one of the interrelated factors that caused the electricity crisis in 2001, the CAISO could establish a price cap within their competitive wholesale electric power markets. The CAISO would need to revise the price cap regularly to ensure that the cap is not below the marginal cost of electric generation from independent power producers and does not create a high cost to entering participants, thereby becoming a barrier to market entry (Weare,

2003). In addition, the CAISO could expand their wholesale electric power markets from the day-ahead and real-time/spot market by creating a month-ahead market. This market would present more opportunities for the electric IOUs to purchase electricity and independent power producers to bid into the competitive market their product. A month-ahead competitive wholesale electric power market would also allow the electric IOUs to hedge against potentially higher electricity prices in the day-ahead or real-time/spot market, similar to the contracts they currently use. Furthermore, the CAISO, once they have gained more experience, could expand their newly created energy imbalance market, which allows independent power producers within nearby electric transmission system operator territories, such as PacifiCorp, to participate in the CAISO's real-time/spot market (CAISO, 2015). This market provides the CAISO with more electric generators to call upon to dispatch their electricity into the electric transmission system. Having access to electric generators regionally will also assist the CAISO to integrate large quantities of variable and intermittent large-scale renewable electric generation, such as wind and solar photovoltaic, into the electric transmission system. Finally, the CAISO should continue its efforts to create pathways for non-residential customers and demand response aggregators to offer electricity demand reductions (negawatts) into the day-ahead and real-time/spot market. This would give the CAISO additional options to operate the electric transmission system and as mentioned in Chapter 3, could help CAISO better integrate large-scale renewable electric generation into the electric transmission system.

To ensure that there is enough electric generation capacity, the CAISO could create a competitive wholesale electric generation capacity market. This market would replace the current arrangement, whereby the electric IOUs procure this capacity through contracts with independent power producers. The CAISO would essentially manage the wholesale electric generation capacity market, matching electric IOUs, ESPs, CCAs and electric POUs with independent power

producers. There are many ways to design this market and the CAISO could look to other wholesale electric generation capacity facilitators. For example, other electric transmission system operators in the eastern United States enter into contracts with independent power producers instead of the electric utilities and other electric service providers, three years in advance, and then allocate the cost to all of these electric service providers in the delivery years in proportion to the electricity demand they are serving (CPUC, 2013). This market design feature, as well as others, is worth the CAISO exploring. Also, as stated in Chapter 3, there is enough electric generation capacity than current needs over the next 10 years in California; however it is not located in areas throughout California where the electric generation capacity is needed (CPUC, 2013). To factor in locational need, the New York Independent System Operator (NYISO) for example, requires that a certain percentage of electric generation capacity be located in designated areas throughout the state (NYISO, 2015). The CAISO could follow a similar model. Overall, there are pros and cons for creating a wholesale electric generation capacity market such as ensuring that independent power producers are contracted for future years but potentially at the expense of overcompensation (CPUC, 2013).

Given that the retail electric power market in electric IOU territories is still monopolized, there is a lot of potential to encourage competition. AB 327 could serve as the platform for the CPUC to begin modifying the roles and responsibilities of the electric IOUs and foster the deployment of DERs. As stated in the previous section, the electric IOUs are to submit their DRPs by July 1, 2015. The CPUC's DRPs guidance document states that they are not to serve as a foundation to reinvent the existing monopolized retail electric power market and the role of the electric IOUs. However, they can in fact be used for that very purpose. The three analytical planning frameworks and data disclosure mechanisms that will be presented in these plans will provide the CPUC and DER providers with greater insight into the electric IOUs electric distribution system

capabilities and operational characteristics. This insight could be what opens up the electric IOUs retail electric power markets to more competition, redefining their primary roles and responsibilities. With the CPUC's guidance, the electric IOUs could become more engaged operators of their electric distribution systems, competitive retail electric power market facilitators and the backstop for electric service, with the majority of electric service provided by DER providers in combination with ESPs and CCAs (Resnick Institute, 2014). This is a bold proposition, yet elements of it were imagined under full electricity sector restructuring back in the late 1990's. Now, with advances in two-way digital communication, data analytics and automation and control systems, it is possible to actively explore the integration and optimization of DERs, while allowing electric IOUs customers with greater electric service provider choice. As discussed in the previous section, the electric distribution system operators will need to enhance their coordination with the CAISO's electric transmission system operations and competitive wholesale electric power markets to avoid duplication and conflicts that upset not only the functions of the markets but the operations of the entire electricity system. This gets back to the need for the development of clear data sharing protocols and processes between the CAISO and the services provided by DERs through the electric distribution system operators.

Transforming the electric IOUs into more engaged electric distribution system operators and competitive retail electric power market facilitators will require the CPUC to actively examine new incentive structures for them (Resnick Institute, 2014). This could be removing the incentive that the electric IOUs have to generate a profit to satisfy their shareholders. However, this begs the question of how the electric IOUs would then accumulate capital to finance their fixed assets, such as electric transmission and distribution system infrastructure. Instead of accumulating private capital through bond financing and the issuing of stock, the electric IOUs could follow the model used by the electric POUs to accumulate capital, whereby they issue

municipal/public bonds that are paid for through electricity rates by all customers. This would begin to erode the private aspect of the electric IOUs. A less radical option could be what is used by CCAs and what was proposed during electricity sector restructuring in the 1990's, in which all customers within electric IOU territory would pay a fixed charge to cover all non-electricity generation costs (i.e. electric transmission and distribution system infrastructure, administration, long-term contracts with Qualified Facilities (QFs), investments in nuclear electricity generators and various public benefit programs) and then the costs of electric generation would be determined by the services offered by ESPs, CCAs and DER providers. This alludes to another area that would be in need of change: electricity rate design.

As explained in chapters 2 and 3 and in the preceding section, electricity rate design is complex and varies among different customers. We know that non-residential customers in electric IOU territories are on TOU electricity rates and that there is a movement toward changing residential customer electricity rates with the enactment of AB 327. Though the CPUC in a recent public regulatory proceeding directed the electric IOUs to not collect a fixed charge, the option is still on the table (CPUC, 2014). The CPUC should actively consider a fixed charge to cover the non-electricity generation costs as discussed in the previous paragraph and pursue voluntary TOU or dynamic pricing electricity rates for residential customers. By 2018, the CPUC should then make TOU electricity rates for residential customers default when the restriction to do so under AB 327 is lifted. Again, this would better align residential electricity rates with the actual costs of electric service and would provide more accurate price signals to residential customers who would then have the opportunity to determine how best to manager their electricity consumption and procure electricity. This is already occurring for non-residential customers who are experiencing economic incentives through TOU electricity rates to invest in DERs and procure electricity through ESPS or CCAs that suit their needs.

