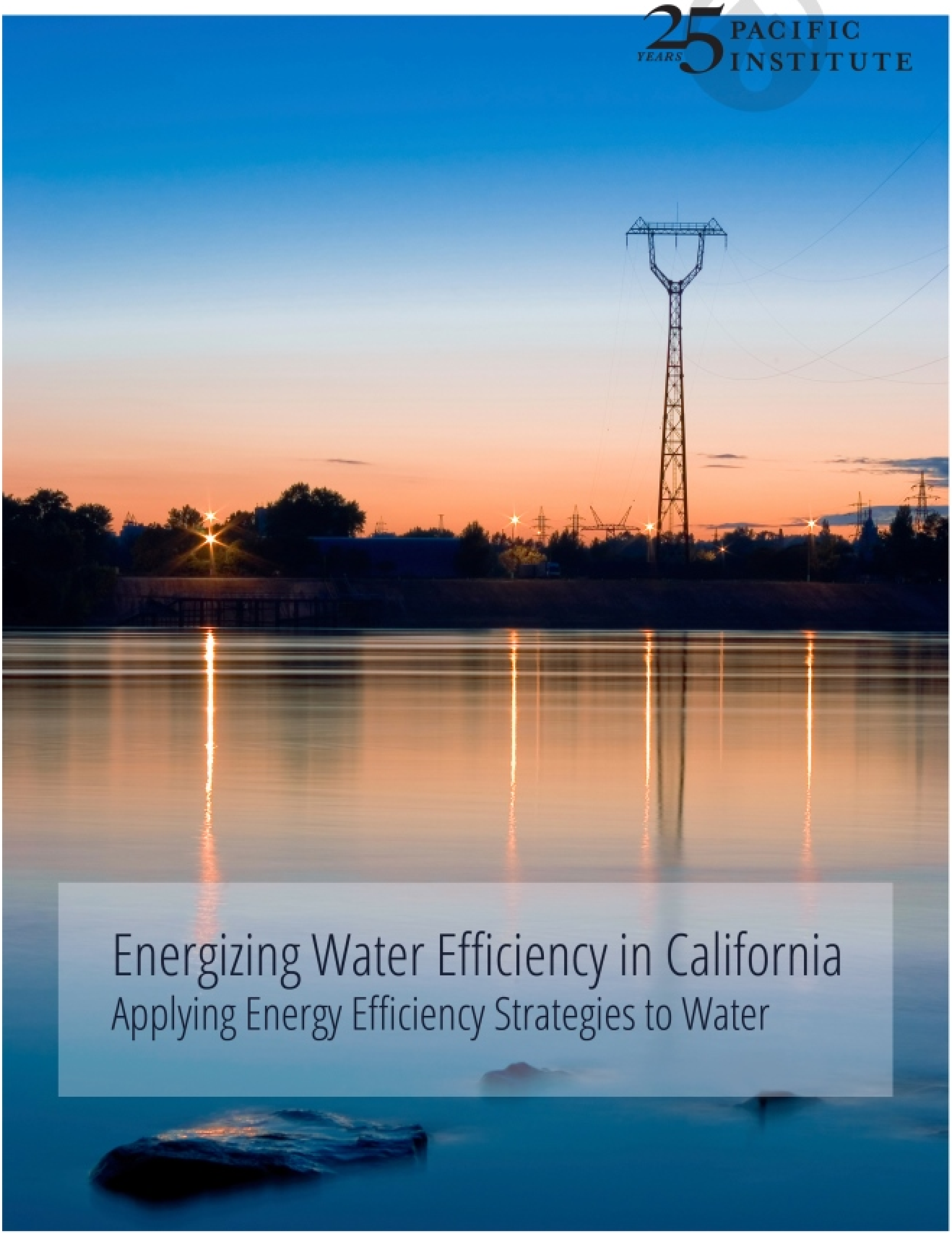

Energizing Water Efficiency in California

Applying Energy Efficiency Strategies to Water

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December 2013

Authors: Heather Cooley, Kristina Donnelly, and Newsha Ajami

The full report is available online at www.pacinst.org/publication/energizing-water-efficiency

ISBN: 1893790541
ISBN-13: 978-1-893790-54-4

Editors: Nancy Ross, Joe Ferrell, Paula Luu
Cover photo: val_shevchenko, istock.com

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Acknowledgements

We would like to thank all those who have offered ideas, data, information, and comments on the report, including (in alphabetical order): Eric Cutter (E3), Max Gomberg (State Water Resources Control Board), Jim Lin (Department of Water Resources), Ed Osann (Natural Resources Defense Council), Evelyn Tipton (Department of Water Resources), Devra Wang (Natural Resources Defense Council), and Rachel Young (American Council for an Energy-Efficient Economy). All findings, errors, and omissions are those of the authors and not those acknowledged here.

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1 Introduction

Major energy efficiency improvements have been made in California over the past several decades, thanks to a variety of techniques including rebates, regulations, pricing policies, and more. Since the mid-1970s, per-capita energy consumption in California has remained nearly constant, averaging about 7,000 kilowatt-hours (kWh) per person per year. Across the United States, in comparison, per capita energy consumption increased by 50% during that same period. These are remarkable improvements and are behind the strong reputation the state has for being a leader in energy efficiency.

Similarly, there have been major advances in water efficiency over the past several decades. Major urban areas across the state, including San Francisco and Los Angeles, have been able to maintain or even reduce water use while supporting population and economic growth. Likewise, California's agricultural output has grown while water use has remained relatively constant. Despite these improvements, more can and should be done. Substantial water savings are still possible in California (Gleick et al. 2003, Cooley et al. 2010), and to achieve the newly mandated 20% reduction in urban per-capita water use by 2020, additional water-efficiency improvements are needed. Furthermore, California's water supplies are under increasing pressure as a result of continued population and economic growth, the need to restore freshwater ecosystems, and climate change, and it is widely recognized that we have come up against natural limits in the amount of water available for human uses.

The experiences that California's energy sector has had implementing efficiency programs offer valuable lessons to the water sector. This paper reviews the major drivers for energy efficiency efforts in California and examines whether and to what degree these drivers could be used in the water sector. We focus on market-based incentive policies, such as rebates, grants, and loans; performance-based regulations, such as standards and codes; and pricing policies that have been implemented within California. We concentrate on the electricity sector, although we discuss the natural gas sector where appropriate.

2 California's Efficiency Improvements

Energy Efficiency Improvements

For the past several decades, per capita energy consumption in California has been consistently lower than in the rest of the United States. California's per capita electricity consumption has remained relatively constant since the mid-1970s, averaging about 7,000 kWh per person per year, and is considerably lower than in other U.S. states (Figure 1). During that same period, per capita electricity consumption across the rest of the United States increased by more than 50%. While per capita natural gas consumption has declined across the United States, it has declined more quickly and to lower levels in California (Figure 2). In 2011, California's electricity and natural gas consumption, which includes the residential, commercial, and industrial sectors, was about 45% and 30% less than that of the rest of the United States.

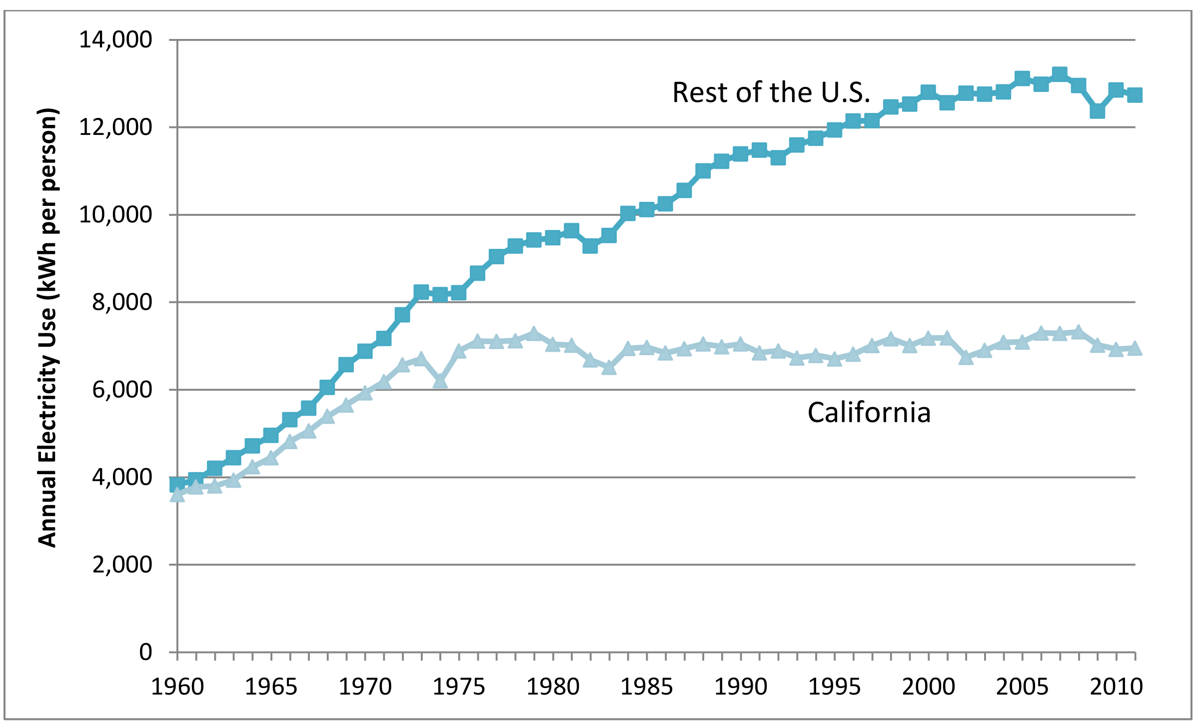

Figure 1. Per Capita Electricity Consumption in California and in the Rest of the U.S., 1960-2011
Source: Population data from US EIA 2012, Table C1; Consumption data from US EIA 2013a.

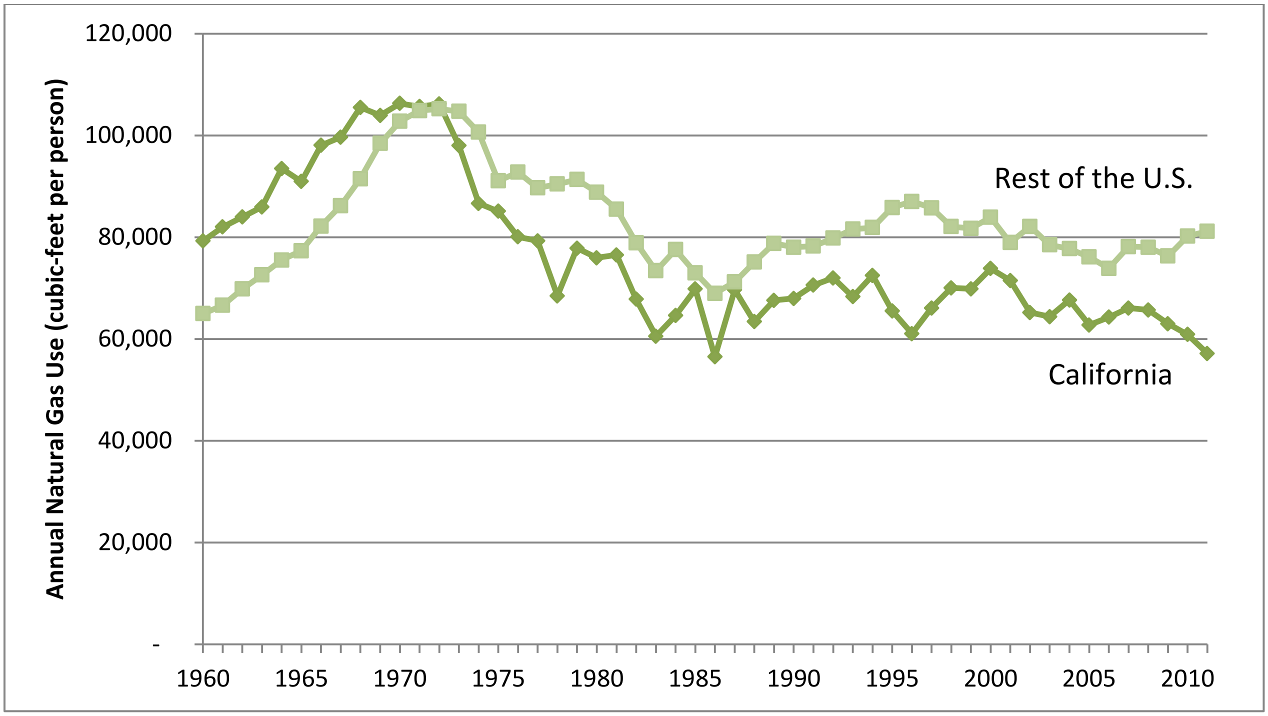

Figure 2. Per Capita Natural Gas Consumption in California and in the Rest of the U.S., 1960-2011
Source: Population data from US EIA 2012, Table C1; Consumption data from US EIA 2013a.

California, however, has several natural advantages that contribute to its having lower energy use than other regions. In particular, California's weather is relatively mild, reducing the need to heat buildings in the winter and cool them in summer. Additionally, the number of people living in a single home is higher than in other regions, a factor that can reduce per capita use.[1] But even taking these factors into consideration, California remains more efficient than any other U.S. state. In a recent study, Kandel et al. (2008) found that only about half of the difference between per capita electricity consumption in California and the rest of the U.S. can be attributed to electricity price, demographics, and weather. Efficiency policy, including the many incentive and education programs operated across the state, has also been a major factor in reducing per capita energy use in California.

California's energy efficiency programs are recognized as among the best in the country. Each year, the American Council for an Energy-Efficient Economy (ACEEE) releases a state energy efficiency scorecard that ranks all 50 states and the District of Columbia on their policies and programs for promoting energy efficiency in buildings, transportation, and industry. California was at the top of the list from 2006 through 2010 and only recently dropped into second place behind Massachusetts, demonstrating a strong and continuous focus on efficiency improvements (Table 1).

[1] Consider home heating requirements. The energy required to heat a home is a function of the size of the home and is largely independent of the number of people living there. As the number of people living in a home increases, the energy required to heat the home does not change; therefore, the amount of energy required for heating the home declines on a per capita basis.

