Putting California on the High Road: A Jobs and Climate Action Plan for 2030

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Chapter 10:
Water

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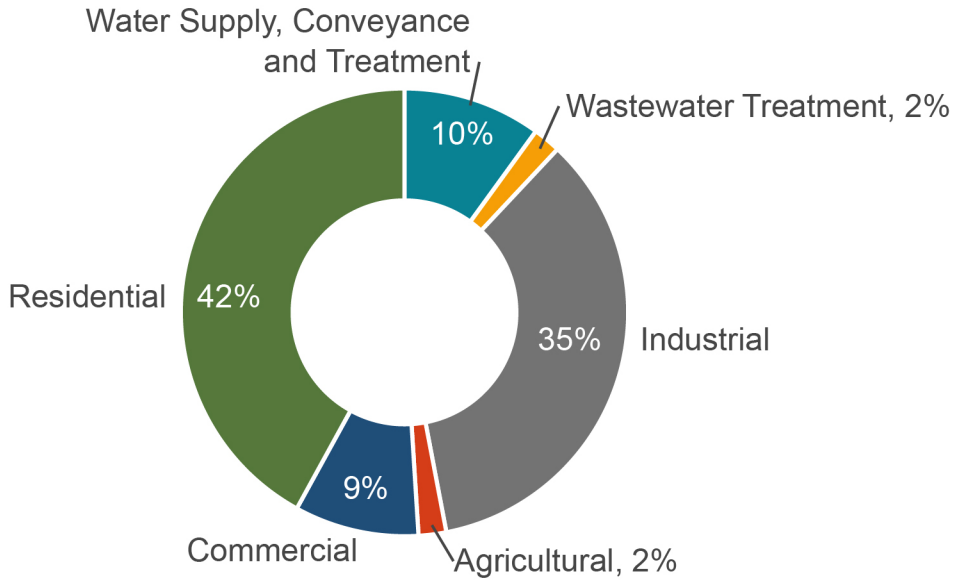
I. Overview of Sector and Key Climate Policies

Water and energy resources are inextricably linked, forming what is referred to as the water-energy nexus. The California water system accounts for 19 percent of the state's total electricity usage, 32 percent of its natural gas consumption,[1] and 10 percent of the state's greenhouse gas emissions.[2] Water conservation efforts are therefore a key target for climate policy. Saving water saves energy, so conservation in commercial and residential usage and reduction of peak demand has a sizeable impact on energy use and, by extension, emissions. Conversely, as electricity gets cleaner, the water-energy nexus will become less critical to the reduction of emissions.

As illustrated in **Exhibit 10.1**, most of the energy consumed by California's water sector (88 percent) is attributable to residential, industrial, commercial, and agricultural end uses.[3] Water supply, conveyance, and treatment accounts for 10 percent, and wastewater treatment for the remaining 2 percent. Supply, conveyance and treatment is the purview of the state's Department of Water Resources, and the vast majority of this agency's climate pollutant emissions (about 98 percent) stem from operations associated with the State Water Project, the world's most extensive system of dams, reservoirs, power and pumping plants, and aqueducts.[4]

Exhibit 10.1. Energy Used by the Water Sector



Source: PPIC Water Policy Center, "Energy and Water" (Public Policy Institute of California, October 2016), http://www.ppic.org/content/pubs/report/R_1016AER.pdf.

Emissions reduction strategies in the water sector are primarily focused on reducing water energy intensity. Energy intensity is a measure of the amount of energy required to take a unit of water from its source to its end user.[5] Energy intensity varies widely across regions throughout the state, depending on the nature of the source, the method of extraction required, the degree of treatment, and most importantly, the distance and topography between source and end user. Supplying water to Southern California requires approximately 50 times the amount of energy required to supply Northern California because it must be pumped for hundreds of miles and over the Tehachapi Mountain Range.[6] As a result, Southern California's water energy intensity is roughly triple that of Northern California.[7]

California's rapidly growing population—projected to reach 44 million by 2030[8]—will continue to place pressure on the state's water supply system. As water demand grows, energy demand typically grows at the same rate and in the same regions.[9] Increased water demand also taxes the state's electricity delivery systems, on which water system reliability depends. The cultivation of the new water supplies that will be needed even with increased conservation efforts, such as water recycling or desalination, will further increase energy demand. Reduced surface water, as during a drought, will also entail an increase in energy usage, due to an increased need for pumping from lower water tables.

This dynamic is further exacerbated by what the California Air Resources Board (CARB) refers to as "the precipitation-population mismatch"[10] between north and south: the fact that Northern California has two-thirds of the state's precipitation, while Southern California has two-thirds of its population.[11] Reducing Southern California's reliance on imported water as well as reducing demand across the state through the peak summer months and during periods of drought will thus contribute significantly to reductions in state energy use.