The other aspect that would need to be modified to foster more competitive wholesale and retail electric power markets are the roles and responsibilities of the CPUC, CEC and CAISO. If the electric IOUs become neutral enhanced electric distribution system operators and competitive retail electric power market facilitators, the CPUC would need to change how it regulates the electric IOUs. The CPUC would essentially become more of an overseer of the electric IOUs fixed cost investments and their impact on electricity rates. The CPUC would also focus more on the safety and maintenance of the electric IOU electric distribution systems and would have a limited role in overseeing electric IOUs procurement of electricity that would only serve as backstop electric service for customers within their territory. The CPUC would also need to have some oversight over ESP and CCA procurement of electric generation capacity. The CEC would remain as the state's primary energy policy and planning agency and would develop their electricity demand forecasts to feed into the CAISO's electric generation capacity market and the CPUCs potentially modified processes for determining expansions to the electric transmission system and upgrades to the electric IOUs electric distribution systems.

Also, since the electric IOUs would become neutral electric distribution system operators and competitive retail electric power market facilitators, the DER incentive programs, though still funded through the electric IOUs fixed charge, would be administered by the CEC, not the electric IOUs. This would make the CEC not only the state's primary energy policy and planning agency but also the state's primary DER incentive program agency. The CEC would essentially serve as a one-stop shop for DER incentive program management, integrating the programs it currently manages with those previously administered by the electric IOUs and overseen by the CPUC. The CAISO would continue to serve as the electric transmission system operator but with more responsibility to manage and facilitate expanded and new wholesale electric power markets as described previously in this section. The CAISO would also need to enhance its coordination

with the electric IOUs competitive retail electric power market and electric distribution system operations.

A Hybrid Approach

The last reform proposes a hybrid approach, combining elements of a stronger regulatory framework with initiatives that increase competition. This approach must be designed thoughtfully as there are some inherent conflicts when imposing a stronger regulatory framework with actions that foster competition. Some actions will likely complement one another while others will require policy-makers and regulators to choose between greater regulation and greater competition. Like the previous two structural reforms, this hybrid approach can be broken down into actions focused on changes to the wholesale and retail electric power markets, electricity rates and the roles of the CPUC, CEC and CAISO. I will present these actions for each of the elements mentioned in the previous sentence throughout the rest of this section

On the wholesale electric power markets side, the CAISO would continue to operate the electric transmission system and manage the competitive wholesale electric power markets as is, while building off of their experience implementing the energy imbalance market. The electric IOUs, ESPs and CCAs could engage in limited contracts and participate in the day-ahead and real-time/spot competitive wholesale electric power markets to purchase electricity. The amount of electricity procured by the electric IOUs will depend on their role as either a backstop or sole provider of electricity. If their role is to serve as a backstop for electric service then ESPs and CCAs would be the primary participants in the wholesale electric power markets. Procurement of electric generation capacity in this hybrid approach could start to mimic the wholesale capacity markets of eastern United States electric transmission system operators with the CAISO responsible for facilitating this market. This electric generation capacity would then be purchased

by the electric IOUs, ESPs, CCA or a mixture of all of them depending on their obligations and the design of the market.

On the retail electric power market side, the implementation of AB 327 could, as described in previous sections, enhance the primacy of the electric IOUs as the sole retailers of electricity or transform them into enhanced electric distribution system operators and competitive retail power market facilitators. A middle ground between these two pathways is difficult to project but a possible balance between the two could be for the CPUC to maintain the IOUs as the default providers of electricity and allow them to offer limited DER services. The bulk of these services would be provided by DER providers. The CPUC, likely with legislative authorization, could also lift the cap on the amount of electricity ESPs serve to non-residential customers. This could even be expanded to residential customers. Thus, electric IOUs would not be the sole provider of electricity or DER services but would be a participant, with limits and restrictions, in order to prevent market domination. Also, to ensure that the electric IOUs facilitate the deployment and integration of DERs, the CPUC could develop an incentive mechanism and/or regulations that increase the agency's oversight of their practices. It is difficult to foresee what electricity rate design would look like under this hybrid approach but it is probably something along the lines of a fixed charge coupled with a TOU volumetric charge. The TOU component could be altered depending on individual non-residential and residential customer electricity needs, which entities they procure electricity from (ESPs, CCAs or the electric IOUs) and the DER services they may or may not have.

The roles and responsibilities of the CPUC, CEC and CAISO would remain relatively the same under this hybrid approach. The CPUC would have oversight and control over the electric IOUs limited procurement of electric generation capacity and electricity as a backstop, electricity rates and the deployment of limited DER services. The CPUC would also have oversight over

ESP and CCA procurement of electric generation capacity. The administration of the electric IOUs various DER incentive programs overseen by the CPUC could be shifted to the CEC. Customers that have the electric IOUs as their backstop electric service provider or those that choose DER providers, ESPs and CCAs to provide electric service would have equal access to these incentive programs. Again, the CEC would remain as the state's primary energy policy and planning agency. The CEC would also continue to develop their electricity demand forecasts to feed into the CAISOs electric generation capacity market and the CPUCs regulated procurement framework, and potentially modified processes for determining expansions and/or upgrades to the electric system. Lastly, the CAISO would continue to function as the electric transmission system operator with a slightly greater role in expanding their competitive wholesale electric power markets.

The three electricity sector structural reforms that I have proposed and explained in the preceding sections will be the policy alternatives I will analyze in chapter 6. These alternatives will be evaluated against how well they accomplish California's energy and environmental goals, specific to its electricity sector. These goals serve as my criteria and were described in further detail in the previous chapter.

Conclusion

In this chapter, I identified and explained the following electricity sector structural reforms, strengthening the current regulatory framework of California's electricity sector, full and deeper restructuring of California's wholesale and retail electric power markets to functional and manageable competition, and a hybrid approach that combines a stronger regulatory framework with initiatives that increase competition. These three new structural reforms will be assessed against the state's high-level energy goals for its electricity sector - affordable, efficient, reliable

and environmentally responsible electric service - in the next chapter. Based on this assessment, I then present the results of my analysis at the end of the next chapter.