Table 1. State Energy Efficiency Rankings

<table>
<tr><th>Rank</th><th>2006[a]</th><th>2008[b]</th><th>2009[c]</th><th>2010[d]</th><th>2011[e]</th><th>2012[f]</th><th>2013[g]</th></tr>
<tr><td>1</td><td rowspan="3">California, Connecticut, Vermont</td><td>California</td><td>California</td><td>California</td><td>Massachusetts</td><td>Massachusetts</td><td>Massachusetts</td></tr>
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<tr><td>9</td><td rowspan="2">Rhode Island, Minnesota</td><td>Wisconsin</td><td>Rhode Island</td><td>Maryland</td><td>Maryland</td></tr>
<tr><td>10</td><td>New Jersey</td><td>Maine</td><td>Maine</td><td>Maryland</td><td>Minnesota</td><td>Illinois</td></tr>
</table>

References: (a) Eldridge et al. 2007; (b) Eldridge et al. 2008; (c) Eldridge et al. 2009; (d) Molina et al. 2010; (e) Sciortino et al. 2011a; (f) Foster et al. 2012; and (g) Downs et al. 2013

California's investor-owned and publicly-owned utilities (IOUs and POUs, respectively) have sponsored energy efficiency programs for several decades. These programs – along with appliance standards, building codes, and other efficiency efforts – have resulted in considerable energy savings. Figures 3 and Figure 4 show statewide historical and projected electricity and natural gas savings for utility and public agency efficiency programs; residential and commercial building and appliance standards; and residential, commercial, and industrial price changes and other market trends not directly associated with programs or standards.[2] Annual electricity and natural gas savings from efficiency efforts implemented in 1990 and earlier was about 24,000 GWh and 2,700 million therms, respectively.[3] By 2012, the cumulative savings reached 66,000 GWh and 5,000 million therms. The pace with which these efficiency improvements are achieved is expected to quicken. In 2024, the cumulative annual electricity savings are projected to rise to nearly 103,000 GWh, reducing statewide electricity consumption by about 25%, as measured against a 1975 baseline (Kavalec et al. 2013). Similarly, by 2024, natural gas savings are projected to increase to more than 6,800 million therms, reducing statewide natural gas consumption by about 35% relative to a 1975 baseline (Kavalec et al. 2013). These represent major improvements and are behind the strong reputation the state has for being a leader in energy efficiency.

[2] CEC staff is developing estimates of incremental uncommitted efficiency savings estimates for the revised version of this forecast.

[3] CEC staff tracks historical impacts back to 1975. As a result, the savings estimate for 1990 includes rate increases in the 1970s and 1980s, building codes in the 1980s, etc.

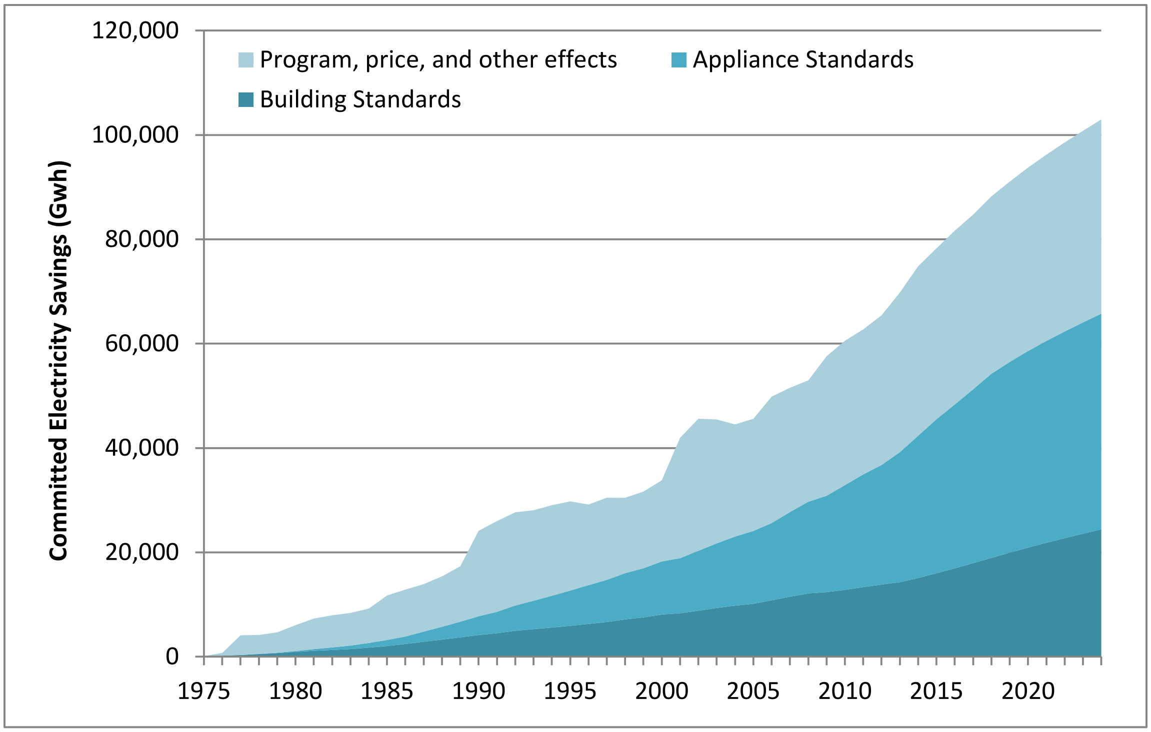

Figure 3. Historic and Projected Committed Electricity Conservation and Efficiency Savings in California, by Source

Source: CEC 2013a

Note: Actual savings are shown for 1975 through 2012; forecasts are shown for 2013 through 2024. Based on electricity savings for Pacific Gas and Electric, Southern California Edison, San Diego Gas and Electric, Sacramento Municipal Utility District, the Los Angeles Department of Water and Power, City of Burbank, City of Glendale, Pasadena, and Imperial Irrigation District. "Programs, price, and other effects" captures savings from utility programs, price, and market trends not associated with other major initiatives.

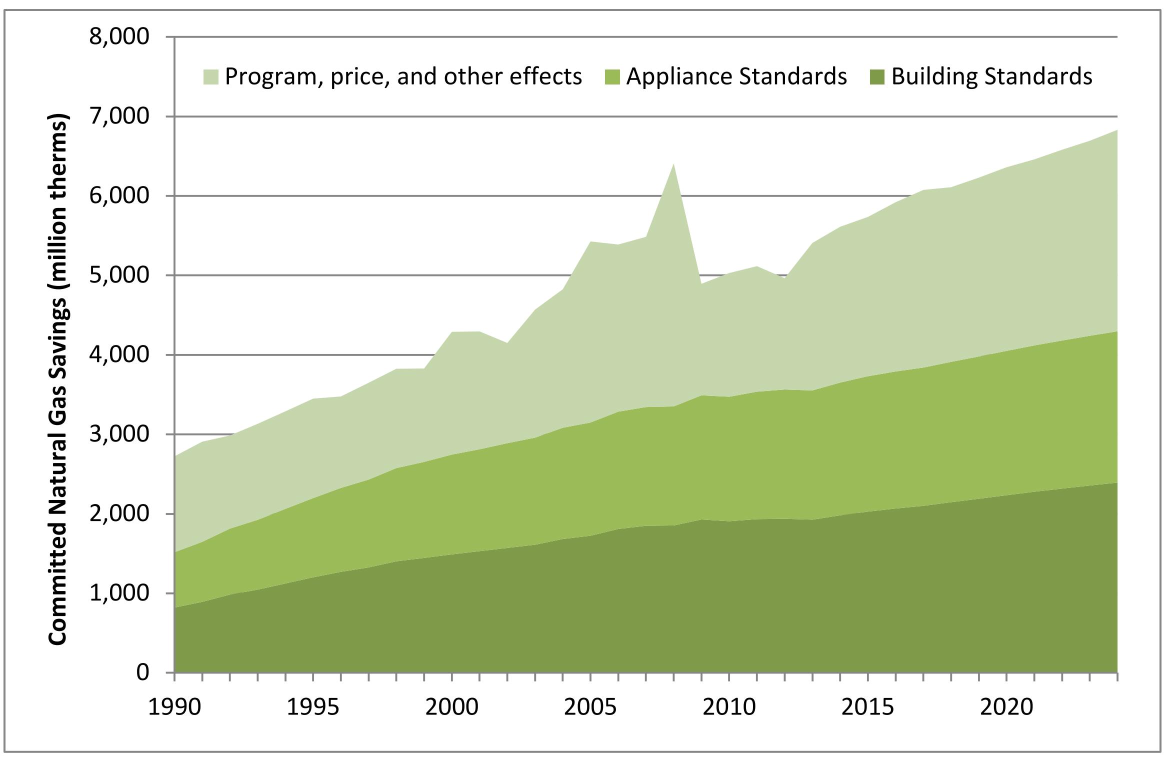

Figure 4. Historic and Projected Committed Natural Gas Conservation and Efficiency Savings in California, by Source

Source: CEC 2013a

Note: Actual savings are shown for 1990 through 2012; forecasts are shown for 2013 through 2024. Based on electricity savings for Pacific Gas and Electric, Southern California Gas Company, and San Diego Gas and Electric. "Programs, price, and other effects" captures savings from utility programs, price, and market trends not associated with other major initiatives.

Water Efficiency Improvements in California

There have been major advances in water efficiency in California over the past several decades. In California's urban areas, water is used for residential, commercial, and industrial uses, as well as outdoor landscaping and other miscellaneous uses. Figure 5 shows total and per capita urban water use in California from 1960-2010. Total water use increased faster than population between 1960 and 1995, resulting in an increase in per capita water use. Water use was low in 1998, a relatively wet year. Between 1998 and 2007, however, per capita use remained relatively constant at 227 gallons per person per day. While there were water conservation and efficiency savings during this period and many urban areas, such as Los Angeles and San Francisco, reported significant reductions in per capita use, these savings were offset by population growth in hot, inland areas where outdoor water use is especially high. Since 2008, total and per capita urban water use declined dramatically, due to several factors, including the economic downturn, mandatory water restrictions in response to the drought, and efficiency improvements.

Reductions in urban per capita water use have been driven by two major factors. First, the economy shifted from one dominated by water-intensive manufacturing to a less water-intensive service-oriented economy. Second, federal, state, and local policies as well as utility

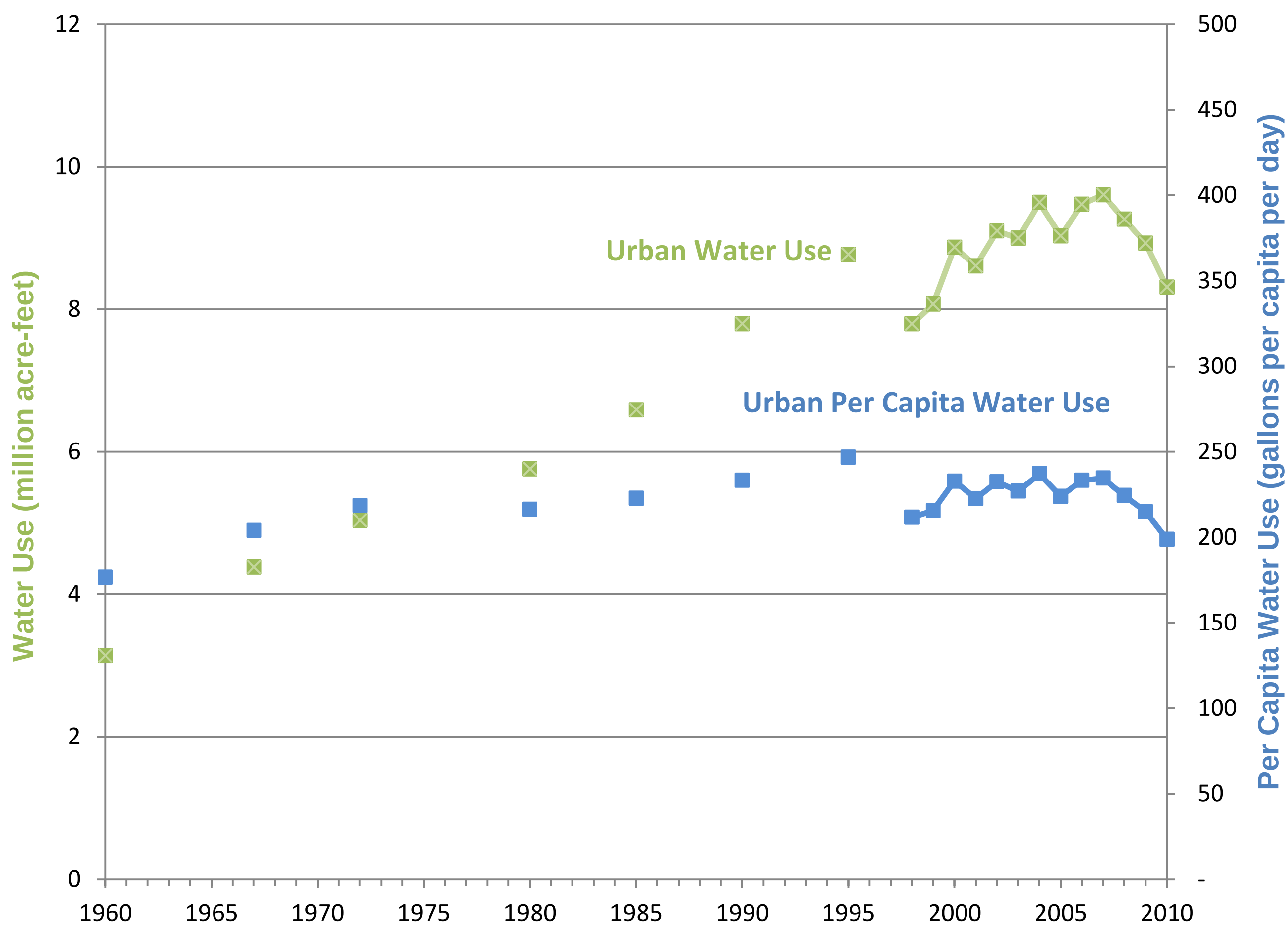

Figure 5. Trends in California Urban Water Use, 1960-2010

Sources: Population data from California DOF (2012). Water use data have been collected by DWR staff from older versions of Bulletin 160 (1972-1985), Annual Reports prepared by District Staff (1989-1995) and the Water Portfolio from California Water Plan Update 2013 (1998-2010) programs have facilitated water efficiency improvements. For example, the National Energy Policy Act of 1992 established efficiency standards for all toilets, urinals, kitchen and lavatory faucets, and showerheads manufactured after January 1, 1994. Subsequent legislation established additional standards for products not included in the original act, including clothes washers, dishwashers, and a number of commercial products. Reductions in per capita water use would likely have been even greater, but this same period saw a rapid shift in population to hotter, drier climates where water use, particularly outdoor water use, is higher. We note, however, that data are not readily available to evaluate statewide water savings or attribute those savings to specific programs or policies.

Agriculture has also become more efficient across the state. California is one of the most productive agricultural regions in the world. The state produces approximately 400 different agricultural commodities, supplying about half of the fresh fruits, vegetables, and nuts consumed by Americans (CDFA 2007) as well as food for the international market. Increasingly, farmers are adopting more efficient irrigation technologies and practices, such as drip irrigation and advanced irrigation scheduling, which allow them to produce more and/or higher quality products without increasing water use.

3 Standards and Codes

Energy Efficiency Standards and Codes

Standards and codes establish minimum efficiency thresholds for buildings, appliances, and/or equipment. California has been a national leader in energy efficiency since the state implemented the first efficiency standards in the 1970s. Nearly four decades later, standards and codes have proven to be among the most effective way of improving energy efficiency, accounting for more than half of statewide electricity savings and more than 70% of natural gas savings (Figure 6 and 7). In this section, we describe some of the key features of appliance standards and building codes in California.