Investment in repairing and upgrading water infrastructure is another important area of focus for improving water-energy efficiency. The state's water infrastructure runs from source to tap and includes drinking water, wastewater, storm water, and water infrastructure systems.[12] These range from traditional "gray" infrastructure (such as pipes, pumps, treatment plants, aqueducts, and levees) to "green" infrastructure (such as rain gardens, watersheds, rivers, lake, ponds, wetlands, and subsurface aquifers), as well as toilets, washing machines, water heaters, and irrigation systems employed by end-users. Some of the best opportunities for water efficiency investments can be found in lower-income areas where water distribution infrastructure may be older or not adequately maintained and where household appliances tend to be older and less efficient.

California has created a comprehensive plan to address both the need for water conservation in a period of growing demand and the need to support the state's climate mitigation efforts.[13] It is employing multiple strategies to achieve these ends, including:

implementing new conservation targets for agricultural, urban, industrial, and recycling usage standards; promoting water utility efficiency through new reporting standards for system water losses; increasing water savings by certifying innovative technologies for water conservation; requiring updated agricultural and urban water management plans; developing a voluntary registry for greenhouse gas emissions; and continuing to increase the use of renewable energy to operate California's State Water Project (which encompass state-operated water utilities, dams, and pipelines).

The following key policies mentioned in the Scoping Plan affect the water sector:

❖ Water Conservation

➢ The Water Conservation Act of 2009 (Senate Bill X7-7, Steinberg, Chapter 4, Statutes of 2009)[14]

SB X7-7 established a requirement for a 20-percent reduction in urban per capita water use by December 31, 2020.[15] The bill also promoted the expansion of sustainable water supplies and required agricultural water management plans and new and more efficient management practices for agricultural water suppliers. The State Water Resources Control Board (SWRCB) and Department of Water Resources (DWR) are currently working on stronger water-use efficiency standards that build on SB X7-7. Existing standards that help achieve the water conservation target include appliance efficiency standards, such as those mandated by the California Energy Commission (CEC) for low-flush toilets (state codes set under Title 24 and 20).

➢ Executive Order B-37-16

Signed in 2016, this order directs five state agencies to: 1) develop and implement new water-use targets beyond the existing target (established in SB X7-7) of a 20-percent reduction in urban per capita water use by 2020, and 2) establish a long-term water conservation framework. The new targets will strengthen standards for indoor and outdoor irrigation, commercial, industrial, and institutional water. This includes setting performance standards to address water system leakage, increasing the use of renewable energies in water production, establishing new appliance standards, and certifying new technologies for water conservation and energy efficiency. Additional recommendations made in the executive order that will require legislative authorization to be implemented include strengthening urban water shortage contingency plans, improving drought planning for small water suppliers and rural communities, and updating agricultural and urban water management plan requirements.

- **Senate Bill 555 (Urban Retail Water Suppliers; Wolk, Chapter 679, Statutes of 2015)**[16]

  Passed in October 2015 to reduce water loss, SB 555 requires urban retail water suppliers to submit independently audited and certified water loss reports annually as prescribed by rules issued by the DWR. The DWR posts the reports to allow the public to make comparisons between suppliers, informing consumer choice and helping to hold bad actors accountable. The bill also requires the DWR to provide technical assistance to help urban retail suppliers improve their water loss detection programs and requires the SWRCB to adopt new rules mandating performance standards for water suppliers to reduce the volume of water losses.

- **Recycled Water, Stormwater Capture, and Building and Landscaping Standards (Assembly Bill 2282, Gatto, Chapter 606, Statutes of 2014)**[17]

  Health and Safety Codes 17921.5 and 18940.6, as amended by AB 2282 in September 2014, directed the California Department of Housing and Community Development (HCD) and the California Building Standards Commission (BSC) to conduct research during the 2016 Intervening Code Cycle to assist in development of mandatory green building standards for the installation of recycled water systems for newly constructed single-family and multifamily residential buildings and non-residential buildings. The timeline for the adoption, given the 2016 Intervening Code Adoption Cycle, would make the standards effective for applicable new construction beginning July 1, 2018.

- **Landscaping (Executive Order B-29-15 and Assembly Bill 2515, Weber, Chapter 576, Statutes of 2016)**[18]

  In California, about half of urban water is used for landscape irrigation. Substantial water savings can therefore be gained by proper landscape design, installation, and maintenance. Executive Order B-29-15 calls for the DWR to update the Model Water Efficient Landscaping Ordinance (MWELO) to promote efficiencies in new development and retrofitted urban landscaping through new rules mandating more efficient irrigation systems, graywater usage and onsite stormwater capture, as well as by limiting the portion of landscapes that can be covered in turf.[19] AB 2515 requires the DWR, on or before January 1, 2020, and at least every three years thereafter, to either update the MWELO or make a finding that an update is not needed.

- **Recycled Water Policy**

  Adopted by the SWRCB in 2009, this policy set the goals of: 1) increasing the use of recycled water beyond 2002 levels by at least 1 million acre-feet per year (AFY)

by 2020 and at least 2 million AFY by 2030; 2) increasing the use of stormwater beyond use in 2007 by at least 500,000 AFY by 2020 and by at least 1 million AFY by 2030; 3) increasing the amount of water conserved in urban and industrial uses in comparison to 2007 by at least 20 percent by 2020; and 4) substituting of as much recycled water for potable water as possible by 2030. Water recycling has the potential to reduce greenhouse gas emissions if it replaces—and not merely serves as an alternative to—an existing, higher-carbon water supply.