Chapter 6

ANALYSIS AND RESULTS

In the previous chapter, I described three new structural reforms to California's electricity sector that could address this sectors emerging issues and help the state achieve its high-level energy goals for this sector – affordable (affordability), efficient (efficient resource use), reliable (reliability) and environmental responsible electric service. This chapter discusses the results of my assessment of these three reforms. The results were determined by assessing the reforms against California's high-level energy goals for its electricity sector. As discussed in Chapter 4, I have assigned scores to each reform based on how well they achieve each goal. I also present an explanation of why I chose to assign these scores to each structural reform. These explanations are based on the history and background presented in Chapters 2 and 3 and my attempt to project the outcomes of each structural reform relative to each goal. A positive score is represented by a "+" which means that the reform would likely help achieve the specified goal. A neutral score represented by an "O" means that it is uncertain if the reform would help achieve the specified goal. A negative score represented by a "-" means that the reform would likely not help achieve the specified goal. The first section of this chapter outlines each reform in relation to each goal. As in Chapter 5, I have broken down each reform into actions focused on changes to the wholesale and retail electric power markets, electricity rates and the roles of the California Public Utilities Commission (CPUC), Energy Resources Conservation and Development Commission (California Energy Commission, CEC), and California Independent System Operator (CAISO). I have also included summary tables with the scores assigned to each reform assessed at the beginning of each section. I then finish by presenting my results in a table that summarizes the results of my assessment with all of the scores assigned to each reform.

Analysis of the Structural Reforms

Strengthening the Existing Regulatory Framework

This reform would enhance California's electric investor owned utilities (IOUs) existing regulatory framework.

Table 1: Summary of Scores for Strengthening the Existing Regulatory Framework

Goal	Score
Affordability	O
Efficient Resource Use	-
Reliability	+
Environmental Responsible	O

Goal 1 - Affordability: Strengthening and modifying the electric IOUs role in the wholesale electric power markets by authorizing them to procure all of their electricity and electric generation capacity through contracts with independent power producers, would likely lead to long-term electricity rate and bill stability. However, this does not mean that electricity rates and its sum total reflected in monthly consumption bills would be within the financial means of customers. Engaging in contracts for 100% of the electric IOUs electricity and electric generation capacity needs could end of up being more expensive. This is dependent upon a multitude of factors, such as the length of the contracts, location and amount of electricity the electric IOUs procure from independent power producers.

On the retail electric power market side, the distribution resource plans (DRPs) coupled with allowing the electric IOUs to offer distributed energy resource (DER) services and products could lead to more affordable rates and bills for certain customers, namely non-residential customers. This is dependent on the package of DER services and products provided to customers and how they are tailored to meet customer needs. For example, integrating energy efficiency

upgrades with demand response, distributed generation and electricity storage could dramatically reduce electricity costs to individual non-residential customers. This could also be true for residential customers. If planned for and optimized, DERs offered by the electric IOUs may reduce the need to upgrade electric transmission and distribution system infrastructure, and reduce the need for the electric IOUs to procure electricity and electric generation capacity from independent power products through contracts.

The electricity rate design proposed under this reform to pursue a fixed charge on residential customers to cover the fixed costs of electric service, coupled with a time-of-use (TOU) volumetric charge tied to electricity consumption may make electric service more affordable for some customers but not others. Any type of fixed charge is likely going to impact low-income residential customers more than high-income residential customers (CPUC, 2012). This is because a fixed charge would likely consume more of a low-income residential customer's income than their wealthier counterparts. Also, a fixed charge imposed upon residential customers will likely prevent them from being able to actively influence a portion of their electricity bill. This however depends on an individual residential customers overall electricity consumption. Strengthening and modifying the roles and responsibilities of the CPUC, CEC and the CAISO will likely not have a direct impact on the affordability of electric service. That is not say that the CPUC's regulatory oversight of the electric IOUs, the CEC's current regulatory and programmatic responsibilities and the CAISO's electric transmission system operator responsibilities do not impact the affordability of electric service as they most certainly do, but its indirect and difficult to attribute. Given all of the uncertainties presented in this section, I have given this structural reform a neutral score. **Score: "O"**

Goal 2 - Efficient Resource Use: Authorizing the electric IOUs to procure all of their electricity and electric generation capacity through contracts with independent power producers

would likely not lead to the most efficient use of electric generators. This is simply because independent power producers would not be competing against one another routinely to sell their electricity and electric generation capacity, as the price they are paid for both products would be determined through negotiated long-term contracts not through competitive wholesale electric power markets (day-ahead and real-time/spot markets). Also, the dispatch of electricity from independent power producers would be more of function of their contract obligations, not the optimization of the products they are providing. On the retail electric power market side, it is likely that the DRPs will allow the electric IOUs to better locate, integrate and optimize of use of DERs. However, there is no indication that having these services and products offered through the electric IOUs would result in greater efficiency that if they were procured directly by customers from third-party DER providers.

The electricity rate design proposed under this reform to pursue a fixed charge on residential customers to cover the fixed costs of electric service, coupled with a TOU volumetric charge tied to electricity consumption would likely better align electricity rates with the full cost of providing electric service. However, a fixed charge on residential electricity customers would likely discourage the conservation and efficient use of electricity, since these customers would not be able to influence a portion of their electricity bill through reduced consumption. Strengthening and modifying the roles and responsibilities of the CPUC, CEC and CAISO would likely not have a direct impact on the efficient use of electric generation resources. That is not say that the CPUC's regulatory oversight of the electric IOUs, the CEC's current regulatory and programmatic responsibilities and the CAISO's electric transmission system operator responsibilities do not impact the efficient use of electric generators as they most certainly do but its indirect and difficult to attribute. The lack of competition under this reform and the potential disincentive of a fixed charge on residential customers to conserve and use electricity more

efficiently would likely lead to a less efficient electric system. For these reasons, I give this reform a negative score. **Score: “-”**

Criterion 3 - Reliability: Authorizing the electric IOUs to procure all of their electricity and electric generation capacity through contracts with independent power producers would likely lead to greater electric service reliability. This is because there would be greater certainty in the supply and delivery of electricity. Also, coupling this with the deployment of DERs likely enhances electric service reliability given the distributed form of these resources. Again, this becomes a question of whether or not the electric IOU could effectively deploy DERs and operate them efficiently.