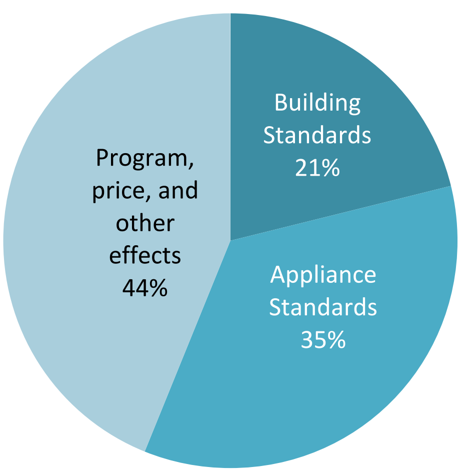

Figure 6. Electricity Savings by Source in 2012
Source: CEC 2013a

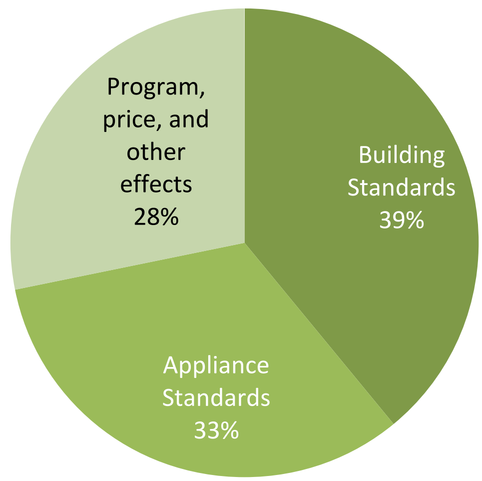

Figure 7. Natural Gas Savings by Source in 2012
Source: CEC 2013a

Appliance Standards (Title 20)

With passage of the Warren-Alquist State Energy Resources Conservation and Development Act in 1974, California became the first state to adopt appliance efficiency standards (Nadel et al. 2005). These standards established minimum energy efficiency requirements for appliances and equipment sold or offered for sale in California, with some exceptions.[4] The first standards were adopted in 1976 and focused on a limited number of appliances, including refrigerators, freezers,

[4] Exclusions include appliances sold wholesale in California for final retail sale outside the state and those designed and sold exclusively for use in recreational vehicles or other mobile equipment.

and air conditioners. Over time, however, these standards were expanded to include a broader set of appliances and equipment. California's appliance efficiency regulations are codified in Title 20 of the California Code of Regulations. The 2012 Appliance Efficiency Regulations, the most recent adopted by the California Energy Commission, includes standards for 23 categories of appliances.

The California Energy Commission has developed a process to regularly update and expand Title 20. This process, shown in Figure 8, is based on broad stakeholder input from "interested parties," including product and component manufacturers, industry associations, consumer rights organizations, retailers, bulk purchasers, utilities, and energy efficiency advocates. It includes both a preliminary rulemaking period and a formal rulemaking period. During the preliminary period, staff develops an initial list of products for consideration of new or updated standards. Interested parties are then asked to provide information on these measures, such as the product lifetime, market characteristics, and market share. Interested parties can also submit proposals for new or updated efficiency standards or measures not included in the initial staff list. Based on this input, staff then proposes a draft set of regulations that is finalized after consultation with the interested parties. Once the staff report is finalized, the formal rulemaking process begins. During the formal period, the California Energy Commission initiates a 45-day public comment period and can then revise the staff proposal based on the public comments received or on its own initiative. The final package is sent to the Office of Administrative Law (OAL) to determine whether the procedural requirements were met and whether the proposed regulation complies with legal standards. If approved by the OAL, the regulations become law.

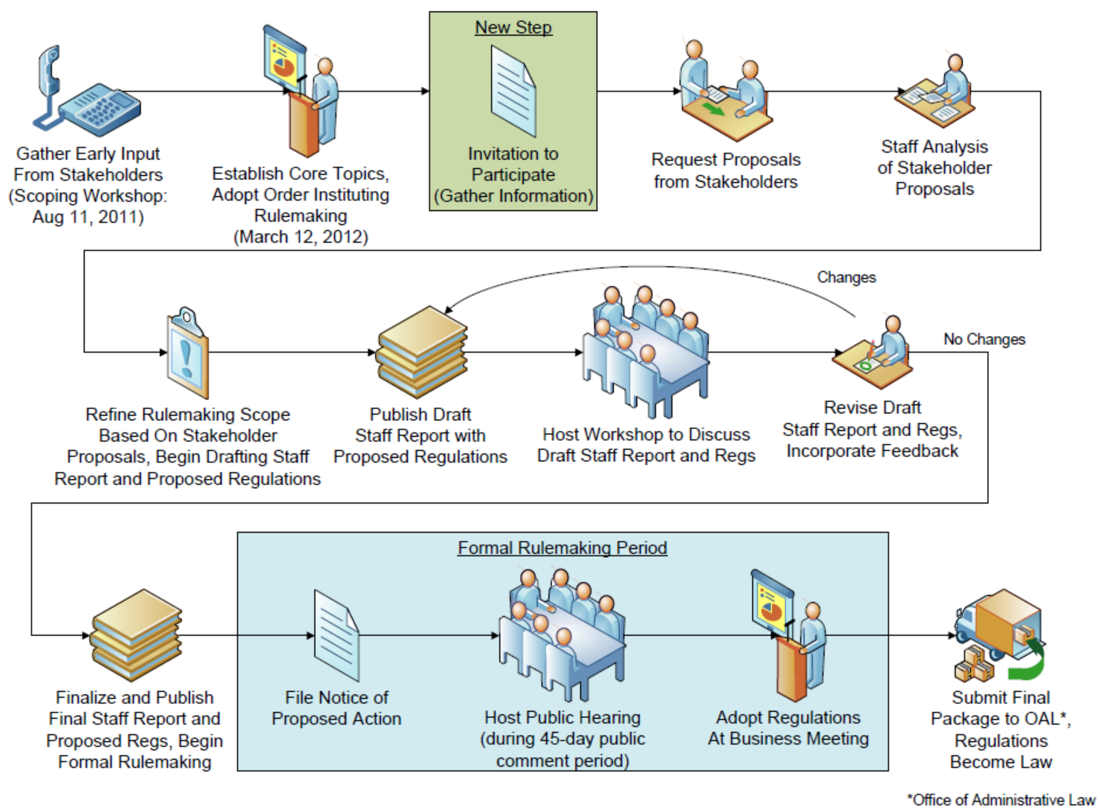

Figure 8. Appliance Energy Efficiency Rulemaking Process
Source: CEC 2013b

The California Energy Commission's rulemaking process helps capture new, efficient technologies and methods as they are developed. As shown in Table 2, California's standards have often preceded those of the federal government by several years. For example, California first adopted appliance standards for central air conditioners in 1977, while the federal government did not adopt national standards until 1993. Likewise, California adopted pool equipment standards in 1982, and the federal government did not adopt standards until 1999. As a result, California's standards have informed the development of standards in other states and even those of the federal government. Because of the emphasis on updating and expanding standards, California maintains some of the strongest standards in the country.

Table 2. Comparison of the Adoption of Energy Efficiency Appliance Standards in California and in the United States

Appliance	Efficiency Standards Adopted	
	In California	In United States
Air conditioners	1977	1990
Central air conditioners	1977	1993
Heat pumps	1977	1990
Refrigerators and freezers	1977	1990
Boilers	1978	1992
Furnaces	1978	1990
Plumbing (showerheads)	1978	1994
Hot water heaters	1978	1990
Clothes dryers	1979	1988
Pool equipment	1982	1999
Ballasts for lighting	1983	1990
Lighting	2003	2006
Distribution transformers	2003	2007
Audio/video equipment	2006	n/a
Commercial cooking appliances	2006	n/a
Televisions	2009	n/a
Battery charger systems	2012	n/a

Source: California Energy Commission

Building Codes (Title 24)

The California Energy Commission adopted the nation's first energy efficiency standards for residential and nonresidential buildings in 1978. Building energy efficiency codes are adopted as part of a larger body of building codes. In California, this larger set of building codes, referred to as the California Building Standards Code, is contained in Title 24 of the California Code of Regulations. Part 6 of Title 24, referred to as the California Energy Code, sets minimum standards for energy-efficient design and construction for new and renovated residential and commercial buildings.[5] These standards must be satisfied as a condition for approval to construct and occupy a building.

Like appliance standards, building standards are updated approximately every three years by the California Energy Commission in a formal rulemaking process intended to capture technology improvements, market penetration, and enhanced processes that improve building energy efficiency. The most recent set of standards were adopted in 2013 and go into effect on January 1, 2014. Today, California is considered to have the "most aggressive and best enforced" energy codes in the United States (ACEEE 2012). Cities or counties may adopt local energy standards that are more stringent than Title 24 and can enforce these standards on a voluntary or mandatory basis.[6]

Water Efficiency Standards and Codes

California has a long history of adopting *water* efficiency standards and codes but has not updated them nearly as frequently as the energy sector. In the 1980s and early 1990s, several states, including California, adopted efficiency standards for various water-using appliances, including toilets, urinals, and faucets. In an effort to promote consistency across the states, the federal government adopted the National Energy Policy Act (EPAct) of 1992, which established efficiency standards for all toilets, urinals, kitchen and lavatory faucets, and showerheads manufactured after January 1, 1994 (Table 3). Subsequent legislation established additional standards for products not included in this act, e.g., clothes washers, dishwashers, and a number of commercial products. For plumbing products, however, the federal standards have not been updated in 20 years.

To date, California's water efficiency standards for appliances and fixtures are largely based on federal standards, although this is likely changing. Under federal law, states are not permitted to adopt efficiency standards on the same products for which there are federal standards, unless they obtain a waiver from the Department of Energy (DOE) by demonstrating a compelling state interest. In 2005, the California Energy Commission applied for such a waiver to establish water efficiency standards for residential clothes washers. DOE denied California's application, although the Ninth Circuit Court of Appeals reversed DOE's decision in 2009 (Canby 2009), allowing California to continue to pursue its waiver request. However, by mid-2010, a negotiated agreement between appliance manufacturers and efficiency advocates included water efficiency standards that will eventually achieve even greater water savings than the standards proposed by the California Energy Commission in the waiver application, so the waiver was not pursued. Also in 2010, DOE officially waived federal preemption for water efficient showerheads, faucets, toilets, and urinals (DOE 2010), paving the way for new, more stringent standards for these products. California has already begun the process of developing

[5] Although California does not currently have standards that apply to existing buildings, AB 758 (2009) requires the CEC to develop a comprehensive energy efficiency program for existing residential and nonresidential buildings.
[6] Voluntary standards motivate the building community by offering incentives such as fast track permitting or reduced permit fees.

Table 3. Efficiency Standards Established by Federal Legislation

Fixture/Appliance	Federal Standard	Law	Effective Date
Toilet	1.6 gpf	EPAct 1992	Jan. 1, 1994
Showerhead	2.5 gpm at 80 psi	EPAct 1992	Jan. 1, 1994
Faucet	≤2.2 gpm at 60 psi	EPAct 1992	Jan. 1, 1994
Clothes washer	≥MEF 1.26 ft^3/kWh/cycle, WF ≤ 9.5 gal/cycle/ft^3		Jan. 1, 2011
Dishwasher (regular size)	≤355 kWh/yr and ≤6.5 gallons/cycle	Energy Independence and Security Act of 2007	Jan. 1, 2010
Dishwasher (compact)	≤260 kWh/year, ≤4.5 gallons/cycle	Energy Independence and Security Act of 2007	Jan. 1, 2010
Commercial toilet	1.6 gpf	EPAct 1992	Jan. 1, 1994
Urinal	1.0 gpf	EPAct 1992	Jan. 1, 1994
Commercial faucet	2.2 gpm at 60 psi	EPAct 1992	Jan. 1, 1994
Commercial faucet (public lavatory)	0.5 gpm at 60 psi	American Society of Mechanical Engineers standard	2005
Commercial pre-rinse spray valves	1.6 gpm	EPAct 2005	Jan. 1, 2006
Commercial ice makers	sliding scale, based on ice harvest rate	EPAct 2005	Jan. 1, 2010
Commercial clothes washers	≥MEF 1.26 ft^3/kWh/cycle, WF ≤ 9.5 gal/cycle/ft^3	EPAct 2005	Jan. 1, 2007

Note: WF = water factor; MEF = modified energy factor; EPAct = Energy Policy Act; gpf = gallons per flush; gpm = gallons per minute; kWh = kilowatt hour; psi = pounds per square inch

stricter standards for these plumbing fixtures andfittings. The 2013 California Plumbing Code includes more stringent standards for showerheads, kitchen faucets, residential lavatory faucets, toilets, and urinals in new construction. The California Energy Commission is likely to adopt stronger standards for all toilets, urinals, and lavatory faucets sold in California in the 2013 Appliance Efficiency Regulations. Thus, the state has initiated a process of continually updating these standards to capture new technologies and practices, as is done by the energy sector in California.

The state has also passed ordinances to reduce outdoor water use. Landscape irrigation typically accounts for more than half of residential demand. In an effort to promote outdoor efficiency, the state adopted the Model Water Efficient Landscape Ordinance (MWELO). In 1990, the State passed AB 325, the Water Conservation in Landscaping Act, which directed the Department of Water Resources to develop a model ordinance. The MWELO, initially developed in 1992 and updated in 2010, establishes a water budget for new construction and rehabilitated landscapes that are at least 2,500 square feet and require a building or landscaping permit. The ordinance requires mulching for most plantings; promotes the use of techniques to increase stormwater retention and infiltration; and requires new and refurbished landscapes to install irrigation systems run by weather, soil moisture, or other self-adjusting controllers. Finally, the ordinance requires the project applicant to submit documentation to the local permitting agency outlining how the landscape will ensure efficient water use. Beginning in 2010, local agencies were required to adopt the MWELO or a local ordinance at least as effective as the state ordinance (CA DWR 2010a).

4 Pricing Policies

Energy Pricing Policies

The price of energy influences demand, and electric utilities have adopted various policies to use the price of energy to promote conservation and efficiency. In particular, all California investor-owned utilities (IOUs) and most publicly-owned utilities (POUs) have adopted tiered pricing for residential customers. Tiered pricing, also referred to as increasing or inclining block rate pricing, is used to send a price signal to customers to conserve energy, as customers are charged more per unit of energy as consumption increases (Figure 9). Tiers usually vary according to customer class in order to accommodate different usage patterns. The lowest tier is often set to represent the average use for a customer, with higher tiers set at higher prices to encourage conservation and efficiency. Tiered pricing may also be used to protect smaller, often low-income, users by keeping a minimum level of supply affordable and allocating more of the cost to larger users.

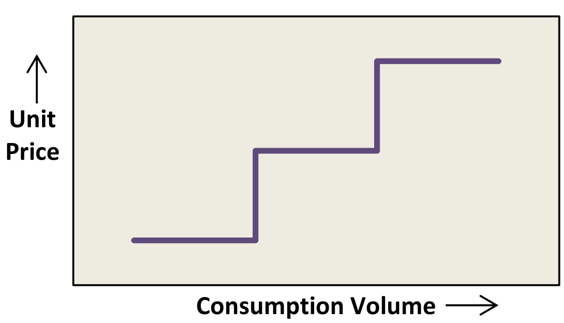

Figure 9. Unit Price versus Consumption Volume for Tiered Pricing Structures

California IOUs use four or five tiers for residential customers. The price for each tier is unique to the IOU, while the breaks between tiers vary by service area, customer class, and, in some cases, by individual customer. The Warren-Miller Energy Lifeline Act of 1976 required IOUs to designate a baseline quantity of electricity that would supply a significant portion of the reasonable energy needs of the average residential customer, below average cost (Cal. Pub. Util. Code §739). As a result, the first tier is set at 50-70% of the average customer's use, with subsequent tiers based on a percent increase above this baseline. The baseline is adjusted by customer according to various customer characteristics, including fuel type, climate, and season. Therefore, the sizes of the tiers for each customer can vary depending on the type of fuel used for space heating and their local climate. In addition, each individual customer has different tier sizes in the winter and summer months.