- **California Green Building Standards Code**

  This state-adopted green building code, commonly known as the "CALGreen Code," was the first in the nation. Originally published in 2008, it sets goals for environmentally friendly building materials, energy efficiency, and water conservation. Regulations contain mandatory and voluntary building standards for the reduction of indoor and outdoor water use for residential and commercial construction.

- **Sustainable Groundwater Management Act (Senate Bill 1168, Pavley, Chapter 346, Statutes of 2014;[20] Assembly Bill 1739, Dickinson, Chapter 347, Statutes of 2014;[21] Senate Bill 1319, Pavley, Chapter 348, Statutes of 2014[22])**

  The most significant legislative water initiative enacted in California in the past half-century by some estimates,[23] this act consists of three bills that require local public agencies and groundwater sustainability agencies (GSAs) in high- and medium-priority basins to develop and implement groundwater sustainability plans (GSPs)—essentially road maps for how groundwater basins will reach long-term sustainability.[24] The DWR defines sustainable groundwater management as "the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results," such as a chronic lowering of groundwater levels or storage levels, significant seawater intrusion, degraded water quality, or depletions of surface water.[25] The act does not specify emissions-related standards or goals. The DWR has developed regulations governing the content of GSPs,[26] and local stakeholders have until 2022 (or 2020 in critically over-drafted basins) to develop, prepare, and begin to implement them. GSAs will have until 2040 to achieve groundwater sustainability. The act also enhances local management of groundwater; establishes minimum standards for effective, continuous management of groundwater; provides local groundwater agencies with authority and technical and financial assistance to maintain groundwater supplies; helps minimizes impacts of land subsidence; improves data collection; increases groundwater storage; and removes impediments to recharge.

❖ Greenhouse Gas Emissions Reduction and Increased Reliance on Renewable Energy

➢ Department of Water Resources Climate Action Plan

The DWR is reducing its environmental impacts and leading by example through its approved, department-wide Climate Action Plan. The vast majority of the DWR's climate pollutant emissions (about 99 percent) stem from operations associated with the State Water Project (SWP), the state's extensive system of dams, reservoirs, power and pumping plants, and aqueducts.[27] The SWP's operations account for around 10 percent of the total energy consumed by California's water sector; most of the rest (88 percent) goes to residential use.[28] The first phase of the Climate Action Plan is a Greenhouse Gas Emissions Reduction Plan, which guides project development and decision making with respect to energy use and greenhouse gas emissions, with the goal of 50 percent below 1990 levels by 2020 and 80 percent below 1990 levels by 2050. The DWR has identified 11 greenhouse gas emissions reduction measures that it will implement to meet these goals, including: the termination of DWR participation in and associated delivery of electricity from a coal-fired power plant (the Reid Gardner Power Station); the purchase of a greater proportion of its energy from renewable sources; the development of renewable energy generation on buildings and lands that it owns; efficiency improvements for the State Water Project and other existing DWR facilities; the purchase and development of renewable and high-efficiency electricity supplies; comprehensive improvements to DWR construction practices; and improvements to DWR business activities. The DWR currently operates five hydroelectric generating plants and four hybrid pumping/generating plants, making it the fourth-largest producer of energy in the state.[29] It also purchases power from outside sources. The majority of this power—81 percent, as of 2016—comes from renewable sources, including solar, hydro, geothermal, and landfill gas; the remainder comes from a high-efficiency natural-gas-fired power plant in Lodi, in which the DWR has a partial ownership interest.[30] As of 2014, DWR carbon emissions were already approximately 30 percent below 1990 levels._

➢ Short-Lived Climate Pollutant Strategy

The California Air Resources Board (CARB) Short-Lived Climate Pollutant Strategy was established under Senate Bill 605 (Lara, Chapter 523, Statutes of 2014)[31] and Senate Bill 1383 (Lara, Chapter 395, Statutes of 2016)[32] and approved in March 2017. SB 605 required CARB to develop a plan to reduce emissions of short-lived climate pollutants (SLCPs). SB 1383 required CARB to begin implementing the plan by January 1, 2018. SB 1383 also set targets

for statewide reductions of SLCPs from 2013 levels by 2030; specifically, a 40-percent reduction of methane and hydrofluorocarbons, and a 50-percent reduction of anthropogenic black carbon. The CARB plan also includes new measures to reduce methane from wastewater treatment plants.

- **Renewable Energy Self-Generation Bill Credit Transfers (RES-BCT)**

  Established by Assembly Bill 2466 (Laird, Chapter 540, Statutes of 2008)[33] and effective as of January 1, 2009, RES-BCT allows local governments—including water agencies—to generate energy from an eligible renewable generating facility for their own use and to export energy not consumed to the electrical grid. The exported energy is converted into bill credits that are applied to eligible benefiting accounts as designated by the local government. Under the legislation, local water and wastewater utilities can develop distributed renewable energy where feasible, using the expanded Local Government Renewable Energy Self-Generation Bill Credit tariff and new net energy metering (which allow for installation without system size limit).