The residential electricity rate design proposed under this reform would likely have no real impact on electric service reliability. However, aligning the full costs of providing electric service with electricity rates amongst all customers likely provides the electric IOUs with more revenue certainty that they need to fulfill their capital, contractual, programmatic and mandated electric system investments. Strengthening and modifying the roles and responsibilities of the CPUC, CEC and CAISO would likely enhance electric service reliability. This is because there would be greater oversight by the CPUC to ensure that this specific goal is achieved. The CEC’s current regulatory and programmatic responsibilities and the CAISO’s electric transmission system operator responsibilities would likely not enhance electric service reliability but would definitely maintain it. Given the various stability oriented aspects of this reform it is likely that electric service reliability would be improved. For these reasons I give this reform a positive score. **Score: “+”**

Goal 4 - Environmentally Responsible: Allowing the electric IOUs to procure all of their electricity and electric generation capacity through contracts with independent power producers could have varying impacts on the environment. This really depends on the types of

electric generation that is being procured (i.e. renewable electric generation or natural-gas fueled electric generation). Currently, certain types of renewable electric generation, such as solar photovoltaic and wind, are not paid for their electric generation capacity since they are intermittent and variable and cannot be dispatched when called by the CAISO. It is likely that electric IOUs would procure a large amount of electricity from renewable electric generators and both electricity and electric generation capacity from natural-gas fueled electric generators to fill any electricity supply gaps.

Also, it is important to note that no electric generator is environmentally benign. Many large-scale renewable electric generators in California are typically located in areas far from where electricity is consumed and can take up large swaths of land, impact avian and ground-based wildlife and require expansion of electric transmission systems. Though there is little to no direct greenhouse gas (GHG) emissions from these generators when generating electricity there are other environmental impacts. Natural-gas fueled electric generators have similar impacts, but can utilize small land parcels and be located in areas where electricity is consumed. However, these generators do directly emit GHGs and criteria pollutants into the local communities. These generators also utilize water for cooling purposes which can have impacts on marine wildlife and local communities. It is difficult to assess what the environmental impact would be if the electric IOUs procured all of their electricity and electric generation capacity needs. In all likelihood, there could be more electric system infrastructure developed under this reform which would have greater impacts on the environment.

However, the electric IOUs DRPs and the offering of DER products and services could offset the need for them to procure electricity and electric generation capacity from independent power producers through contracts. This in turn would likely reduce the need to expand the electric transmission system and its associated components, thereby minimizing the

environmental impact of such development. Deploying DERs within the electric IOUs electric distribution systems takes advantage of the existing built environment and has little adverse effects on the environment. The question becomes whether or not the electric IOUs could deliver DER products and services efficiently and effectively to achieve the minimization of environmental impacts.

The electricity rate design proposed under this reform would likely discourage residential customers from conserving and efficiently using electricity given the fixed charge. This could potentially mean the need for greater amounts of electricity and electric generation capacity procured by the electric IOUs from independent power producers. However, this depends on the interaction and deployment of DERs, especially distributed generation and electricity storage, which could offset some of the need for both. Strengthening and modifying the roles and responsibilities of the CPUC, CEC and CAISO is likely it not have a direct environmental impact. That is not say that the CPUC's regulatory oversight of the electric IOUs, the CEC's current regulatory and programmatic responsibilities and the CAISO's electric transmission system operator responsibilities do not impact the environment as they most certainly do but its indirect and again, difficult to attribute. It is difficult to assess whether this reform would reduce the overall impact of the electric system on the environment as it really depends on the electricity generation procured by the electric IOUs, the operational characteristics of these generators and the ability of the electric IOUs to deploy DERs and operate them efficiently. For this reform, I give it a neutral score due to the many uncertainties. **Score: "O"**

Expanding and Creating Competitive Electric Power Markets

This reform would expand the competitive wholesale electric power markets and create a competitive retail electric power market within the electric IOU territories.

Table 2: Summary of Scores for Expanding and Creating Competitive Electric Power Markets

Goal	Score
Affordability	+
Efficient Resource Use	+
Reliability	O
Environmental Responsible	O

Goal 1 - Affordability: Limiting the number of contracts the electric IOUs enter into for electricity and electric generation capacity, and fostering energy service provider (ESP) and community choice aggregator (CCA) participation would likely increase competition within the day-ahead and real-time/spot competitive wholesale electric power markets. This is mainly because the electric IOUs, ESPs and CCAs would become more dependent on procuring electricity through these routine auction based competitive markets than through pre-arranged contractual agreements. Establishing a price cap within the competitive wholesale electric power markets would ensure that electricity prices do not exceed the marginalized costs of electric generation. This, plus expanding the competitive wholesale electric power markets (month-ahead and energy imbalance market) and fostering participation from the electric IOUs, ESPs and CCAs in these markets would likely lead to cheaper more affordable electricity prices, given the nature of supplier competition. In addition, if the CAISO allowed high-consumption electricity customer's and demand response aggregators to bid electricity demand reductions (negawatts) into the day-ahead and real-time/spot market, it would not only give the CAISO additional options to operate the electric transmission system, but would increase the number of market participants, and thereby increase competition. Finally, a competitive wholesale electric generation capacity market, though highly dependent on its design, would likely send appropriate

price signals to independent power producers to invest in new electric generation capacity without the need for the electric IOUs, ESPs and CCAs to obligate themselves to long-term contracts with pre-arranged negotiated prices. This could lead to more affordable and reduced prices for electric generation capacity that would otherwise be acquired through long-term contracts.

On the retail side, if the electric IOUs became more engaged electric distribution system operators and facilitators of competitive retail electric power markets, it is likely that the services and products offered by DER providers, in combination with ESPs and CCAs, would ultimately lead to electricity bill reductions for electricity customers. This is highly dependent on the types of electricity customers and electricity rate design, but DER providers, ESPs and CCAs would likely be more customer oriented. This is because in order to appeal to customers they would need to offer lucrative prices for the electricity they procure through the competitive wholesale electric power markets, and tailored DER products and services to fit the needs of their customers. In regards to electricity rate design, if the CPUC established a fixed charge for the electric IOUs, ESPs and CCAs and a volumetric TOU charge tied to customer electricity consumption, it would not only better align residential rates with the actual costs of electric service, but it would provide accurate price signals to these customers. These accurate price signals in turn would likely motivate residential customers to determine how best to manage their electricity consumption and procure electricity. This is already occurring for non-residential customers who are experiencing economic inducements through TOU electricity rates to invest in DERs and contract with ESPs and CCAs to suit their needs. The same could be true for residential customers and would likely lead to electricity bill reductions.