California energy utilities are increasingly adopting time-variant and dynamic rates that vary according to the time of use. While there is considerable daily and seasonal variability in the cost of energy, most retail consumers are charged a single rate throughout the day. In order to create rates that more closely reflect how the cost of service changes over time, energy utilities can use time-variant pricing to signal customers to avoid consumption when marginal costs are relatively high. These pricing structures are not necessarily intended to reduce overall energy consumption; rather they are designed to shift demand to off-peak periods (EPRI 2011, Jessoe and Rapson 2013, York and Kushler 2005).

Several policies have been adopted to encourage the use of time-variant pricing in California. In 2003, for example, the California Energy Commission and the CPUC adopted the first Energy Action Plan (EAP), which included key actions to implement time-variant pricing schemes and make them available to all customers. The EAP set a goal that, by 2007, price response from consumers would reduce peak demand by 5%. To further promote time-variant pricing, SB 695 of 2009 established guidance to transition IOU residential customers onto time-variant rates. Some POUs are also implementing time-variant pricing. For example, Sacramento Municipal Utility District (SMUD) plans to have all users on time-variant rates by 2018 (SMUD 2013).

The CPUC uses two approaches for time-variant pricing. Time-of-use (TOU) rates have different rates according to established periods that vary by season and time of day. Critical Peak Pricing (CPP), on the other hand, allows a short-term price increase when demand is particularly high (CPUC 2013a). Both TOU rates and CPP use price to encourage customers to reduce or shift their demand during peak periods (Faruqui and Hledik 2007, CPUC 2013a); however CPP rates are more aligned with the true cost of service since the charges increase during system peaks rather than individual customer peaks. California IOUs have implemented mandatory TOU rates and default CPP for large agricultural, commercial, and industrial customers. Small and medium commercial and industrial customers will have made the same transition by 2016. TOU rates and CPP remain optional for residential customers and have seen very little implementation; as of this writing, less than 1% of residential customers have opted into the time-variant pricing programs (CPUC 2013a).

The CPUC is currently examining existing rate design policies for residential customers to determine if they meet the CPUC's stated objectives (CPUC 2012b). The combination of tiered pricing and time-variant pricing has added complexity to rate design and billing in California. Additionally, there is concern about inequitable rates and cross-subsidies among customer classes. For example, during the 2001 electricity crisis, the legislature prevented the CPUC from increasing residential electricity rates on the lowest tiers. As a result, a significant portion of revenue is collected from the higher tiers, creating a cross-subsidization between customers within the higher and lower tiers (CPUC 2012b). The rate freeze was removed in October 2013, and re-allocating costs to customers will likely result in higher costs for lower tiers, which may alter the price signal to residential customers and affect electricity use. These issues are evolving, and discussions are likely to extend into 2014.

Water and Wastewater Pricing Policies

While tiered pricing is becoming increasingly common among water utilities in California, it is not nearly as widely employed as in the energy sector. A 2011 survey by Raftelis Financial Consultants, Inc. and the California-Nevada Section of the American Water Works Association found that nearly a quarter of California water utilities have uniform rates, and some still have declining block rates (Figure 10). The majority of utilities with uniform rates are in Northern California and the San Joaquin Valley (RFC and CA-NV 2011). However, previous rate surveys suggest that utilities are moving away from uniform rates in favor of tiered rates (Black & Veatch 1999, Black & Veatch 2006, RFC and CA-NV 2011), and this trend is likely to continue. Additionally, a growing number of water utilities are adopting budget-based rates, a form of tiered pricing similar to the rates implemented by energy utilities in that the sizes of the blocks are unique to the individual customer.

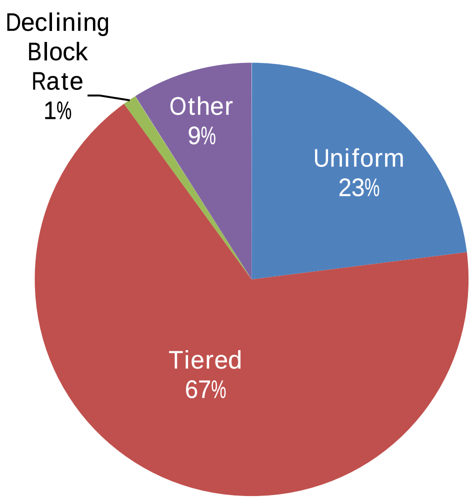

Figure 10. Rate Structures of Surveyed California Utilities

Note: Survey sample was not statistically random; therefore, results are not necessarily representative of California water utilities in general. Source: RFC and CA-NV (2011)

Similar to electric utilities, some water utilities are implementing rates that vary according to seasonal or interannual limits on water availability. The cost to provide water increases when usage peaks during the summer months and also during droughts, periods when availability is constrained. As a result, water utilities and customers can benefit from policies and practices that reduce use during these periods. These rates are somewhat analogous to time-variant pricing that has been implemented by energy IOUs in California. One example of a water utility that has implemented seasonal rates is the City of Riverside, which has established modestly higher rates during the summer months (June through October), with larger differences for the higher tiers (Table 4). While seasonal rates have not yet been widely adopted in California, they can, if structured properly, send a price signal to reduce outdoor water use (Hanak and Davis 2006).

Water utilities may also use surcharges that apply when water supplies are constrained, such as during droughts. Drought surcharges can provide a price incentive to reduce water use during drought periods while allowing the utility to recover revenue lost from reduced sales and mitigate the need for future permanent rate increases (Hughes et al. 2009). Drought surcharges are usually temporary and can be in the form of an overall rate adjustment or an additional fee that is added to the customer bill. Another way to structure drought surcharges is to establish baseline use limits and charge higher rates for customers exceeding their allocation (AWWA 2012). For example, during a water supply shortage in 2008, East Bay Municipal Utility District implemented their Drought Management Program, which established a water use allocation for each customer based on a percentage of the customer's baseline water use.[7] Customers who exceeded their allocation were charged an additional $2 per hundred cubic feet (EBMUD 2012). While drought surcharges are more common than seasonal rates, all California utilities should consider adopting policies to enable rapid implementation during drought periods.

While the water sector is moving toward tiered pricing and implementing other mechanisms to reduce demand, the majority of California wastewater utilities use flat rates that provide no incentive to conserve because customers are charged the same amount regardless of the amount of wastewater generated. A recent survey of municipal wastewater collection, transport, and treatment utilities found that in 2007/2008 more than 80% of these utilities had flat rates, generating revenue from only fixed-charges (RFC and CA-NV 2011). In comparison, 75% of

[7] The baseline water use was calculated based on average customer water use over a prior three-year period.

Table 4. Seasonal Water Rates for the City of Riverside, California

Water Use	November-May ($/unit)	June-October ($/unit)	Difference ($/unit and %)
First 15 units	$1.13	$1.14	$0.01 (0.9%)
16-35 units	$1.64	$1.83	$0.19 (12%)
36-60 units	$2.26	$2.85	$0.59 (26%)
More than 60 units	$2.75	$4.10	$1.35 (49%)

Note: 1 unit is equal to 100 cubic feet (or 748 gallons); percent difference in parentheses
Source: City of Riverside PUD (2013)

wastewater utilities across the nation have uniform or tiered rates for residential customers.

An even larger percentage of wastewater utilities (83%) have uniform or tiered rates for non-residential customers (AWWA and RFC 2013). While it is impractical for wastewater flows to be metered separately, wastewater utilities can obtain water use data from water utilities and with adjustments, estimate wastewater flows. Indeed, major cities across the country, including Boston, New York, Philadelphia, Atlanta, Houston, and Seattle, and even some California cities (e.g., Los Angeles, San Diego, San Francisco, Long Beach, Pasadena, and San Luis Obispo) use volumetric rates (Mehta 2012). Some, such as Seattle, have tiered wastewater rates. A 2011 study found that adopting volumetric wastewater rates in California would save an estimated 141,000 acre-feet per year in the short term and 283,000 acre-feet per year in the long term, contributing to statewide goals to reduce per capita water use (Chesnutt 2011).[8]

[8] These savings are equivalent to the annual water use of 280,000 – 560,000 families.

4 Efficiency as a Resource

Energy Efficiency as a Resource

Energy utilities have traditionally looked to develop new supplies to meet energy needs. But California has taken an important step in recognizing energy efficiency and demand response as the preferred means of meeting energy needs. In 2003, California's primary energy agencies – the California Energy Commission, the California Public Utilities Commission, and the now defunct California Consumer Power and Conservation Financing Authority – established an energy resource loading order to guide energy decision making. This loading order specifies that, in order to meet the state's energy needs, utilities should first pursue efficiency and demand response measures to the extent they are cost effective, reliable, and feasible, followed by renewable resources and distributed generation, and lastly by "clean" and efficient fossil-fuel sources (such as natural gas). This loading order was made explicit in the State's first Energy Action Plan in 2003 and has been reiterated in multiple forums. In 2005, Senate Bill 1037 made the loading order mandatory for both IOUs and POUs and set requirements for ensuring compliance (PU Code 454.5 and 9615, respectively).

As required by SB 57, all California energy utilities must submit procurement plans that, among other things, detail the utility's projected resource needs and their plans for meeting those needs.[9] These plans must adhere to the loading order. IOUs submit Long Term Procurement Plans to the CPUC every two years (PU Code 454.5), following the adoption of official load forecasts by the California Energy Commission in its biennial Integrated Energy Planning Report process. Procurement plans evaluate the overall long-term need for new system and local reliability resources and allow the CPUC to comprehensively consider the impacts of state energy policies on the need for new resources.

Despite the adoption of the loading order by the various energy agencies, some question remained about whether adherence to the loading order is ongoing or finite. The IOUs argued that the loading order is finite, i.e., if they meet energy efficiency, demand response, and renewable energy targets set by other rules and regulations (also known as "the preferred targets"), they should be able to meet any additional energy needs with conventional sources (although they may also choose to use preferred sources). Other groups, such as Pacific Environment and Sierra Club, argued that the loading order is ongoing and that utilities must adhere to the loading order even if the preferred targets had been met. In a 2012 decision, the CPUC provided some clarity when it found that the utility obligation to follow the loading order is ongoing: "the loading order applies to all utility procurement, even if pre-set targets for certain preferred resources

[9] The requirements for POUs will be automatically repealed in 2016 unless it is extended by the legislature (PUC Section 9615.5(d)).

have been achieved" (CPUC Rulemaking 10-05-006).

Water Efficiency as a Resource

Several groups have proposed adopting a loading order for water. Not surprisingly, one of the first discussions about a loading order for water was in a 2005 California Energy Commission report (Klein 2005). The authors note that the three strategies in the state's 2005 Water Plan Update with the greatest potential to provide new supplies and enhance water supply reliability – efficiency, conjunctive management and groundwater storage, and recycled water - "in many respects…mirrors the state's adopted loading order for electricity resources" (Klein 2005, p.18). Several years later, in 2007, the Natural Resources Defense Council (NRDC), in a presentation to the Delta Vision Blue Ribbon Task Force, more clearly articulated the loading order, urging the Legislature, State Water Resources Control Board, and CPUC to adopt a state policy that identifies efficiency as the preferred approach to improving water supply reliability, followed by alternatives resources (e.g., recycled water, groundwater cleanup, and conjunctive use), and lastly by traditional water supply options. NRDC further notes that the state must move beyond simply adopting a policy and take steps to operationalize it, including through establishing a public goods charge to fund efficiency programs, evaluating the efficiency potential, and establishing efficiency targets (NRDC 2007). This approach was also supported by the Environmental Water Caucus, a coalition of environmental and social justice groups formed in 1991 to advocate for equitable and sustainable water resource use in California.

As described above, the proposed loading order is consistent with the potential availability of various water supply and reliability options identified in several updates of the State Water Plan. As shown in Figure 11, efficiency represents the largest potential resource, followed by recycled water and conjunctive management (Klein 2005, Wilkinson 2011). The loading order is also generally consistent with estimated costs associated with these options, with efficiency being among the cheapest option and seawater desalination among the most expensive (Table 5).

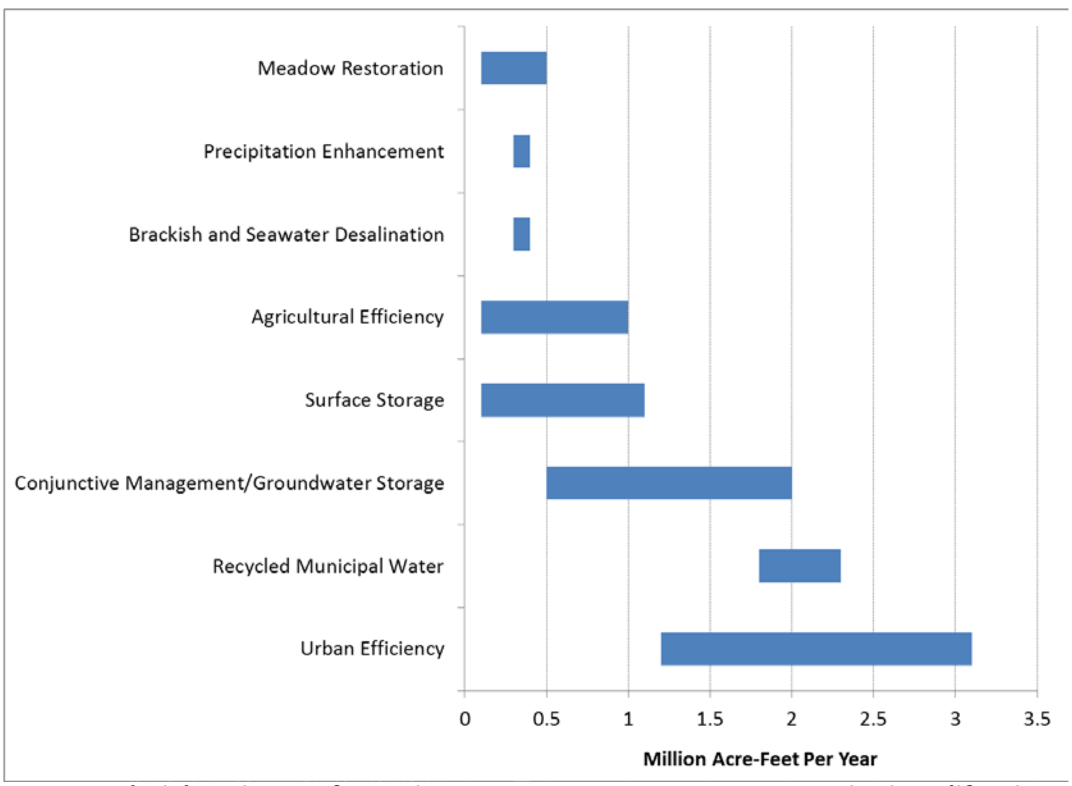

Figure 11. Low and High Estimates for Various Resource Management Strategies in California

Source: CA DWR 2013a

Table 5. Range of Cost Estimates, in Dollars Per Acre-Foot, for Various Water Supply Options

	Range of Cost Estimates ($/AF)
Agricultural Efficiency	$85 - $675
Meadow Restoration	$100 - $250
Urban Efficiency	$223 - $522
Surface Storage	$300 - $1,100
Recycled Municipal Water	$300 - $1,300
Brackish Groundwater Desalination	$500 - $900
Seawater Desalination	$1,000 - $2,500

Source: CA DWR 2013b

While the state's water planning documents are suggestive of a loading order, a formal policy has not yet been adopted. The CPUC's Water Action Plans (2005 and 2010) indicate that conservation should be at the top of the water sector's "loading order"; however, no formal policy exists to operationalize this order. For public agencies, decisions about water supply and reliability investments are typically made at the local level, with a publicly elected Board of Directors providing oversight and approval of program and project budgets. These decisions are not reviewed by some other authority, and therefore it would be difficult to enforce a loading order at the local level. The state, however, can help to operationalize a loading order by prioritizing grants and loans for those projects at the top of the load order. Furthermore, the state can encourage water utilities participating in the Integrated Regional Water Management (IRWM) Planning process, a voluntary state program that encourages water managers to collaborate with one another in order to manage all aspects of water resources in a region, to pursue preferred resources. Finally a City Council or utility Board of Directors may voluntarily adopt a formal policy to implement a loading order for its service area.