II. Industries and Occupations Affected

The California water system encompasses an elaborate infrastructure designed to facilitate the capture, use, conveyance, storage, conservation, and treatment of water and wastewater across multiple sectors: industrial, commercial, agriculture, and residential. Key players in the system include interrelated government entities at the state, regional, county, and city level as well as regulators, elected leaders, private and public (often municipal) water suppliers, and perhaps most importantly, end users who drive demand. Within this sector, distinct subsystems are responsible for different functions, including the handling, movement, and treatment of drinking water; the construction, operations, and maintenance of water infrastructure; wastewater treatment; flood control; capture of run-off; and standard setting for irrigation control and appliance efficiency.

The water sector as a whole spans numerous industries, encompassing anyone employed in the design, construction, management, or governance of California's multiple water infrastructure systems, including drinking water, wastewater, storm water, and green infrastructure, such as green roofs and rain gardens. Green infrastructure generally refers to systems and practices that use natural landscapes and processes to manage storm water.[34] While precise estimates would be difficult to formulate given the complexity entailed in this span, it would be safe to say that the principal industries affected by the climate policies considered here are the utilities and construction industries.

A 2018 Brookings report on water workers nationwide—the most comprehensive workforce analysis available to date—identifies 212 individual occupations in the sector across seven industries at the four- to five-digit NAICS code level.[35] The primary industries are utilities and construction, though consulting services, remediation and waste management services, and government are also included. The largest occupation by employment, representing roughly one-fifth of the water-sector workforce—more than double the employment of the next ranking category—is plumbers, pipefitters, and steamfitters, followed by construction laborers (roughly 9 percent) and water and wastewater treatment plant and system operators (roughly 7 percent). Some of these occupations can be found in multiple industries. By the Brookings calculations, around 17 percent of all water workers nationwide are employed in the utility industry. See **Exhibit 10.2** for a list of the major occupations in the water sector.

Exhibit 10.2. Top 10 Occupations in the Water Sector Nationwide[36]

Occupation	Total Employment	% of Water Workforce	% in Utility Industry
Plumbers, Pipefitters, and Steamfitters	324,500	19.4%	4.0%
Construction Laborers	149,513	8.9%	1.7%
Water and Wastewater Treatment Plant and System Operators	115,840	6.9%	88.5%
Operating Engineers and Other Construction Equipment Operators	79,900	4.8%	3.2%
Heating, Air Conditioning, and Refrigeration Mechanics and Installers	70,811	4.2%	NA*
First-Line Supervisors of Construction Trades and Extraction Workers	56,021	3.3%	3.3%
Office Clerks, General	47,602	2.8%	20.3%
Helpers—Pipelayers, Plumbers, Pipefitters, and Steamfitters	46,510	2.8%	1.7%
Heavy and Tractor-Trailer Truck Drivers	38,548	2.3%	4.0%
Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	35,141	2.1%	20.1%

* There are fewer than 250 workers from this occupation employed in the utility industry.

Source: Joseph Kane and Adie Tomer, “Renewing the Water Workforce: Improving Water Infrastructure and Creating a Pipeline to Opportunity” (The Metropolitan Policy Program at Brookings, June 2018), https://www.brookings.edu/research/water-workforce/.

State-level employment numbers are more difficult to determine due to the smaller scale of the pool and the wide spread across industries. The Brookings report calculates water employment for 10 California metropolitan areas, though not for the state as a whole.[37] The combined total for those areas is 142,806 workers, or 1 percent of total employment. The highest concentration is in the Los Angeles area, which at 53,424 is more than double that of the next-ranking metro, San Francisco (23,959).

Water efficiency programs also impact plumbing and construction occupations. A 2011 study by the Economic Roundtable analyzed $1.2 billion of investment in water efficiency projects in the Los Angeles area—a total of 53 projects—charting the impact across 12 industries.[38] It found that the vast majority of impact was in the construction industry (83.3 percent), followed by professional services (11.5 percent). Water conservation projects, the study notes, "have particularly high multiplier effects for local manufacturing, professional services, utilities and wholesaling establishments, along with local environmental organizations, recreation sites, museums, and parks."

III. Workforce Issues in Key Subsectors and Policies

The following section addresses the workforce issues embedded in the major climate policy areas in the water sector: water conservation and water agency emissions reductions. For each subsector, the analysis describes the relevant climate policies, examines the available evidence on workforce outcomes, and identifies additional workforce policy levers that implementing agencies can use to create good jobs and increase the demand for skilled labor. It also highlights opportunities to develop and leverage the state's training and education infrastructure to prepare workers for the sector's climate-driven labor market changes.