Modifying the roles and responsibilities of the CPUC, CEC and CAISO to foster more competition within the wholesale and retail electric power markets would likely have some

impact on the affordability of electricity. This impact is probably less so with the modified role of the CPUC under this reform, except for their continued regulatory authority over customer electricity rates. Centralizing the management of a majority of the DER incentive programs at the CEC and forcing the integration of such programs would likely make it easier for customers to navigate and access all of the financial opportunities available that reduce the costs of deploying DERs. This in turn would likely lead to reduced electricity bills through DER deployment. Finally, if the new and expanded wholesale electric power markets are designed and implemented appropriately, and coordinated with the operations of the electric IOUs electric distribution system, it is likely that the overall optimization of the electric system would lead to reduced electricity rates and bills for all customers. It is because of all these reasons that I have given reform a positive score. **Score: “+”**

Goal 2 - Efficient Resource Use: Limiting the number of contracts the electric IOUs enter into, encouraging them to procure most all of their electricity from the CAISO’s competitive wholesale electric power markets and fostering ESP and CCA participation within these markets would likely increase the economic efficiency of electric generation. This is because the generation and dispatch of electricity would be based more on the competitive prices independent power producers bid into expanded (month-ahead market and energy imbalance market) and existing competitive wholesale electric power markets (day-ahead and real-time/spot markets). Independent power producers who bid the lowest prices into these markets have a higher likelihood of being procured from an electric IOU, ESPs and CCAs than higher priced independent power producers. This in essence would lead to the efficient economic generation and dispatch of electricity into the electric system. The same concept would apply to a competitive wholesale electric generation capacity market. Also, if the competitive wholesale electric power markets allowed high-consumption electricity customer’s and demand response

aggregators to bid in electricity demand reductions (negawatts) it is likely that electricity consumption efficiency would increase. This is because high-consumption customers and demand response aggregators would reduce their or their client's electricity consumption and receive payments for doing so. This may be more economical than consuming electricity when it is perhaps the most expensive (usually during peak electricity demand).

Creating a competitive retail electric power market would likely encourage the efficient generation and consumption of electricity. Transforming the electric IOUs into electric distribution system operators and retail electric power market facilitators could potentially increase the deployment of DERs offered through third-party DER providers. This deployment coupled with two-way digital communication, data analytics and automation and control systems would optimize the use of DERs and lead to the efficient generation, dispatch and consumption of electricity. However, this is where retail electricity rate design plays an important role in presenting both residential and non-residential customers with price signals. For example, if the CPUC makes a fixed charge and a volumetric TOU charge tied to customer electricity consumption default for all electric IOU, ESP and CCA customers, it would better align residential electricity rates with the actual costs of electric service. It would also provide more accurate price signals to residential customers who would then have the opportunity to determine how best to manager their electricity consumption and procure electricity through ESPs, CCAs and/or DER providers. The electric IOUs coordination with the CAISO on the dispatch of electricity within the electric transmission and electric distribution systems would also impact the efficient operation of the entire electric system. Duplication or miscommunication between the two entities could mistakenly lead to more electric generation than needed, or encourage customers to reduce their electricity consumption at times when it is not necessary.

Modifying the CAISO's role as proposed within this reform, and increasing their responsibilities could lead to greater electric system efficiency, but as mentioned above, it would have to be well coordinated with the electric IOUs electric distribution system operations. The CPUC's role of regulating the electric IOUs as enhanced electric distribution system operators and competitive retail electric power market facilitators could improve electric system efficiency. This is likely, but only if the CPUC diligently oversees the electric IOUs responsibilities to maintain their electric system infrastructure and electricity rates. Finally, the CEC's expanded role as a one-stop shop for DER incentive programs would likely improve the efficiency of the electric system by reducing the upfront costs of DER investments for various customers. This in turn would likely increase the deployment of DERs within the electric IOUs electric distribution systems and provide the generation, dispatch and consumption efficiency benefits discussed earlier in this section.

However, relying solely on competitive markets to determine the efficient use of resources is highly dependent on how well they function. Active market management, oversight and coordination between the CAISO and CPUC within this reform are foundational. As was witnessed before and during the electricity crisis in 2001, the competitive wholesale and retail electric power markets were not appropriately designed, managed and implemented in tandem with one another nor were they well-coordinated. This does not necessarily mean, especially with advancements in DER technologies and two-way digital communication, data analytics and automation and control systems that the same outcome would occur. Policy-makers and regulators also have the advantage of learning from those mistakes. For all of the reasons stated above I give this reform a positive score. **Score: “+”**

Goal 3 - Reliability: It is difficult to assess whether encouraging the electric IOUs, ESPs and CCAs to purchase electricity and electric generation capacity from new and expanded

competitive wholesale electric power markets would improve electric service reliability. It really depends on the design, governance and structure of the markets. Forcing competition in the wholesale electric power markets led to electric system outages in the early 2000's but as discussed in previous chapters there were many complex and interwoven reasons for those outages. However, some of those reasons can be traced back to the design, governing and structure of the markets. Applying lessons learned from the 2001 electricity crisis and mimicking elements of other competitive wholesale electric power markets, as proposed under this reform could, improve electric service reliability but it is highly uncertain, especially given past experience.

It is possible that a well-functioning competitive retail electric power market with DERs deployed throughout the electric IOUs electric distribution systems could offset some of the electric service reliability concerns on the wholesale side. This however depends on the type, ubiquity, location and flexibility of these resources. However, DERs in essence would provide electricity customers, the electric IOUs and CAISO with more options to balance the supply and demand of electricity, which would likely improve the reliability of electric service. This is because customers would not be solely dependent on purchasing electricity through an electric IOU, ESP or CCA who in turn purchase electricity from the competitive wholesale electric power markets.

Better aligning electricity rates amongst all customers with the actual costs of electric service, especially residential customers, using a fixed charge and a volumetric TOU charge tied to customer electricity consumption would likely improve reliability. This is because the electric IOUs fixed electric system infrastructure costs would no longer be bundled within a tier electricity rate but would be fixed, guaranteeing them a stable revenue stream to expand and maintain their electric system infrastructure. This, coupled with a TOU volumetric charge tied to

customer electricity consumption (used to pay for electric generation), would likely give the electric IOUs, ESPs and CCAs a better sense of their revenue stream in which to meet electricity demand for their customers. Customers who do purchase electricity from ESPs or CCAs would still be required to pay this fixed charge but the volumetric TOU charge would fluctuate depending on their agreement with an ESP or CCA, the price of electricity within the competitive wholesale electric power markets and their electricity consumption.