5 Efficiency Targets and Resource Standards

Energy Efficiency Targets and Resource Standards

Nearly half of all U.S. states, including California, have adopted policies that establish long-term energy efficiency savings goals that utilities or other organizations must meet through their customer energy efficiency programs (Sciortino 2011b). These policies are referred to as Energy Efficiency Resource Standards (EERS). An EERS goal may be expressed as an annual or cumulative savings and may be based on physical units (e.g., 1,800 kWh) or as a percent reduction in either retail sales or per capita use from some baseline. While most EERS policies focus on reducing energy use, others emphasize reducing peak consumption. There is some debate about what is considered an EERS policy, and depending on the definition used, 20 to 24 states have adopted EERS policies, as of 2012 (ACEEE 2012, Palmer et al. 2012).[10] According to one analysis, most states were meeting or were on-track to meet their goals in 2010 (Sciortino et al. 2011b).

In 2004, the California Public Utility Commission (CPUC) adopted explicit energy savings goals for the four largest IOUs: Pacific Gas and Electric Company (PG&E); San Diego Gas & Electric Company (SDG&E); Southern California Edison Company (SCE); and Southern California Gas Company (SoCalGas).[11] The annual and cumulative goals for electricity and natural gas were for the period 2004 through 2013 and are shown in Table 6. The electricity goals represented about 70% of the economic potential and 90% of the maximum achievable potential for electric energy savings over the 10-year period, according to the most up-to-date studies available at the time. If these goals were achieved, efficiency was projected to meet 55% to 59% of the IOUs' additional electric energy needs between 2004 and 2013.The cumulative natural gas goals were 444 million therms per year, which represented approximately 40% of the maximum achievable potential. Utilities are required to make up any shortfalls in savings in future cycles and ensure that savings persist. The IOUs are responsible for administering the efficiency programs to achieve these goals and have a great deal of flexibility in their design, funding, and administration (Nowak et al. 2011).

[10] ACEEE, for example, uses a relatively broad definition of EERS and includes polices that (1) establish a statewide energy savings standard; (2) set energy savings targets for each utility; or (3) incorporate energy efficiency as an eligible resource in Renewable Portfolio Standards (Sciortino et al. 2011b). Palmer et al. 2012, however, uses a narrower definition, excluding policies that fail to include an entity or group of entities legally obligated to meet the goals or that fail to obligate funding for the projects to achieve those goals. They also exclude policies that allow energy savings to receive credit under the state RPS but do not have a separate, multi-year energy efficiency policy.

[11] CPUC Decision 04-09-060

Table 6. Total Electricity and Natural Gas Program Savings Goals

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total Annual Electricity Savings (GWh/yr)[a]	1,838	1,838	2,032	2,275	2,505	2,538	2,465	2,513	2,547	2,631
Total Cumulative Savings (GWh/yr)	1,838	3,677	5,709	7,984	10,489	13,027	15,492	18,005	20,552	23,183
Total Peak Savings (MW)[b]	379	757	1,199	1,677	2,205	2,740	3,259	3,789	4,328	4,885
Total Annual Natural Gas Savings (MMTh/yr)	21	21	30	37	44	52	54	57	61	67
Total Cumulative Natural Gas Savings (MMTh/yr)	21	42	72	110	154	206	260	316	377	444

Source: CPUC Decision 04-09-060

Notes: (a) Total annual energy savings = all savings from energy efficiency programs funded by public goods charge and procurement funding. This total includes savings from baseline energy efficiency program funding of $100 MM/yr accounted for in the CEC sales forecast.

(b) Average peak MW estimated by multiplying GWh from utility by the ratio they used in 2004/5 filings ranges from 0.19 to 0.21. This is an estimate of average peak savings not coincident peak = GWh savings in peak period/ 560 hours in period.

In the initial CPUC decision, the efficiency goals would be adopted every three years, which was consistent with the 3-year program planning and funding cycle for efficiency programs. Subsequent decisions put off these updates, and instead the CPUC focused on developing goals through 2020. In 2008 and in 2009, the CPUC adopted annual electricity and natural gas goals for 2012-2020 (Table 7). Unlike the previous set of goals, which focused solely on savings from utility programs, these goals were intended to capture savings from IOU programs, building codes, state and federal appliance standards, and market transformation programs. Goals are updated "as necessary to ensure they remain aggressive yet attainable" (CPUC Decision 09-09-47, p. 30).

Between 2004 and 2008, California IOUs achieved 90% of the cumulative efficiency goals (Sciortino et al. 2011b) and committed to make up shortfalls in the 2010-2012 program cycle (Nowak et al 2011, CPUC Decision 09-05-037). Based on reported (but not verified) savings to date for all IOU programs, the IOUs are on track to meet the projected savings for the 2010 – 2012 portfolio and have met or exceeded the CPUC's 2010 and 2011 adopted goals (CPUC 2012a).

Energy efficiency goals adopted by the CPUC only apply to the IOUs. They do not apply to the state's estimated 40 publicly-owned utilities (POUs), which collectively account for about 22% of statewide electricity consumption (CEC 2010). To fill this gap, the California legislature passed Assembly Bill 2021 (AB 2021) in 2006. Beginning in 2007 and every three years thereafter, AB 2021 requires the POUs to identify all potentially achievable cost-effective electricity efficiency savings and establish annual targets for energy efficiency savings and demand reduction that could reduce total forecasted electricity consumption by 10% for the next 10-year period.[12] AB 2021 also requires the POUs to report their energy efficiency investments, programs, expenditures, cost-effectiveness, results, and independent evaluation of reported energy savings to the California Energy Commission.

[12] Assembly Bill 2227 changed the efficiency target reporting requirement to once every four years.

Table 7. Total Electricity and Natural Gas Savings Goals

	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total Annual Electricity Savings (GWh/yr)[a]	2,365	2,630	1,741	1,669	1,720	1,745	1,778	1,783	1,788
Total Peak Savings (MW)[b]	521	517	455	472	510	514	533	533	534
Total Annual Natural Gas Savings (MMTh/yr)	53.2	66.8	71	73	73	70	72	73	73

Note: These are total market goals, which capture savings from IOU programs, building codes, state and federal appliance standards, and market transformation programs.
Source: CPUC Decision 08-07-047, CPUC Decision 09-09-047

California POUs have made significant strides in achieving their efficiency goals, although more is needed. Between 2006 and 2010, POUs dramatically increased their investments and tripled their energy savings (Ettenson et al. 2012). Despite these efforts, the POUs fell short of meeting their 2010 energy savings goals; furthermore, forecasts to 2020 suggest they will achieve less than 7% savings, falling short of the 10% reduction goal. A recent study found that most POUs could meet the AB 2021 reduction target by increasing customer incentive levels (Lewis et al. 2011). Some POUs are already moving in that direction. For example, in 2012, the Los Angeles Department of Water and Power, the nation's largest municipal utility, adopted an energy efficiency goal of 10% by 2020, along with a "stretch" target of 15%, and allocated $128 million and $139 million in FY 2012-2013 and 2013-2014, respectively, for energy efficiency programs.

A key feature of the IOU and POU efficiency goals is that they are based on comprehensive assessments of the energy savings potential within the utility's service area. These studies are conducted from several perspectives. In particular, they evaluate the technical potential (the total energy savings available by end use and sector relative to existing uses); the economic potential (a subset of the technical potential that includes an analysis of those efficiency measures that are cost effective); and the market potential (a subset of the economic potential that includes an analysis of the willingness to adopt the efficiency measures). For the IOUs, these quantitative estimates help the CPUC choose energy efficiency goals in a way that best meets its policy objectives. For the POUs, these quantitative estimates provide some basis for them to set their own efficiency goals and some metric for the California Energy Commission to evaluate whether these goals are reasonable.

Not surprisingly, the efficiency targets and the process to develop those targets have been imperfect and the subject of considerable debate. Several CPUC proceedings have been initiated on certain methodological issues, including whether to use savings estimates reported by the utilities or estimates that have been verified by third-parties. But overall, the efficiency goals have served several important roles in the state regulatory framework. In particular, they provided guidance for the development of the utilities' energy efficiency portfolios. The efficiency targets also informed the development of utility and state demand forecasts for long-term procurement planning. Additionally, they informed development of statewide energy efficiency targets to meet greenhouse gas emissions reductions as required in the California Global Warming Solutions Act of 2006 (AB 32). Finally, they established benchmarks for shareholder incentives to reward investor-owned utilities that meet or exceed their energy efficiency goals (discussed in more detail below).

Water Efficiency Targets

California's energy utilities have efficiency targets that are updated periodically and are based on comprehensive assessments of the energy savings potential within each utility's service area. Efficiency targets are far less common within the water sector. In November 2009, California became the first state to adopt an efficiency target for the water sector with the passage of Senate Bill x7-7 (SB x7-7). SB x7-7 mandates that the state achieve a 20% reduction in urban per capita water use by 2020, with an interim goal of achieving 10% by 2015. In addition to establishing a statewide goal, SB x7-7 also directs water suppliers to develop individual targets using one of four options:

- Method 1 sets the goal at 80% of the water supplier's baseline daily per capita water use, which is defined using continuous five- and ten-year periods ending no earlier than December 31, 2007, and no later than December 31, 2010.
- Method 2 calculates the goal using the sum of performance standards for indoor residential use, landscaped area water use, and commercial, industrial, and institutional (CII) uses.
- Method 3 calculates the supplier's per capita daily water use target using 95% of the target set for their hydrologic region.
- Method 4, which was developed by the Department of Water Resources (DWR) in collaboration with technical experts and organizations, sets the target as the difference between the baseline and the estimated total savings, which is calculated as the sum of metering, indoor residential, CII, and landscape and water loss savings.

Urban suppliers that do not meet the necessary requirements are ineligible for state grants and loans. The law applies to all urban retail water suppliers, both public and private. To further promote its implementation among private water utilities, the CPUC has adopted conservation goals that comply with SBx7-7. In 2007, the CPUC required Class A utilities to submit a plan to achieve 5% reduction in average customer water use over the 3-year rate cycle, but did not make the reductions mandatory (CPUC Decision 07-05-062). In order to bring the conservation goals and reporting in line with SBx7-7, the Commission established a tentative conservation goal of a 1-2% annual reduction in consumption through price and non-price programs (CPUC Decision 08-02-036). These reductions were formally adopted in 2011 (CPUC Decision 11-05-004).

It is too early to assess the effectiveness of SB x7-7. Urban water suppliers were required to submit their 2020 water use target in the 2010 Urban Water Management Plans and must report on progress in 2015. According to a preliminary analysis of the targets that have been submitted, the average baseline water use was 200 gpcd. Based on a 20% reduction, the 2020 target should be 160 gpcd. The average reported target, however, was 167 gpcd, higher than the statewide 2020 goal. Furthermore, new census data released in 2011 indicates that California's population was less than previously thought, thereby increasing the baseline and target estimates. Overall, the preliminary analysis suggests that the state is not on track to meet a 20% reduction by 2020.

Furthermore, California's water resource challenges are likely to intensify due to continued population and economic growth, climate change, and the need to restore ecosystems. This increases the likelihood that a new set of targets will be introduced that go beyond 2020. When developing these targets, stakeholders should examine how energy efficiency targets have been developed and implemented to identify any changes that may be needed. Some of the key differences that may help inform the development of new targets include the following:

- The energy efficiency targets are established through a regulatory process and are updated periodically. By contrast, the water efficiency targets were established through a legislative process and updates are uncertain.
- The energy targets are developed based on relatively comprehensive assessments of the efficiency potential for each utility. The water target was not based on such an analysis. Rather, the target and the baseline were negotiated through the legislative process.
- Water utilities have several compliance methods, enabling them to pick the method that gives them the higher target and virtually ensures that the state, as a whole, will not be able to meet its compliance target.
- The energy targets are absolute numbers, e.g., kWh, and progress can be assessed by multiplying the savings from a particular measure by the number of measures implemented or installed. The water target, however, is based on a percent reduction from a baseline during a particular year. Given that water use is subject to variations due to weather and economic activity, several methods have been developed or are being developed to normalize water use in the target year. This adds another layer of complexity to the calculations and another opportunity to introduce error.
- Finally, savings estimates are integrated into future statewide demand forecasts for energy. Reductions in water use from implementation of SBx7-7 are not adequately integrated into statewide or in some cases even local water demand forecasts.

6 Revenue Recovery

Revenue Recovery for Energy

Efficiency improvements can result in a reduction in sales and subsequent under-collection of revenue necessary for utility operation. The incentive to sell more of a product in order to increase revenue is known as the "throughput incentive." This incentive is thought to discourage utilities from pursuing efficiency and conservation, as reductions in sales have a disproportionate impact on the utility's ability to recover its fixed costs and remain financially viable. Some utilities have adopted revenue decoupling mechanisms to ensure that the authorized revenue is collected to recover fixed costs – no more and no less – removing the throughput incentive and breaking the link between revenue and sales.

California IOUs have adopted decoupling mechanisms to allow for the full recovery of approved revenue, regardless of sales. The CPUC first introduced the Electric Revenue Adjustment Mechanism (ERAM) for California's electric utilities in 1982. The ERAM was abandoned in 1996 following the deregulation of the electricity market but forms of this mechanism were reinstated after the California energy crisis (Cal. Pub. Util. Code §739.10). Between 2002 and 2005, each of California's IOUs set up their own decoupling mechanism by creating balancing accounts that are used for annual true-ups (Kushler et al. 2006, Weber et al. 2006): when there is an over- or under-collection of base rate revenue, the decoupling mechanisms annually adjust the rates so that over-collections are refunded to customers and under-collections are recouped from customers.[13] In 2007, California implemented "decoupling plus," which combined the decoupling mechanism with performance incentives and penalties for meeting or exceeding efficiency targets (Box 1).