A. Water Conservation

Moving to bolster California's climate and drought resilience and build on temporary statewide emergency conservation efforts, Governor Jerry Brown signed Executive Order B-37-16 in May 2016. The executive order tasked state agencies with establishing a long-term framework for water conservation and drought planning and set forth a list of actions to help California make smarter decisions about water use. These measures include scheduled water-use reporting by water utilities, new urban water-use targets, reducing system leaks, permanently eliminating wasteful practices, strengthening urban drought planning, and improving agricultural water management.[39] The executive order directed five state agencies—the California Department of Water Resources (DWR), the

State Water Resources Control Board (SWRCB), the California Department of Food and Agriculture (CFDA), the California Public Utilities Commission (CPUC), and the California Energy Commission (CEC)—to create a framework for implementing the order. Some of the measures recommended by these agencies could be implemented based on existing state administrative authority, others required new statutory authorization.

SB 555, one of the new legislative measures to emerge from the executive order, sets one of the toughest water loss control reporting standards in the nation.[40] Passed by the state legislature in October 2015, the bill requires water utilities to submit independently verified and certified water loss audits to the DWR. SB 555 also requires the SWRCB to adopt new rules no later than July 1, 2020, that will mandate performance standards for water suppliers to reduce the volume of water losses, including standards for equipment replacement and new infrastructure to address leakage.[41] It also specifies that compliance with the Urban Water Management Planning Act is a prerequisite to receiving state funding for water projects and programs.[42]

The executive order clears the way for California to become the first state in the nation to set mandatory indoor and outdoor water-use efficiency targets. On May 31, 2018, Governor Brown signed into law two new bills (Senate Bill 606, Hertzberg, Chapter 14, Statutes of 2018[43] and Assembly Bill 1668, Friedman, Chapter 15, Statutes of 2018[44]) that will require urban water providers throughout California to set new permanent water-use targets for their service areas by 2022. These bills also establish a framework for implementing and enforcing the new water-use requirements, including: 1) a standard for indoor residential water use of 55 gallons per person per day, dropping to 50 gallons by 2030; 2) new standards for outdoor residential water use based on community climate and landscaped area; and 3) a new standard for water loss due to leaks in water system pipes. These three standards together will be used to calculate overall water-use targets for individual water providers. The State Water Board can fine providers that do not meet their targets up to $1,000 per day during non-drought years and $10,000 per day during drought emergencies.[45]

These new measures are part of the broader, multifaceted implementation of the California Water Action Plan, which creates a roadmap for sustainable water management in California.[46]

The Water Action Plan provided the foundation for Prop. 1, the $7.5-billion water quality and supply bond measure passed in 2014, and the state administration's legislative agenda on water, including groundwater legislation and new mandates for reduced residential and agricultural usage levels.[47] These and other new water management measures recently passed by the state legislature are still in the implementation phase and have had few discernible labor impacts to date. But they set the stage for significant new investment in state water infrastructure.

These sustainable water conservation and use policies—along with efforts to reduce greenhouse gas emissions—have begun to promote the management of water and

energy in tandem. There is good reason for this twin focus, since continued population growth and disruptions in water supplies caused by a changing climate will place increasing pressure on both water and energy supplies. To meet the challenge, some state programs have provided grants to help pilot new technologies[48] and programs for water and energy efficiency programs,[49] and the CPUC is working with utilities to quantify energy savings from water conservation.[50] In addition, allocations from the Greenhouse Gas Reduction Fund (GGRF) have been used to lower water usage rates.[51]

To date, more than $180 million has been allocated from the state's GGRF to promote water and water-energy use reductions, which includes the following:

- The DWR's Water-Energy Grant Program has provided $70 million in funds from the GGRF to implement water efficiency programs.[52] The goal of the program is to reduce greenhouse gas emissions as well as water and energy use by funding commercial and institutional water-energy efficiency projects, residential water-energy efficiency projects, and projects benefiting disadvantaged communities.[53] Expected project benefits include savings of more than half a billion gallons of water; a reduction in greenhouse gas emissions by 67 MMTCO2e (million metric tons of carbon dioxide equivalents); the removal of 170,000 acres of grass; and the installation of thousands of new and more efficient faucets, toilets, washing machines, showerheads, water heaters, and sprinklers.[54]

- The State Water Efficiency Enhancement Program (SWEEP), administered by the California Department of Farm Administration (CDFA), has been awarded $68 million[55] to provide financial grants for new farm irrigation systems that reduce greenhouse gas emissions and help save water. So far, the program has funded nearly 600 projects covering 109,000 acres that promote initiatives such as soil moisture monitoring, the installation of low-pressure irrigation, and technology to promote renewable energy on farms.[56] These initiatives have saved an estimated 31 billion gallons of water and reduced CO2 emissions by 74,130 metric tons.