Modifying the roles and responsibilities of the CPUC, CEC and CAISO would likely determine the effectiveness of the competitive wholesale and retail electric power markets that in turn would affect the reliability of electric service. If these markets function and are regulated appropriately and the electric system operates as intended then it is likely that electric service reliability could be improved. However, as was experienced during the 2001 electricity crisis creating competitive wholesale and retail electric power markets could harm the reliability of electric service. Given the uncertainty, I give this reform a neutral score. **Score: “O”**

Goal 4 - Environmentally Responsible: Creating and expanding competition in the wholesale and retail electric power markets would likely reduce the environmental impacts associated with the generation, dispatch and consumption of electricity. On the wholesale electric power market side it is likely that the independent power producers that bid in the lowest priced electricity have electric generators that are the most efficient (i.e. natural-gas fueled electric generators that generate more electricity per unit of natural gas) or have minimal operation costs (i.e. renewable electric generators, specifically solar photovoltaic and wind which take advantage of virtually free fuel sources). More electricity generated from efficient and renewable generators reduces GHG emissions and thus has less of an environmental impact. However, many large-scale renewable electric generators in California are typically located in areas far from where electricity is consumed and can take up large swaths of land, impact avian and ground-based

wildlife and require expansion of electric transmission systems. Though there is little to no direct GHG emissions from these generators when generating electricity but there are other environmental impacts. Natural-gas fueled electric generators have similar impacts, but can utilize small land parcels and be located in areas where electricity is consumed. However, these generators directly emit GHG emissions and criteria pollutants into the local communities. These facilities also utilize water for cooling purposes which can have impacts on marine wildlife and local communities. Some of these impacts can be offset by the deployment of DERs through a competitive retail electric power market as these resources are typically deployed within the existing built environment rather than the natural environment. This depends on the proliferation of these resources. But if the electric IOUs, ESPs and CCAs procure a majority of electricity within the competitive wholesale electric power markets from large-scale renewable electric generators and highly-efficient natural-gas fueled electric generators it would likely reduce the environmental impact of the overall electric system. This is especially true when complimented with high penetrations of DERs.

Modifying the roles and responsibilities of the CPUC, CEC and CAISO under this reform would likely determine the effectiveness of the competitive wholesale and retail electric power markets that in turn would affect the electric systems impact on the environment. If these markets function and are regulated as envisioned and the electric system operates as intended, it is likely that the overall environmental impact of the electric system would be reduced. Given the uncertainty of which electric generator electric IOUs, ESPs and CCAs procure electricity from, and uncertainty surrounding the proliferation of DERs under this reform, I give it a neutral score.

Score: “O”

A Hybrid Approach

This reform would combine elements of a stronger regulatory framework for the electric IOUs with initiatives that increase competition within the wholesale and retail electric power markets.

Table 3: Summary of Scores for a Hybrid Approach

Goal (Criteria)	Score
Affordability	+
Efficient Resource Use	+
Reliability	O
Environmental Responsible	+

Goal 1 - Affordability: Limiting the expansion of the competitive wholesale electric power markets, encouraging participation from ESPs and CCAs within these markets and allowing the electric IOUs, ESPs and CCAs to continue to engage in limited contracts, would likely strike a good balance and diversified approach to procuring electricity. This balanced, diversified approach would likely not expose the electric IOUs, ESPs or CCAs to massive fluctuations in wholesale electricity prices and thereby not drastically translate into higher electricity rates for the customers they serve. There is tremendous uncertainty about how an electric generation capacity market would impact electric service affordability but it is worth exploring by looking at how these markets function in the eastern United States.

On the retail electric power market side, a balance between allowing the electric IOUs to provide limited DERs products and services and serve as a backstop provider of electricity coupled with products, services and electricity offered by third-party DER providers, ESPs and CCAs would likely improve electric service affordability for customers. Again, DERs can help residential and non-residential customers better manage their electricity consumption and give

them more electricity procurement options. Having the electric IOUs and third party providers in the business of providing complimentary DER products and services, coupled with the ability of customers to choose between the electric IOUs, ESPs and CCAs for electricity would likely improve the affordability of electric service. This is mainly because these entities would be in competition with another to provide customers with electricity, products and services they want and need.

This again would depend on electricity rate design, but if these rates are designed as proposed under this reform as having a fixed charge coupled with a TOU volumetric charge tied to electricity consumption, it could lead to more affordable bills for many customers. Since the roles and responsibilities of the CPUC, CEC and CAISO would remain relatively the same under this reform it is not likely that there would not be an adverse or positive impact on the affordability of electric service. For all these reasons, I give this reform a positive score. **Score:** “+”

Goal 2 - Efficient Resource Use: Limiting the expansion of the competitive wholesale electric power markets, encouraging participation from ESPs and CCAs within these markets and allowing the electric IOUs, ESPs and CCAs to engage in limited contracts, could improve the efficient generation of electricity but probably only incrementally. This would depend on the mix of electric generation the electric IOUs, ESPs and CCA’s procure from the day-ahead and real-time/spot markets, and through contracts. Again, there is tremendous uncertainty about how an electric generation capacity market would impact the efficient production of electricity, but it is worth exploring by looking at how these markets function in the eastern United States.

On the retail side, a balance between allowing the electric IOUs to provide DERs products and services along with third-party providers would likely improve the efficient generation and consumption of electricity. Having the electric IOUs and third-party providers in

the business of providing complimentary DER products and services, coupled with the ability of customers to choose between the electric IOUs, ESPs and CCAs for electricity procured through the competitive wholesale electric power markets, would likely help residential and non-residential customers better manage their electricity consumption and give them more electricity procurement options. This in turn would likely lead to overall electric system efficiency.