Decoupling can also play a role with POUs. In late 2012, the nation's largest POU, the Los Angeles Department of Water and Power (LADWP), adopted a revenue decoupling mechanism that automatically adjusts rates in response to changes in electricity sales (Cavanagh 2012). This new mechanism was adopted as LADWP vastly expands its energy efficiency investments.

Revenue Recovery for Water

Decoupling has been piloted at investor-owned water utilities in California, with mixed results (AWI 2012). In 2008, as part of its Water Action Plan, the CPUC adopted two decoupling mechanisms for water IOUs: the Water Revenue Adjustment Mechanism (WRAM) and Modified Cost Balancing Account (MCBA). The WRAM enables utilities to collect any revenue shortfalls that result from water conservation by calculating the

[13] Fuel- and transmission-related costs are not addressed in the decoupling true-ups, although other balancing accounts exist to recover these costs.

Box 1: Shareholder Incentives

Investor-owned utilities (IOUs) are private companies that are owned by investors, and these IOUs have a fiduciary obligation to pay a reasonable return to their investors. While decoupling allows utilities to retain sufficient revenue to cover their fixed costs, thereby removing a disincentive to efficiency investments, it does not generate a return on investment and therefore does not provide a positive financial incentive to IOUs to invest in conservation and efficiency. Some states have attempted to address this issue by adopting policies that allow investors to make a return on efficiency investments. These shareholder incentives, some argue, put supply-side and efficiency investments on a more level playing field from the investor's perspective. Because energy efficiency programs are designed to be more cost effective than developing new supplies, shareholder incentives can provide a financial benefit to investors while still ultimately saving the customer money.

A recent national analysis by ACEEE (Hayes et al. 2011) found that 18 states have implemented shareholder incentives. These incentives generally fall into three broad categories:

- shared benefit – incentive is based on a share of the net benefit of an efficiency program, e.g., the difference between the cost of the efficiency program and the value of the energy savings achieved;
- performance targets – incentive is based on a percentage of the program cost with the percentage varying according to the energy savings achieved; and
- rate of return – incentive is based on a rate of return on efficiency investments or savings.

Shared benefit mechanisms are among the most common, with 60% of states adopting this approach. Performance targets are also popular, especially in the Northeast, where five states have adopted this approach. Only two states (Wisconsin and Nevada) have adopted a rate of return approach for determining incentive levels.

Initially, California, like the majority of U.S. states that have adopted shareholder incentives, used a shared benefit mechanism to determine incentive levels. In 2007, the CPUC established the Risk/Reward Incentive Mechanism (RRIM) for California IOUs, whereby utilities were rewarded or penalized based on the level of energy savings achieved. The financial reward for each IOU was calculated based on the net economic benefits to the customers, i.e., the difference between the cost and the benefits for the efficiency program, according to the earnings rates shown in Table A. An IOU that achieved 85% - 100% of its energy savings goal would receive a financial reward equal to 9% of the net benefits. An IOU that exceeded its savings goals would receive a financial reward equal to 12% of the net benefits. Earnings and penalties were capped and would be paid in three installments for each three-year program cycle.

Table A. Shareholder Incentive Levels

Average of Savings Goals Achieved	Penalty or Reward Earnings Rate
More than 100%	12% of net benefits
85-100%	9% of net benefits
65-85%	Deadband; no penalties or rewards
Less than 65%	Greater of per unit charge for shortfall or ratepayer pay-back of negative net benefits

Source: CPUC Decision 07-09-043
Note: Subsequent decisions reduce the reward from 9% to 7% for utilities.

Several elements of the RRIM have been controversial, and within the first year of the program, the CPUC recognized that the RRIM was not functioning as intended. In September 2013, the CPUC adopted a new incentive, the Efficiency Savings and Performance Mechanism, for the 2013-14 efficiency program cycle and beyond. Rather than use a shared-benefit approach, this new mechanism uses performance targets whereby the incentive is based on some percentage of the program cost. To promote comprehensive, long-lived efficiency investments, the resource savings incentives will be based on the lifetime energy savings, rather than savings for a single year (CPUC Decision 13-09-023). While it is too early to tell whether this approach will be effective, these incentives may provide IOUs with motivation to pursue efficiency beyond the minimum efficiency targets.

difference between actual and adopted quantity charge revenues. The MCBA allows utilities to recoup lost revenue from purchased power, purchased water, and pump taxes.

By 2009, the ten largest water IOUs (which serve the majority of water customers regulated by the CPUC) had decoupling policies in place. The adoption of the decoupling policies, however, coincided with a global recession and several wet years. At the time, revenue forecasts that were based on historical water sales drastically overestimated actual sales. In 2010, a wet year, 31 of 35 water utilities under-collected revenue and, in the following year, 33 of 34 under-collected revenue. Indeed, three utilities under-collected revenue by 26-27% of expected, representing major budgetary shortfalls (Kahlon 2012). With the decoupling agreement in place, these utilities recovered these revenues through customer surcharges authorized by WRAMs. The Division of Ratepayer Advocates has argued that customers should not have to reimburse IOUs for budget shortfalls unrelated to water conservation for which the decoupling program was specifically adopted, claiming that much of the reduction in water sales did not result from conservation but were associated with the economic slowdown and climatic conditions (DRA 2012).

Revenues at publicly-owned water utilities are not decoupled. Rather, these systems can use rate stabilization funds to provide a reserve that can be used to mitigate unexpected changes in revenue that may result from changes in demand associated with, for example, cool temperatures, drought restrictions, an economic downturn, and increased conservation and efficiency. Rate stabilization funds may also be used to phase-in a major rate change (Hughes et al. 2009). A key concern associated with rate stabilization funds is that if they are used regularly to mitigate increases in customer rates, they can preserve rates that do not fully recoup revenue, and can ultimately result in the need for larger rate changes (Spitz and Brennan 2012, American Rivers 2013).

While rate stabilization funds are used by the water sector, these funds must be carefully structured to ensure they are effective. For example, the utility should establish clear policies about how and when the funds will be used and create a process for regular review. Setting quantitative targets for when to withdraw reserve funds and how to apply them can help establish clear expectations for their use and avoid potential customer concerns over the existence of a reserve. Furthermore, these funds should be designated as enterprise funds in order to ensure that revenues are not used for any purpose other than rate stabilization (Coleman 2005).

7 Efficiency Investments

Investments in energy efficiency are large and have grown markedly over the last decade. According to a recent ACEEE study, "the term 'energy efficiency investment' refers to the expenditure of capital necessary to upgrade, modernize, and improve the energy efficiency of any aspect of the nation's built environment" (Laitner 2013). This broad definition includes state and federal spending on programs that incentivize efficiency investments in homes and businesses and on farms. It includes utility spending on audits and incentive programs available to customers and the investments made by individuals, businesses, and institutions on more efficient products and services. A complete analysis of energy efficiency investments in California is beyond the scope of this study. In this section, we focus primarily on utility energy efficiency programs, describing the total expenditures on these programs, the funding sources, and the cost effectiveness of utility efficiency programs. Note that all dollar values in this section are expressed in year 2013 dollars.

Funding Sources for Energy Efficiency

Utility energy efficiency programs are funded by their ratepayers through two primary sources: a public goods charge and more recently, a procurement charge. The public goods charge is a surcharge imposed on energy sales to fund utility energy efficiency, renewable energy, and other public purpose programs. The fee varies by utility and by customer class but is typically a fraction of a cent per unit of energy consumed. In 2006, for example, the public goods charge for an SDG&E customer was $0.00585 per kilowatt-hour (kWh), or about 4% of the typical energy cost for that customer (Kuduk and Anders 2006). California's public goods charge was established in 1996 as part of the energy market deregulation efforts. Initially focused on electricity sold by IOUs from 1998-2001, it was later expanded to include electricity sold by POUs and was extended through January 1, 2012. Similar legislation, passed in 1999, created a surcharge on all natural gas consumed in California to fund efficiency and other public purpose programs. Despite several attempts in 2011 to extend the IOU's public goods charge for electricity, the California legislature failed to pass an extension. The natural gas surcharge remains in place, although it represents a relatively small amount of money for electricity.

California energy utilities also use procurement funds for their efficiency programs. Procurements funds are collected through charges on a customer's bill to purchase power or reduce demand so as to ensure sufficient and reliable energy supply. During the electricity restructuring in the late 1990s, California energy utilities were encouraged to divest themselves of at least 50% of their fossil-fueled energy generation sources. This divestiture created a more competitive environment whereby utility and non-utility suppliers could compete in the generation market, and as a result, California energy utilities became increasingly reliant on purchased power to meet their energy needs (CPUC 2012c). Funds to purchase this energy are collected from the customer through the procurement component of the utility rates, and since 2004, some portion of these procurement funds have been used to fund efficiency programs.

The source of funding for utility efficiency programs has changed over time. Beginning in 1998, utility energy efficiency programs were largely funded through the public goods charge. The POUs still rely heavily on the public goods charge to fund their efficiency programs (NCPA 2013).[14] Since 2004, however, the IOUs have increasingly relied on procurement funds for their efficiency programs, and as shown in Figure 4, this coincided with a major increase in IOU spending on efficiency programs. By 2011, an estimated 70% of IOU efficiency budgets were from procurement funds and the remaining 30% were from the public goods charge (CPUC 2012c).

Future funding levels for efficiency programs remains uncertain, due in part to the Legislature's failure to renew the public goods charge for electricity. As a short-term measure, the CPUC increased efficiency funding in 2012 from procurement charges to replace those from the public goods charge in order to achieve efficiency goals established for that year. But as described above, the state's cap-and-trade auction and passage of Proposition 39 may provide additional funding for efficiency programs in California.

Energy Efficiency Expenditures

California energy utilities have made major investments in energy efficiency programs (**Error! Reference source not found.**). Between 1998 and 2012, energy utilities in California spent more than $10 billion (in 2013 dollars) on efficiency programs (Martinez et al. 2010, NCPA 2013, EEGA 2013).[15] These expenditures have grown markedly in recent years. Between 1998 and 2004, expenditures averaged $420 million (in 2013 dollars) per year. Beginning in 2005, efficiency investments increased dramatically, and by 2012, annual utility efficiency expenditures exceeded $1 billion (in 2013 dollars).[16]

Compared to the IOUs, efficiency expenditures by the POUs have been relatively low, although this is changing. The POUs provide 20-25% of the electricity consumed in California, however, their expenditures represent only about 13% of the total efficiency spending since 2006. Thus, POUs in California have invested less per unit of energy supplied than the IOUs. The POUs, however, recently increased their efficiency expenditures considerably and for the fifth consecutive year, have invested more than $100 million in their efficiency programs. In 2012, the POUs invested about $129 million in efficiency, which represented about 1.7% of their total sales (NCPA 2013).

Figure 13 shows energy efficiency expenditures between 2007 and 2011 as a percent of utility revenue for all of California and for the four major IOUs. During this period, California utilities spent an average of more than 2.3% of their total revenue on energy efficiency programs. Efficiency expenditures, in both absolute (Figure 12) and in relative terms (Figure 13), have been increasing, although there is considerable variability among each of the four major IOUs. PG&E, the largest of the four IOUs in terms of revenue, invested more than 3.3% of their revenue in efficiency programs in 2008, although they have reduced their

[14] Some municipalities may allocate additional money from the general fund, which could be considered a procurement funding as it is a means to defer additional procurement investment (NCPA 2013).

[15] Actual expenditures are likely higher, as comprehensive data on investments from POUs are not available prior to 2006.

[16] Note that some of the variability is due to the CPUC's program cycles. For example, the 2006-08 program cycle was approved very late, which led to a ramp up in program efforts in 2007.

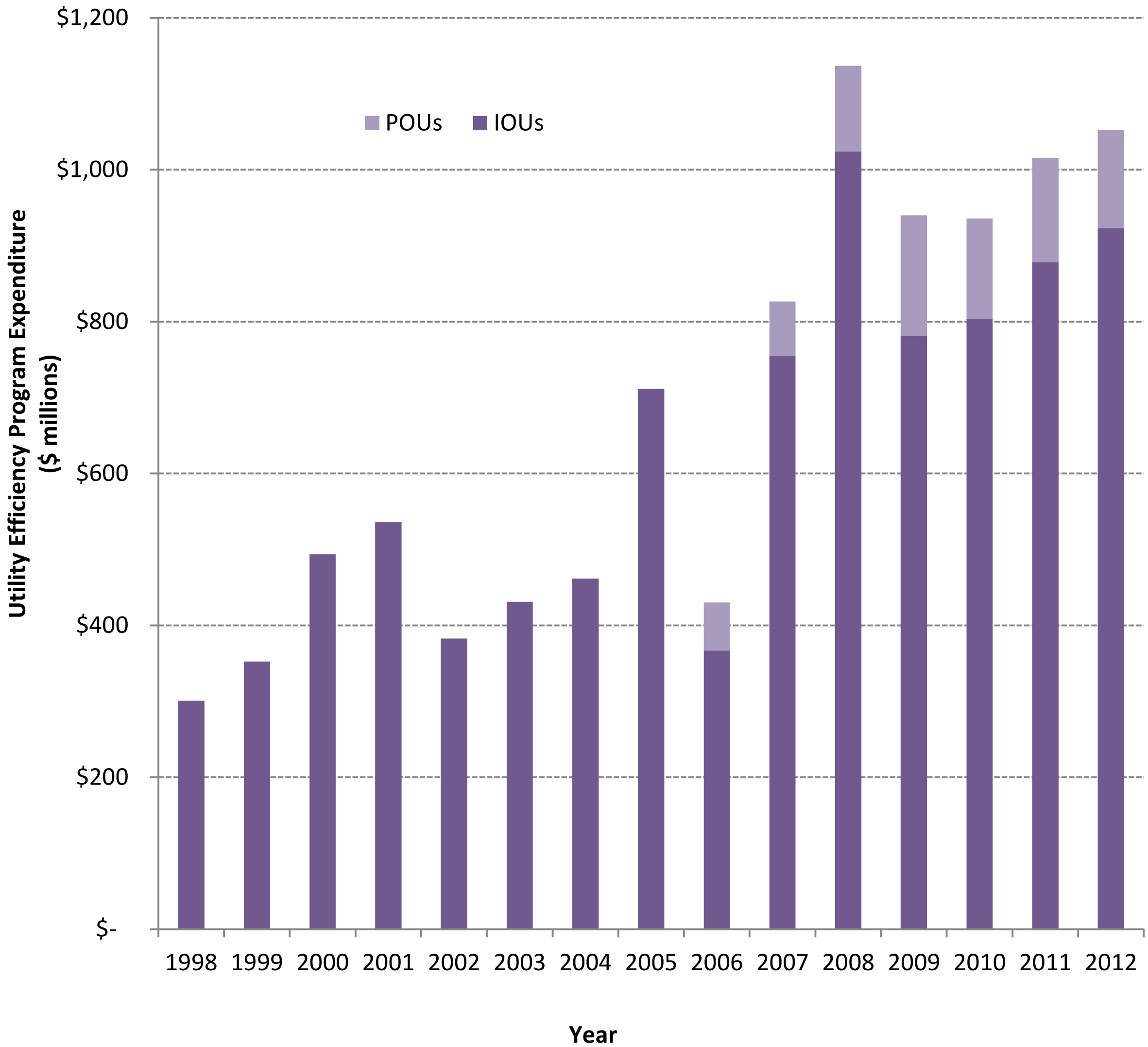

Figure 12. Utility Energy Efficiency Program Expenditures, 1998 – 2012
Source: Martinez et al. 2010, CMUA 2013, EEGA 2013
Note: All dollar values have been converted to year 2013 dollars. Includes investment for both electricity and natural gas efficiency programs. Many POUs have offered efficiency programs for decades, although comprehensive data on these investments are only available beginning in 2006. Does not include expenditures on weatherization programs for low-income residents, which are funded by ratepayers and by the federal government.

spending in recent years. SCE, the second largest of the four IOUs, recently increased their efficiency expenditures to 3.1% of their total revenue. We note that these estimates do not provide an indication of the cost effectiveness of these investments, although this is discussed in more detail in the next section of this report.