- The Department of Fish and Wildlife has so far been allocated $30 million for wetland and watershed restoration.[57]

- Transformative Climate Communities, a program of the California Strategic Growth Council, awarded $140 million to help fund the development and implementation of neighborhood-level community plans to reduce greenhouse gas emissions and the deliver local economic, environmental, and health benefits for disadvantaged communities.[58] Some of the projects include water-energy efficiency as plan components.[59]

These programs are a small down payment on the public investments required to achieve needed gains in water-use efficiency, which are estimated not in the millions, *but in the tens of billions*. Such investments can take many forms, such as storm water capture and treatment infrastructure, groundwater treatment equipment and recharge

systems, graywater systems for homes, sub-metering for multifamily housing, water desalinization facilities, indoor appliance/fixture retrofit campaigns, landscaping and ecosystem restoration, and irrigation system evaluation and repair. The initial focus in the implementation of the executive order and the Water Action Plan has been on setting new usage targets, standardizing data reporting and management planning, and supporting the development of new technology. The next phase of the Water Action Plan, to be laid out in a final report that will be released before the end of 2018,[60] makes modernizing and rehabilitating water resource management systems a key priority and calls on the state legislature, in concert with the other agencies and stakeholders, to develop a strategy to provide sufficient and sustainable funding to meet that need.[61]

Historically, the annual investment in the state's water system has been significant. Between 2005 and 2015, the average total investment in capital and ongoing expenditures by local, state, and federal agencies was approximately $30 billion per year.[62] Capital expenditures alone averaged approximately $5 billion per year, with the majority of the funds (85 percent) coming from local agencies. However, shortfalls are not uncommon. For example, the state has a funding gap of $2-3 billion per year in water and flood management.[63]

According to a working draft of the Water Action Plan released in 2018, California's total integrated water management funding need, across all levels of government, is an estimated $365 billion over the next 50 years.[64] If current funding levels are maintained, there will be a funding gap of more than $175 billion over that period. The Water Action Plan estimates that the state's share of funding required just to implement the plan's recommended actions—not to meet the total need outlined above—equates to around $2 billion per year over the next 50 years. Funding mechanisms have not yet been determined but could include: maximizing state GGRF funding for water infrastructure investment projects; allocating additional money from the state general fund; introducing further state ballot initiatives to gain voter approval for new bond issuances; and novel funding mechanisms such as private/public investment partnerships.

Such a large investment in state water infrastructure would have a significant impact on employment, creating tens of thousands of new jobs.[65] A significant share of these jobs would be middle-class, family-sustaining positions in construction and water utility operations and management.[66]

Under the plan, California would provide financial incentives for major rehabilitation, replacement, and construction of new facilities that both promote modernization of water and flood-related infrastructure, including natural infrastructure and ecosystem restoration, and support statewide water resource management systems and modernization of the system's operations and maintenance.[67] These incentives could provide the state with a significant lever to ensure better workforce outcomes for workers employed in the California water sector.

1. Workforce Outcomes

a. Job Growth

Labor impacts from the state's water conservation initiatives remain largely unknown at this point. As discussed above, many of the state's water strategies remain in the standard-setting, data-collection, implementation, or pilot phase. In some cases, their impact on state employment to date has been minimal, and in others, any job growth associated with these polices has yet to be captured at the state level.

The potential for job growth, however—particularly with water efficiency measures—is significant. At the regional level, a 2011 study published by the Economic Roundtable found that an investment of $1.2 billion in water-use efficiency projects in the Los Angeles region provided an estimated 8,654 direct job-years of employment.[68] The majority of the direct jobs created (81.3 percent) were in the construction industry; 11.5 percent were in the legal, architectural, scientific, and technical services industry; and 2.7 percent in utilities. The remainder were primarily in the government sector, manufacturing, and excavation and mining (each less than 2 percent).

On the basis of this evidence, the study estimates that an investment of $1 million in the five types of water-use efficiency projects it identifies—water conservation, graywater systems, groundwater management, recycled water, and stormwater—will generate between 6.6 to 9.4 direct jobs in the Los Angeles economy.[69] This estimate equates to more jobs per $1 million invested than motion picture and video production or housing construction as well as commercial construction or utility systems construction, in some cases, though the wages are generally lower (see **Exhibit 10.3**).

Exhibit 10.3. Job Impacts of Water-Use Efficiency Projects per Million Dollars Invested, Los Angeles

Project Type	Direct Jobs Stimulated	Average Wages
Water Conservation	9.1	$37,558
Graywater Systems	9.4	$33,286
Stormwater	6.6	$52,828
Groundwater	6.8	$50,001
Recycled Water	6.6	$49,092

Source: Patrick Burns and Daniel Flaming, "Water Use Efficiency and Jobs" (Economic Roundtable, 2011), https://economicrt.org/wp-content/uploads/2011/12/Water_Use_Efficiency_and_Jobs_2011.pdf.

While these estimates are not directly comparable to the state-level investments under discussion here, they offer a framework for a rough calculation. The 2018 update of the California Water Action Plan estimates that modernizing and rehabilitating water resource management systems across the state will require $102.5 billion in capital investment plus $43.6 million per year in ongoing funding over the next 50 years—a total of roughly $104.7 billion over 50 years, or $2.1 billion per year.[70] Extrapolating the Economic Roundtable's localized estimates to this per-year total would result in the creation of between 13,860 and 19,110 direct jobs per year. This calculation relies on at least two major assumptions: that the ratio of jobs created per $1 million of investment in Los Angeles would be roughly equivalent on the state level; and that the jobs required for the modernization and rehabilitation of water resource management systems, as conceived in the plan, would be roughly equivalent—or similar—to those required in energy efficiency projects.

b. Job Quality

Given the wide variety of occupations covered by the water sector, the quality of jobs created by the state's investment in water infrastructure and water conservation strategies varies considerably. On the whole, however, these jobs tend to pay well and many, particularly in construction and operations, provide opportunities for career advancement. According to the 2018 Brookings study, "Water occupations not only tend to pay more on average compared to all occupations nationally, but also pay up to 50 percent more to workers at lower ends of the income scale."[71] Workers at the 10th and 25th percentiles of this spectrum nationwide earn hourly wages of $14.01 and $17.67, respectively, as compared to $9.27 and $11.60 at the same percentile for all U.S. workers.