However, this would depend on electricity rate design, but if these rates are designed as proposed under this reform as having a fixed charge coupled with a TOU volumetric charge tied to electricity consumption it could lead to the overall electric system efficiency. This is because the actual costs of electric service would be aligned with electricity rates. Thus, providing accurate price signals to customers. Since the roles and responsibilities of the CPUC, CEC and CAISO would remain relatively the same under this reform it is not likely that there would be an adverse or positive impact on the efficiency of the electric system. Incrementally fostering competition with the wholesale and retail electric power markets and allowing the electric IOUs to play a role in providing electricity and DERs could help stabilize the markets. The stability of these markets could in turn lead to the efficient generation and consumption of electricity. Therefore, I give this reform a positive score. **Score: “+”**

Goal 3 - Reliability: Limiting the expansion of the competitive wholesale electric power markets, encouraging participation from ESPs and CCAs within these markets and allowing the electric IOUs, ESPs and CCAs to engage in limited contracts, may improve electric service reliability, but its highly uncertain. Creating an electric generation capacity market may provide independent power producers the right economic prices signals of when and where to develop this capacity. Developing only the needed amount of electric generation capacity to meet electricity demand rather than overbuilding this capacity would probably not improve or compromise electric service reliability.

On the retail side, the deployment, integration and optimization of DERs would most likely improve electric service reliability. This is because of the distributed nature of these resources. DERs in essence would provide customers with more options to manage their electricity consumption. These resources would also provide the electric IOUs with more options to balance the supply and demand of electricity within their electric distribution system. This would likely improve electric service reliability since electricity customers would not be solely dependent on large-scale electric generators for electricity whether they procure it through electric IOUs, ESPs or a CCA. Again, this depends on how effective these resources are deployed and managed by the electric IOUs and third-party providers.

Better aligning electricity rates amongst all customers with the actual costs of electric service, especially residential customers, using a fixed charge and a volumetric TOU charge tied to customer electricity consumption would likely improve reliability. This is because the electric IOUs fixed electric system infrastructure costs would no longer be bundled within a tier electricity rate but would be fixed, guaranteeing them a stable revenue stream to expand and maintain their electric system infrastructure. This, coupled with a TOU volumetric charge tied to customer electricity consumption (used to pay for electric generation), would likely give the electric IOUs, ESPs and CCA a better sense of their revenue stream in which to meet electricity demand for their customers who do not utilize DERs. Customers who purchase electricity from ESPs or a CCA would still be required to pay this fixed charge but the volumetric TOU charge would fluctuate depending on their contractual agreement with an ESP or a CCA, the prices of electricity within the wholesale electric power markets and their electricity consumption.

Maintaining a majority of the current roles and responsibilities of the CPUC, CEC and CAISO would likely determine the effectiveness of the competitive wholesale and retail electric power markets that in turn would affect electric service reliability. If these markets function and

are regulated appropriately, and the electric system operates as intended under this reform, then it is likely that electric service reliability would be maintained. Given the balance between competitive reforms and the regulatory stability of this reform it is likely that electric service reliability would not improve nor be compromised. With that said, I give this reform a neutral score. **Score: “O”**

Goal 4 - Environmentally Responsible: Limiting the expansion of the competitive wholesale electric power markets, encouraging participation from ESPs and CCAs within these markets and allowing the electric IOUs, ESPs and CCAs to continue to engage in limited contracts, may reduce the environmental impact of the electric system. This likely depends on the type of electric generation that is procured through these mechanisms. If renewable electric generator are procured through contracts and natural-gas fueled electric generators are procured through the competitive wholesale electric power markets to fill in electricity gaps from intermittent and renewable electric generators, there is a high likelihood that the environmental impact of generating electricity would be reduced. This is mainly because renewable electric generators procured through contracts would have defined terms within those contracts to generate electricity when they are able to. Coupling this with the most competitive and likely most efficient natural-gas fueled electric generators procured through the competitive wholesale electric power market would likely mean a reduction in local air pollutants and GHG emissions. Creating an electric generation capacity market may provide independent power producers the right economic prices signals of when and where to develop this capacity. Developing only the needed amount of electric generation capacity to meet electricity demand rather than overbuilding this capacity would also likely reduce the impact of electric generation on the natural environment.

On the retail side, the deployment, integration and optimization of DERs through the electric IOUs and third-party providers would most likely reduce the electric systems impact on the natural environment. This is because these resources are located within the electric distribution system and likely the existing built environment. Some DERs generate electricity from renewable sources where it is demanded (renewable distributed generation) but they also manage this generation with demand (electricity storage and demand response), in addition to reducing absolute electricity demand (energy efficiency). If electric IOUs and third-party providers work in tandem with another to thoughtfully and effectively deploy DERs it is highly likely that it will help reduce the electric systems impact on the natural environment. This deployment not only depends on the providers but also electricity rate design, as discussed in previous sections. If residential customers have a fixed charge coupled with a TOU volumetric charge tied to their electricity consumption there could be more of a proliferation of DERs.

Maintaining a majority of the current roles and responsibilities of the CPUC, CEC and CAISO would likely have a direct and indirect impact on the management of the wholesale and retail electric power markets, the deployment of DERs and electricity rate design. If the markets are managed accordingly, DERs are deployed more rapidly than they are today and electricity rates, specifically residential electricity rates, are implemented as envisioned under this reform, then it is likely that the overall electric system would have less of an impact on the natural environment than what currently exists today. For all of these reasons, I give this reform a positive score. **Score: “+”**

Table 4: Summary of Scores for All Three New Structural Reforms

	Affordability	Efficient Resource Use	Reliability	Environmentally Responsible
Strengthening the Existing Regulatory Framework	O	-	+	O
Expanding and Creating Competitive Electric Power Markets	+	+	O	O
A Hybrid Approach	+	+	O	+

Results

Strengthening the existing regulatory framework of California’s electric IOUs scored neutral against the affordability and environmentally responsible goals. This is mainly because of the uncertainties in alignment between the costs of providing electric service and customer electricity rates. It is challenging to determine if this misalignment would lead to reduced or higher customer electricity rates and bills. Also, it is difficult to assess whether this reform would reduce the overall impact of the electric system on the environment, as it really depends on the electric generation procured by the electric IOUs, the operational characteristics of these generators and the ability of the electric IOUs to deploy DERs and operate them efficiently. This reform did however receive a positive score against the reliability goal. This is because of the certainty in electric generation procured through contracts by the electric IOUs and the designation of the electric IOUs as the sole providers of DER products and services. However, this reform did score negatively against the efficient resource use goal. Primarily, because of the lack of competition due to the pre-arranged price agreements for electricity and electric

generation capacity from independent power producers and the electric IOUs continued monopoly of the retail electric power market.