The state and federal government have also made short- and long-term expenditures on energy efficiency programs in California, although there is no single estimate of the amount spent. For example, the state of California established the Energy Conservation Assistance Account in 1979. This account, which is funded by appropriation from the state's General Fund, loan repayments, and supplemental federal funding when available, has provided more than $308 million in low-interest loans over the past 25 years (CPUC 2013b). In February 2009, the federal government

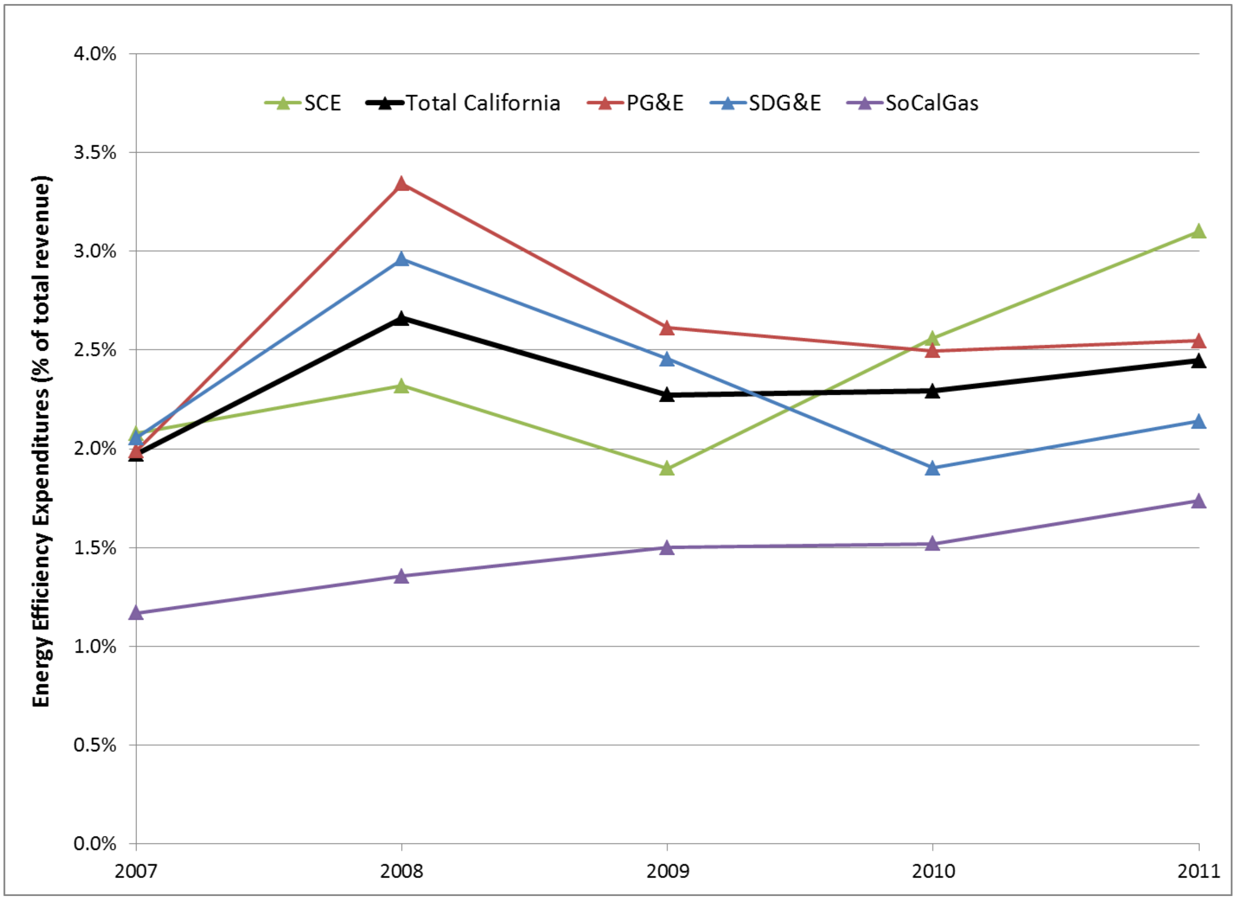

Figure 13. Percent of Total Revenue Spent on Energy Efficiency for California's Four Largest IOUs, 2007-2011

Data Sources: Electric Revenue for the four IOUs: US EIA 2013b
Total Electric Utility Revenue: US EIA 2013c
Total Natural Gas Revenue: US EIA 2013d
Energy Efficiency Expenditures: EEGA 2013

enacted the American Recovery and Reinvestment Act (ARRA), providing California with a one-time influx of $314 million for various energy-efficiency-related activities (LAO 2012). Most recently, California voters approved Proposition 39, which increases corporate tax revenue and allocates half of the revenues – up to $550 million per year – to support energy efficiency and renewable energy in public schools, colleges, universities, and other public buildings. This funding, available for a five-year period beginning in 2013-14, is a significant investment and could increase total efficiency expenditures dramatically over the next several years. Additional funding will likely be available for efficiency programs from revenue generated by the state’s cap-and-trade auction.

Funding Sources for Water Efficiency

Water utilities fund efficiency programs through their operating and, in some cases, capital budgets. These funds are generally provided through water sales, connection fees, interest earnings, property taxes, state and federal grants, and other miscellaneous sources. In some cases, utilities have designated funds for efficiency programs collected from high water users. Decisions about budget allocations among

Table 8. California Voter-approved Bonds That Have Provided Funds for Water Management since 1986

Title	Proposition	Total Amount (in $ million)
Bonds for Water Conservation (1986)	Proposition 44	$150
Water Conservation Bond Law (1988)	Proposition 82	$60
The Safe, Clean, Reliable Water Supply Act (1996)	Proposition 204	$995
The Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Act (2000)	Proposition 13	$1,970
The California Clean Water, Clean Air, Safe Neighborhood Parks, and Coastal Protection Act (2002)	Proposition 40	$2,600
Water Security, Clean Drinking Water, Coastal And Beach Protection Act (2002)	Proposition 50	$3,440

Source: CA DWR (2009)

utility programs are driven largely by internal processes and reflect utility policies and priorities.

Utilities may augment these local investments with monies available from state and federal sources. Since the mid-1980s, California voters approved several general obligation bonds that, in part, fund water efficiency and conservation in both urban and agricultural sectors (Table 8). Typically, DWR and the State Water Resources Control Board (State Water Board) have been in charge of administering these funds and allocating them as grants and low-interest loans among local water agencies through a competitive process. While the amounts available have, in some cases, been substantial, they “are subject to ‘boom and bust’ cycles that make it difficult to plan long-term or multi-phase projects. Furthermore, bond funding at current levels is insufficient to meet California’s long-term water infrastructure needs” (CA DWR 2010b, p. 41).

The federal government also provides funding for water efficiency programs in California. For example, the federal Farm Bill has authorized several cost-share programs for the agricultural community to encourage water conservation and efficiency improvements, including the Conservation Stewardship Program (CSP) and the Environmental Quality Incentives Program (EQIP). The American Recovery and Reinvestment Act (ARRA) of 2009 provided $27 million in funding to improve water conservation and efficiency in California (DOI 2009). Shortly thereafter, in 2010, the United States Bureau of Reclamation established the WaterSMART program. WaterSMART grants provide 50/50 cost-share funding to irrigation and water districts, tribes, states, and other entities with water or power delivery authority for projects that conserve and use water more efficiently, increase the use of renewable energy, protect endangered species, or facilitate water markets.

Water Efficiency Expenditures

Budgets for water efficiency programs are generally small compared to other utility expenditures and may vary from year to year. An analysis of eight large utilities in the western United States found that, on average, conservation and efficiency expenditures represent about 1% of total water budgets (WRA 2003). A detailed analysis of water efficiency expenditures in California has not been conducted. However, the Metropolitan Water District of Southern California (MWD), which delivers an estimated 1.7 million acre-feet of water per year to member agencies serving 19 million people in Southern California, invested $11.4 million in water efficiency programs in fiscal year 2012/2013 (MWD 2014), or about 0.9% of its total annual expenditures (MWD 2013).[17] Efficiency expenditures by energy utilities in California are considerably higher than water utilities, exceeding $1 billion in 2012 (EEGA 2013, CMUA 2013) and generally representing more than 2% of utility revenues (Figure 13).

[17] This estimate doesn't include the administrative costs for the program, including outside service, vendor fees, marketing, and staff time. Additionally, member agencies provided additional funding for efficiency programs.

8 Conclusions and Recommendations

Major energy efficiency improvements have been made in California over the past several decades. California's per capita electricity consumption has remained relatively constant since the mid-1970s, while per capita electricity consumption across the rest of the United States increased by more than 50%. Similarly, California's per capita natural gas consumption has been below the U.S. total since the early 1970s. These energy savings are the result of a broad array of rules, regulations, and policies that promote energy efficiency, including appliance standards, building codes, pricing policies, and utility-sponsored energy efficiency programs.

During this same period, California has made major advances in water conservation and efficiency, although more can and should be done. California's limited water supplies are under increasing pressure as a result of continued population and economic growth, the need to restore freshwater ecosystems, and climate change. The experiences of California's energy sector in implementing efficiency programs offer valuable lessons to the water sector. This paper reviewed the major drivers for energy efficiency efforts in California and examined whether and to what degree these drivers could be used in the water sector. Below we provide recommendations to advance water conservation and efficiency in California:

Continuously update standards and codes: Until recently, the state has been unable to adopt efficiency standards for fixtures and appliances that exceed federal standards. In 2010, however, the federal government officially waived federal preemption for water efficient showerheads, faucets, toilets, and urinals, paving the way for new, more stringent standards. Additionally, in 2011, the Building Standards Commission added water industry representatives to two committees that make recommendations on water-related building codes and standards, such as efficiency fixtures, recycled water, and greywater. The state must take advantage of these opportunities and continuously update existing standards and codes to capture new technologies and practices.

Adopt a loading order for water: State and local agencies should adopt a loading order for water that can serve as a guidepost for various policies and decisions at local, regional, and state levels. The Department of Water Resources, for example, could enforce a loading order through eligibility for grants and loans. Likewise, local agencies could adopt a loading order in their urban water management plans and base resource allocations accordingly. Additionally, the CPUC could adopt a loading order that would apply to water IOUs and guide their resource investments.

Update water efficiency targets: California currently implements efficiency targets through SBx7-7. Future targets should be based on a quantitative assessment of the efficiency potential within a particular region and across the state. In addition, these targets should be periodically updated. Finally, the state should consider setting absolute savings targets rather than a percent savings to avoid complications associated with weather and other factors.

Improve water pricing policies: Water and wastewater pricing can be effective mechanisms for promoting water conservation and efficiency. Tiered pricing and seasonal rates, in particular, have been shown to send a price signal to reduce water use. Water utilities should adopt tiered pricing for residential customers and consider adopting tiered pricing for other customer classes. Water utilities should also examine adopting seasonal rates and drought surcharges to promote efficiency during periods when supplies are constrained. Additionally, wastewater utilities should move beyond flat rates to adopt uniform volumetric or even tiered pricing structures. To promote these practices, state and federal governments could require conservation-oriented rate structures in order to be eligible for grants and loans.

Increase efficiency investments: The state and water utilities should increase investment in water efficiency and conservation programs. The state should also consider adopting a public goods charge to fund water efficiency programs. Investments, water savings, and benefits should be tracked at the state level, as is done for energy IOUs. In addition, water utilities should partner with energy utilities on programs that increase both water and energy efficiency in order to reduce cost and increase effectiveness.

Collect more and better water data: Unlike with the energy sector, data are not readily available to evaluate statewide water savings or attribute those savings to particular programs or policies. More and better data are needed. Comprehensive, independent evaluations of existing efficiency programs are needed to quantify and verify water savings. These evaluations will help improve program design and support local and statewide water resource planning efforts.

References

American Council for an Energy-Efficient Economy (ACEEE). (2012). State Energy Efficiency Resource Standards. Policy Brief. http://aceee.org/files/pdf/policy-brief/state-eers-summary-0912.pdf

American Rivers. (2013). Drinking Water Infrastructure: Who pays and how (and for what?). An Advocate's Guide. http://www.americanrivers.org/assets/pdfs/reports-and-publications/drinking-water-infrastructure-report.pdf

American Water Intelligence (AWI). (2012). Decoupling gets mixed reviews in CA four years on. Vol. 3(2).

American Water Works Association (AWWA). (2012). M1 Principles of Water Rates, Fees and Charges, 6th Edition.

American Water Works Association (AWWA) and Raftelis Financial Consultants, Inc. (RFC). (2013). 2012 Water and Wastewater Rate Survey. Denver, CO and Charlotte, NC.

Black & Veatch. (1999). California Water Charge Survey.

Black & Veatch. (2006). California Water Rate Survey.

California Energy Commission (CEC). (2010). Quarterly Fuel and Energy Reports.

California Energy Commission (CEC).(2013a). Electricity Efficiency Conservation Savings by Planning Area and Sector Mid Demand Forecast Spreadsheets. Workshop on Preliminary Electricity and Natural Gas Demand Forecasts 2014 – 2024.

California Energy Commission (CEC). (2013b). Appliance energy efficiency rulemaking process. http://www.energy.ca.gov/appliances/2013rulemaking/documents/2013-03-22_Appliance_Efficiency_Rulemaking_Process.pdf

California Department of Finance (DOF). (2012). "California Population Estimates, with Components of Change and Crude Rates, July 1, 1900–2012." http://www.dof.ca.gov/research/demographic/reports/estimates/e-7/view.php.

California Department of Food and Agriculture (CDFA). (2007). California Agricultural Resource Directory. Accessed on July 29, 2008 at http://www.cdfa.ca.gov/statistics.html

California Department of Water Resources (CA DWR). (2009). Economic Incentives. Chapter 21, Volume 2 of the California Water Plan Update 2009.