In California's metro regions, the wages are even higher. In Fresno, which has the lowest wages of the 10 cities profiled by the 2018 Brookings study, water workers at the 10th and 25th percentiles made $14.07 and $17.32, respectively.[72] In San Jose, the highest paying city, they made $19.81 and $25.81—more than double the wages of all U.S. workers. In the 75th percentile, California water workers made as much as $36.38 (Los Angeles), $42.77 (San Jose), and $43.11 (San Francisco).

Slightly less than one-fifth of water workers—17.5 percent in the United States as a whole, 17 percent in California metro regions—are employed directly by public utilities.[73] As mostly unionized public-sector employees, these workers receive decent benefit packages that include health insurance and retirement benefits. The blue-collar occupations that predominate in this sector include: meter readers (98.4 percent of whom are utility employees nationwide); water and wastewater treatment plant system operators (88.5 percent); industrial machinery mechanics (75.3 percent); maintenance and repair workers (53.4 percent), and electricians (42.8 percent). Many of these occupations have certified apprenticeship programs in place. An apprenticeship for water treatment plant operators is available through IUOE Stationary Engineers, Local 39, in

San Francisco.[74] There are also numerous apprenticeships available for electricians, machinery mechanics, and maintenance mechanics across the state.[75]

The skilled jobs in water utilities generally earn wages at or above the averages for all water workers listed above. A 2016 study by Jewish Vocational Service (JVS), examining career opportunities in the water and wastewater industry in the Bay Area found these types of jobs paid annual salaries ranging from $70,000 to $96,000 a year at the journey level. It is worth noting that the majority of California's water systems, excluding small systems like mobile home parks and housing developments, are operated by municipal and public agencies.[76]

Professional and technical water workers employed primarily by utilities include lawyers, architects and landscape architects, surveying and mapping technicians, civil engineering technicians, compliance officers, and managers.[77] By and large, these jobs are both well paid and well trained.

The majority of water workers—more than 80 percent—are employed outside the utility industry, in private firms in a variety of industries. Most of the blue-collar jobs at this end are construction jobs, including: carpenters, construction laborers, construction equipment operators, and truck drivers. Plumbers, pipefitters, and steamfitters (considered a single occupational category) represent the largest portion of all water workers nationally: 19.6 percent (22.4 percent when combined with plumbers, pipefitters, and steamfitters helpers). Professional and technical jobs in the non-utility arena are generally not construction related. These include sales representatives, management analysts, purchasing agents, bookkeepers, accountants, environmental engineers, and software developers.

The wages among these predominantly non-utility construction occupations are roughly equivalent to those of blue-collar utility workers. The construction labor market in California, however, is highly bifurcated, plagued at the bottom by the underground economy and served at the top by the best training system in the state, with certified apprenticeships. Construction funded by public agencies such as local water utilities generally, but not inevitably, supports quality jobs.

Construction is also an industry where workers with less formal education can gain skills that allow them to earn family-supporting wages. Fewer than 10 percent of construction workers have college degrees.[78] Construction sectors that use state-certified apprenticeships can help workers with low educational attainment get on a career ladder that leads to significantly higher wages (see Chapter 3).[79] A journey-level operating engineer working in the Los Angeles area can earn more than $46 an hour.[80]

Some of the occupations at the lower end of the wage spectrum in the non-utility water sector include landscaping and grounds-keeping workers. Nationwide, workers in these occupations can earn less than $10 an hour. The 10th-percentile average wage for landscaping and grounds-keeping workers, for instance, is $9.21 an hour. In many cases, however, these workers are employed by vendors who have agreements with municipal

or other public agencies to maintain landscaping on publicly funded projects, such as rain gardens. In those instances, government procurement offers an opportunity to improve wages in firms contracting with public agencies.

c. Job Access

While some segments of California's water sector produce well-paid jobs, prospective workers can face significant barriers to entry. Lack of relevant work experience is one potential barrier. The Brookings analysis found that a majority of water workers—53 percent—have a high school diploma or less, which suggests few formal educational barriers to entry.[81] Instead, employers place a premium on experience, preferring to hire workers who are already familiar with the necessary tools and technologies. The study also found that more than two-thirds of water workers needed at least one year of related work experience to get a job, and 16 percent need four years or more.