Encouraging greater competition within the wholesale electric power markets and creating a competitive retail electric power market within the electric IOU territories scored positively against the affordability and efficient resource use goals. This is because the competitive nature of these markets would likely lead to the use of the most efficient electric generators. Also, aligning electricity rates with the costs of providing electric service and deploying DERS through third-party providers would likely lead to the most efficient use of electricity due to the price signals translated through rates and ability of customers to better manage their consumption with DERs. These price signals and customers having more control over how best to manage electricity consumption would likely lead to more affordable electricity rates and bills overtime. In terms of the environmentally responsible and reliability goals this reforms score was neutral. Primarily due to the uncertainties of how effective the CPUC and CAISO would be at managing the competitive wholesale and retail electric power markets proposed within this reform. There is also great uncertainty of what electric generators would be procured and operated, and how DERs would complement or conflict with these generators.

Combining elements of a stronger regulatory framework for the electric IOUs with initiatives that increase competition within the wholesale and retail electric power markets scored positively against the affordability, efficient resource use and environmentally responsibility goals. This is mainly because of the balanced approach of this reform. However, this reform did score neutral against the reliability goal, mainly because this reform would likely maintain reliable electric service and not compromise nor improve it.

Conclusion

This chapter assessed the potential effects of each structural reform against California's high-level energy goals specific to its electricity sector - affordable (affordability), efficient (efficient resource use), reliable (reliability) and environmental responsible electric service. The results of my assessment shows that the hybrid approach structural reform that combines elements of a stronger regulatory framework for the electric IOUs with initiatives that increase competition within the wholesale and retail electric power markets received the most positive scores. The conclusion is that this reform would likely achieve the majority of California's high-level energy goals for its electricity sector. This is not entirely surprising given the hybrid-market structure of California's electricity sector today. The hybrid reform approach in this thesis improves upon the existing electricity sector structure and perhaps more so within the retail electric power market. My final chapter discusses my major observations, findings, and broader policy implications of this assessment.

Chapter 7

FINDINGS AND POLICY IMPLICATIONS

California's electricity sector is at a crossroads. New and emerging technologies pioneering environmental policies, relatively high electricity rates in electric IOU territories and the inefficient operation of the electric system are applying pressure to California's electricity sector and challenging the ability of the state to meet its high-level energy goals for this sector – affordable, efficient, reliable and environmental responsible electric service. This means that new policy ideas and structural reforms will likely need to be created and enacted. How and when comprehensive structural reform comes to California's electricity sector is uncertain. Over the next several decades California's electricity sector will face increasing internal and external pressure to evolve, that much is certain.

Given these issues and the challenges they pose to California achieving its high-level energy goals, this paper assessed three new structural reforms to California's electricity sector. These reforms are aimed at addressing these issues and achieving the state's high-level energy goals. Strengthening the existing regulatory framework of California's electric investor-owned utilities (IOUs) structural reform focused on enhancing the primacy of these utilities within the wholesale and retail electric power markets as the sole provider of electricity and distributed energy resources (DERs) to customers. Expanding and creating competition within the wholesale and retail electric power markets structural reform focused on stimulating competition within these markets through new and expanded markets and facilitating the participation of non-electric IOU market actors such as energy service providers (ESPs), community choice aggregators (CCAs) and DER providers. The last structural reform proposed a hybrid approach combining elements of a stronger regulatory framework with initiatives that increase competition within the within the wholesale and retail electric power markets.

Through my assessment, I found that the hybrid approach structural reform was the best choice to address this sectors issues and achieve the state's high-level energy goals. This structural reform was more likely than the other reforms to improve the affordability of electric service, maximize the efficiency of the electric system and be less environmentally impactful. This structural reform may not improve electric service reliability but it is likely that it would not compromise it either.

Questions for Future Research

To continue the research of this thesis, there are a few areas I would explore further. First, I would have liked to conduct interviews with the policy-makers and regulators involved in addressing the issues confronting California's electricity sector and challenging the ability of the state to achieve its high-level energy goals. This information would have added depth to the three new structural reforms allowing the assessment to include more of their stated concerns rather than just the information publicly available. I did not include interviews in this study because of time and resource limitations, and political sensitivities. The main benefit of this assessment is that it presented a rational framework to advance the policy conversations focused on addressing the issues challenging California's ability to achieve high-level energy goals.

Second, I only chose three structural reforms. All of which I derived from existing literature. There may be other structural reforms worth exploring, however the three structural reforms presented in this paper are comprehensive and touched on most all of the aspects of California's electricity sector – at least those specific to California's electric IOUs. Additionally, because of time constraints, it was necessary to limit the number of structural reform considered in the assessment to the three chosen.

Finally, conducting a deeper analysis of each of these three structural reforms presented in this paper would be an appropriate and necessary exercise, especially if any one of these

reforms are being seriously considered for implementation. None of the three structural reforms presented and assessed in this paper discussed the necessary and specific actions that would need to be taken to implement them. The barriers to implementation were also not discussed or presented in this paper, but there are likely many. For example, coordinating and aligning perspectives and authority amongst the California Public Utilities Commission, California Energy Commission, California Independent System Operator and the State Legislature is by far the most comprehensive barrier to implementation.

Policy Implications

Although this work was exploratory, the assessment of the three new electricity sector structural reforms in this paper could potentially have major policy implications for the state. First, California's electricity sector is already extremely complex with many energy governing institutions, participants and interests. Any structural reform aimed at improving the state's electricity sector must be examined with care and caution. It is likely that complexity is unavoidable, given the sectors long history and that to achieve the state's high-level electricity sector energy goals, interdisciplinary and holistic (complex) solutions will need to be employed. Especially, since there will always be trade-offs between solutions for achieving these goals. Second, given the complexity of California's electricity sector, strategic, thoughtful and coordinated actions amongst California's energy governing institutions is a necessity. However, this is easily stated but often difficult in practicality due to differing and conflicting authority, personalities, the nature of public processes, stakeholder involvement and oftentimes-prescriptive mandates from the state Legislature.

Conclusion

This thesis presented and examined three structural reforms for the state's electricity sector, specific to the electric IOUs, to address issues that are challenging the ability of the state

to achieve its high-level energy goals for this sector - affordable, efficient, reliable and environmental responsible electric service. The conclusion is that a hybrid approach that combines elements of a stronger regulatory framework with initiatives that increase competition is the best choice to address these issues and achieve these goals. However, additional research and analysis should be considered before this could be considered a strong policy recommendation and the relevant policy conversations must continue. It is not a matter of if California's electricity sector will evolve, but how and when.

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