California Department of Water Resources (CA DWR). (2010a). Status of Adoption of Water Efficient Landscape Ordinances, Pursuant to AB 1881 Section 65597. http://www.water.ca.gov/wateruseefficiency/docs/LandscapOrdinanceReport_to_Leg-4-22-2011.pdf

California Department of Water Resources (CA DWR). (2010b). 20x2020 Water Conservation Plan. Sacramento, California.

California Department of Water Resources (CA DWR). (2013a). Table 1-2, Volume 3. Water Plan Update 2013: Public Review Draft. Sacramento, California.

California Department of Water Resources (CA DWR). (2013b). Table 1-3, Volume 3. Water Plan Update 2013: Public Review Draft. Sacramento, California.

California Municipal Utilities Association (CMUA). (2013). Energy Efficiency in California's Public Power Sector: A 2013 Status Update. Produced in collaboration with the Northern California Power Agency and the Southern California Public Power Authority.

California Public Utilities Commission (CPUC). (2005). Water Action Plan. ftp://ftp.cpuc.ca.gov/PUC/hottopics/3water/water_action_plan_final_12_27_05.pdf

California Public Utilities Commission (CPUC). (2010). Water Action

Plan. http://docs.cpuc.ca.gov/PUBLISHED/Graphics/125501.PDF

California Public Utilities Commission (CPUC). (2012a). 2010-2011 Energy Efficiency Annual Progress Evaluation Report. San Francisco, CA.

California Public Utilities Commission (CPUC). (2012b). Order instituting rulemaking on the Commission's own motion to conduct a comprehensive examination of investor owned electric utilities' residential rate structures, the transition to time varying and dynamic rates, and other statutory obligations. Filed Public Utilities Commission, June 21, 2012, San Francisco office. Rulemaking 12-06-013.

California Public Utilities Commission (CPUC). (2012c). Electric and Gas Utility Cost Report: Public Utilities Code Section 747 Report to the Governor and Legislature. San Francisco, CA.

California Public Utilities Commission (CPUC). (2013a). Public Utilities Code Section 748 Report to the Governor and Legislature on Actions to Limit Utility Cost and Rate Increases. June.

California Public Utilities Commission (CPUC). (2013b). Energy Conservation Assistance Act (ECAA) Program Loans. http://www.energy.ca.gov/efficiency/financing/calmap/county/

Canby, W.C. (2009). California Energy Commission v. U.S. Department of Energy. On Petition for Review of an Order of the Department of Energy Argued and Submitted November 17, 2008—San Francisco, California, Filed October 28, 2009, Before: William C. Canby, Jr. and Kim McLane Wardlaw, Circuit Judges, and David G. Trager, District Judge. Opinion by Judge Canby. No. 07-71576, DOE No. EE-RM-PET-100.

Cavanagh, M. (2012). LA Utility's Historic Energy Efficiency Action Will Reverberate Nationwide. Switchboard: Natural Resources Defense Council Staff Blog. Accessed on December 5, 2013 at http://switchboard.nrdc.org/blogs/rcavanagh/la_utilitys_historic_energy_ef.html.

Chesnutt, T.W. (2011). Volumetric Pricing for Sanitary Sewer Service in the State of California. A & N Technical Services. Encinitas, CA.

City of Riverside Public Utilities Department (PUD). (2013). Schedule Wa-1 Residential Metered Service, Effective Date: August 13, 2013. http://www.riversideca.gov/utilities/pdf/2013/Water%20Schedule%20WA-1%20effective%208-13-13.pdf

Coleman, Michael. (2005). A Primer on California City Finance. League of California Cities. http://www.californiacityfinance.com/FinancePrimer05.pdf

Cooley, H., J. Christian-Smith, P.H. Gleick, M.J. Cohen, M. Heberger. (2010). California's Next Million Acre-Feet: Saving Water, Energy, and Money. Oakland, CA: Pacific Institute.

Division of Ratepayer Advocated (DRA). (2012). Supplemental Testimony on WRAM/MCBA Golden State Water Company - Test Year 2013 and Escalation Years 2014 and 2015. Application 11-07-017.

Downs, A., A. Chittum, S. Hayes, M. Neubauer, S. Nowak, S. Vaidyanathan, K. Farley, and C. Cui. (2013). The 2013 State Energy Efficiency Scorecard. Report Number E13K. American Council for an Energy-Efficient Economy: Washington, D.C.

East Bay Municipal Utility District (EBMUD). (2012). Water Management Plan 2011. http://www.usbr.gov/mp/watershare/wcplans/2012/EBMUD_2011_WMP2.pdf

Eldridge, M., M. Neubauer, D. York, S. Vaidyanathan, A. Chittum, and S. Nadel. (2008). The 2008 State Energy Efficiency Scorecard. Report Number E086. American Council for an Energy-Efficient Economy: Washington, D.C.

Eldridge, M., B. Prindle, D. York, and S. Nadel. (2007). The State Energy Efficiency Scorecard for 2006. Report Number E075. American Council for an Energy-Efficient Economy: Washington, D.C.

Eldridge, M., M. Sciortino, L. Furrey, S. Nowak, S. Vaidyanathan, M. Neubauer, N. Kaufman, A. Chittum, S. Black, C. Sheppard, C. Chamberlin, A. Jacobson, Y. Mugica, and D. Bryk. (2009). The 2009 State Energy Efficiency Scorecard. Report Number E097. American Council for an Energy-Efficient Economy, Humboldt State University, and Natural Resources Defense Council.

Electric Power Research Institute (EPRI). (2011). The Effect on Electricity Consumption of the Commonwealth Edison Customer Applications Program: Phase 2 Final Analysis. Technical Update.

Energy Efficiency Groupware Application (EEGA). (2013). California Energy Efficiency Statistics. http://eestats.cpuc.ca.gov/

Ettenson, L., A. Leupp, S. Martinez, S. Tomashefsky, and D. Wang. (2012). Energy Efficiency Progress in

California's Public Power Sector. ElectricityPolicy.com. December.

Faruqui, A. and R. Hledik. (2007). The State of Demand Response in California. Prepared for the California Energy Commission by the Brattle Group. CEC-200-2007-003-D.

Foster, B., A. Chittum, S. Hayes, M. Neubauer, S. Nowak, S. Vaidyanathan, K. Farley, K. Schultz, T. Sullivan, C. Sheppard, A. Jacobson, C. Chamberlin, and Y. Mugica. (2012). The 2012 State Energy Efficiency Scorecard. Report Number E12C. American Council for an Energy-Efficient Economy: Washington, D.C.

Gleick, P.H., D. Haasz, C. Henges-Jeck, V. Srinivasan, G. Wolff, K. K. Cushing, and A. Mann. (2003). Waste Not, Want Not: The Potential for Urban Water Conservation in California. Pacific Institute: Oakland, Ca.

Hanak, E., and M. Davis. (2006). Lawns and Water Demand in California. Public Policy Institute of California, California Economic Policy, 2(2): 1-24.

Hayes, S., S. Nadel, M. Kushler, and D. York. (2011). Carrots for Utilities: Providing Financial Returns for Utility Investments in Energy Efficiency. American Council for an Energy-Efficient Economy (ACEEE): Washington, D.C.

Hughes, J., M. Tiger, and S. Eskaf. (2009). Utility Rate Setting for Cost Recovery and Conservation. Summary of Research Support Services for the NC State Water Infrastructure Commission.

Jessoe, K. and D. Rapson. (2013). Commercial and Industrial Demand Response under Mandatory Time-of-Use Electricity Pricing.

Kahlon, Rami. (2012). Personal Communication with the Director, Division of Water and Audits at California Public Utilities Commission.

Kandel, A., M. Sheridan, and P. McAuliffe. (2008). A Comparison of Per Capita Electricity Consumption in the United States and California. California Energy Commission (CEC): Sacramento, California.

Kavalec, C., N. Fugate, B. Alcorn, M. Ciminelli, A. Gaut am, K. Sullivan, and M. Weng-Gutierrez. (2013). *California Energy Demand 2014 - 2024 Revised Forecast, Volume 1: Statewide Electricity Demand, End-User Natural Gas Demand, and Energy Efficiency.* California Energy Commission, Electricity Supply Analysis Division. Publication Number: CEC-200-2013-004-SD-V1-REV.

Klein, G. (2005). California Energy Commission, California's Water – Energy Relationship. Final Staff Report, Prepared in Support of the 2005 Integrated Energy Policy Report Proceeding, (04-IEPR-01E) November 2005, CEC-700-2005-011-SF.

Kuduk, C.A., and S.J. Anders. (2006). Following California's Public Goods Charge: Tracking Contributions and Expenditures of the Renewable Energy Program and the PIER Program. Energy Policy Initiatives Center, University of San Diego School of Law. http://www.sandiego.edu/documents/epic/060911_PGC_FINAL_000.pdf

Kushler, M., D. York, and P. Witte. (2006). Aligning Utility Interests with Energy Efficiency Objectives: A Review of Recent Efforts at Decoupling and Performance Initiatives. Research Report U061. Washington, DC: American Council for an Energy-Efficient Economy.

Laitner, J.A. (2013). Calculating the Nation's Annual Energy Efficiency Investments. American Council for an Energy-Efficient Economy (ACEEE): Washington, D.C.

Legislative Analyst Office (LAO). (2012). Energy Efficiency and Alternative Energy Programs. Sacramento, California.

Lewis, Kae, Che McFarlin, Cynthia Rogers, Doug Kemmer. (2011). *Achieving Cost-Effective Energy Efficiency for California 2011–2020*. California Energy Commission, Electricity Supply Analysis Division. CEC-200-2010-007-SD.

Martinez S., D. Wang, J. Chou. (2010). "California Restores its Energy Efficiency Leadership: Smart Policies Provide Enormous Economic and Environmental Benefits." http://docs.nrdc.org/energy/files/ene_10030901a.pdf

Mehta, M. (2012). Volumetric Wastewater Pricing: Frequently Asked Questions. Natural Resources Defense Council. Santa Monica, CA.

Metropolitan Water District of Southern California (MWD). (2013). Basic Financial Statements, Years ended June 30, 2013 and 2012. Los Angeles, California.

Metropolitan Water District of Southern California (MWD). (2014). Regional Progress Report: An Annual Report to the California State Legislature on Achievements in Conservation, Recycling, and Groundwater Recharge. Los Angeles, California.

Molina, M., M. Neubauer, M. Sciortino, S. Nowak, S. Vaidyanathan, N. Kaufman, A. Chittum, C. Sheppard,

M. Harper, A. Jacobson, C. Chamberlin, and Y. Mugica. (2010). The 2010 State Energy Efficiency Scorecard. Report Number E107. American Council for an Energy-Efficient Economy: Washington, D.C.

Natural Resources Defense Council. (2007). Transforming Water Use: A California Water Efficiency Agenda for the 21st Century. Submitted to the Delta Vision Blue Ribbon Task Force. February 28, 2007.

Northern California Power Agency (NCPA). (2013). "Energy Efficiency in California's Power Sector: A 2013 Status Report." Roseville, CA.

Nowak, S., M. Kushler, M. Sciortino, D. York, and P. Witte. (2011). Energy Efficiency Resource Standards: State and Utility Strategies for Higher Energy Savings. ACEEE Report Number U113.

Palmer, K., S. Grausz, B. Beasley, and T. Brennan. (2012). Putting a Floor on Energy Savings: Comparing State Energy Efficiency Resource Standards. Resources for the Future: Washington, D.C.

Raftelis Financial Consultants, Inc. (RFC) and California-Nevada Section of the American Water Works Association (CA-NV AWWA). (2011). California-Nevada Water Rate Survey.

Sacramento Utility District (SMUD). (2013). General Manager's Report and Recommendation on Rates and Services. Volume 1. https://www.smud.org/en/about-smud/company-information/document-library/documents/2013-GM-Rate-Report-Vol-1.pdf

Sciortino, M., M. Neubauer, S. Vaidyanathan, A. Chittum, S. Hayes, S. Nowak, M. Molina, C. Sheppard, A. Jacobson, C. Chamberlin, and Y. Migica. (2011a). The 2011 State Energy Efficiency Scorecard. Report Number E115. American Council for an Energy-Efficient Economy: Washington, D.C.

Sciortino, M., S. Nowak, P. Witte, D. York, and M. Kushler. (2011b). Energy Efficiency Resource Standards: A Progress Report on State Experience. ACEEE Report Number 112.

Spitz, S. A. and D. Brennan. (2012). Water and Wastewater Projects – Financing with Tax-Exempt Bonds. Orrick, Herrington & Sutcliffe LLP. http://www.orrick.com/Events-and-Publications/Documents/Water-and-Wastewater-Projects-Financing-with-Tax-Exempt-Bonds.pdf

United States Department of Energy (DOE). (2010). Final Rule - Energy Efficiency Program for Consumer Products: Waiver of Federal Preemption of State Regulations Concerning the Water Use or Water Efficiency of Showerheads, Faucets, Water Closets and Urinals. 75 FR 80289. https://www.federalregister.gov/articles/2010/12/22/2010-32116/energy-efficiency-program-for-consumer-products-waiver-of-federal-preemption-of-state-regulations

United States Department of the Interior (DOI). (2009). "Secretary Salazar Announces $27.3 Million of Economic Recovery Funding to Improve Water Conservation in California", Press release, August, 2009.

United States Energy Information Administration (US EIA). (2012). State Energy Consumption Estimates, 1960 Through 2010. DOE/EIA-0214(2010).

United States Energy Information Administration (US EIA). (2013a). State Energy Data System (SEDS), Data File "All Consumption Estimates in Physical Units, 1960–2011," ESTCP (Electricity total consumption (i.e., sold)) and NGTCP (Natural gas total consumption (including supplemental gaseous fuels)) (June 28, 2013). Available at: www.eia.doe.gov/emeu/states/_seds.html

United States Energy Information Administration (US EIA). (2013b). Electric Sales, Revenue, and Average Price. From EIA-861 Annual Electric Power Industry Report. www.eia.gov/electricity/sales_revenue_price

United States Energy Information Administration (US EIA). (2013c). Form EIA 826, "Monthly Electric Utility Sales and Revenue Report with State Distributions" http://www.eia.gov/electricity/data/eia826/

United States Energy Information Administration (US EIA). (2013d). Natural Gas Annual Respondent Query System, form EIA-176 "Annual Report of Natural and Supplemental Gas Supply and Disposition," Data through 2011. http://www.eia.gov/cfapps/ngqs/ngqs.cfm?f_report=RP1

Weber, T., A. Besa, and B. Miller. (2006). Decoupling Mechanisms: Energy Efficiency Policy Impacts and Regulatory Implementation. ACEEE Summer Study on Energy Efficiency in Buildings. Washington, DC: American Council for an Energy-Efficient Economy.

Western Resource Advocates (WRA). (2003). Smart Water: A Comparative Study of Urban Water Use Efficiency Across the Southwest. Boulder, Colorado.

Wilkinson, R. (2011). The Water-Energy Nexus: Methodologies, Challenges, and Opportunities. In

Kenney, D.S., and R. Wilkinson (editors). 2011. The Water-Energy Nexus in the Western United States. Cheltenham: Edward Elgar Publishing.

York, D. and M. Kushler. (2005). Exploring the Relationship Between Demand Response and Energy Efficiency: A Review of Experience and Discussion of Key Issues. American Council for an Energy-Efficient Economy, Report Number U 052.