In addition, water workers tend to be older and significantly less diverse than the U.S. workforce as a whole. Eighty-five percent of the U.S. water workforce is male, according to the Brookings study, and 72 percent of workers employed by water utilities are white.[82] In many water occupations—particularly in construction—women are a vanishingly small percentage of the workforce. Only 1.4 percent of plumbers, pipefitters, and steamfitters are women, for example. Asian and African American workers were also underrepresented, comprising 12 percent of the water workforce, as compared with 18 percent of the U.S. workforce as a whole. The water workforce is also aging, with a significant portion expected to retire within the next few years.

The construction industry also offers great opportunities to incorporate training and career ladders for entry-level workers. Construction is one of the few industries in which someone with little formal education can gain the skills that lead to higher family-sustaining wages. Construction Careers Policy (CCP), a Los Angeles-area initiative, is a contracting approach that includes targeted hiring provisions for certain designated populations that can be based on income, geography, or historic barriers to entry, such as those experienced by military veterans or the formerly incarcerated (See Chapters 2 and 3).[83] It has been embraced by the City of Los Angeles and the Los Angeles County Board of Supervisors on multi-billion-dollar construction projects at the Port and on the Metro line. CCP has covered tens of thousands of jobs on $12.3 billion worth of Los Angeles-area infrastructure projects since 2008[84] and could similarly be applied to needed water infrastructure improvements around the state. New workers on CCP projects gain valuable on-the-job training through apprenticeship training programs. The Los Angeles Building and Construction Trades Council has sought to further bolster the career ladder with its Multi-Craft Core Curriculum, partnering with local community and educational groups to offer standardized, comprehensive apprenticeship readiness programs. See Chapter 3 for a description of pre-apprenticeship and apprenticeship.

One training initiative directly related to the policies under consideration here was launched by the State Water Resources Control Board (SWRCB) in January 2016.

SWRCB allocated $3.2 million for the California Water Loss Collaborative, which executed a Technical Assistance Program (TAP) and Water Audit Validator (WAV) Certificate Program to aid water suppliers in producing validated water audits, helping to ensure compliance with SB 555.[85] Modeled in part on a successful statewide initiative in Georgia, the TAP was made available to utilities at no cost in 2016 and 2017 and was conducted via a series of workshops and teleconferencing sessions between utility employees and water auditing experts. It trained more than 1,500 incumbent water utility employees and completed more than 400 Level 1 validated water audits, providing the necessary water audit review for 93 percent of the legislatively mandated suppliers. The SWRCB subsequently partnered with the California-Nevada American Water Works Association (CA-NV AWWA) to develop the WAV Certificate Program, an auditor validator training certification program aimed at increasing the availability of qualified validators in California. This program was due to be launched in 2018.

As the state continues to implement mandates that require water suppliers to meet lower water-use targets, efforts to promote water efficiency will increase. Some of the best opportunities to make conservation and water efficiency gains are to be found in the lower-income areas of the state where water distribution infrastructure has been inadequately maintained or updated and where household and commercial appliances tend to be older and less efficient. In the 1990s, the Los Angeles Department of Water and Power (LADWP) pioneered a community-based organization (CBO) model for promoting ultra-low-flush toilet installation.[86] LADWP teamed up with local nonprofits, including the Korean Youth Community Center, the Watts Labor Community Action Committee, and ADVANCE, to canvas residents of Hollywood and southwest Los Angeles to offer the delivery of free new toilets that significantly reduced water use and helped lower the cost of monthly utility bills. Working with the CBO helped the city replace more than two million toilets and also created employment opportunities in communities with high unemployment rates. Such a program could be improved moving forward with the introduction of a viable career pathway into union utility jobs, much in the same way as the Utility Pre-Craft Training Program has done for weatherization work (See Chapter 6 on low-carbon energy).

The California Conservation Corps (CCC) prepares at-risk youth for jobs and careers in the natural environment, combining classroom education with paid, on-the-job training.[87] The Los Angeles Conservation Corps, for example, helps improve the watershed by planting trees and building community gardens and provides participants with expertise in landscaping, irrigation, storm water and erosion control, and tree planting. With a state grant received under the Clean Energy Act, the CCC has also trained participants to conduct water audits in commercial facilities. If a direct link to utility careers can be systematically developed, these programs could serve as an effective pre-apprenticeship pathway into good construction and utility jobs. More explicit partnerships with employers and unions can improve the impact of CCC and CBO training programs, capitalizing on their excellent track record in supporting and mentoring young participants but making a much needed explicit link to career job placement.

PROMISING PRACTICE #10.1
BAYWORK Water Utility High Road Training Partnership

Because the sector already generates family-supporting jobs in utility operations, it is a good target for efforts aimed at inclusion of workers from disadvantaged communities. The coming wave of retirements in the utility industry offers both a challenge and an opportunity, as one successful Bay Area program exemplifies. In 2009, the San Francisco Public Utilities Commission (SFPUC), the Santa Clara Valley Water District, East Bay Municipal District and Union Sanitary District organized to create BAYWORK to help find qualified candidates and train them to operate the latest water utility technologies. The SFPUC already has a strong infrastructure for inclusion that BAYWORK can build on. It includes a community benefits policy with workforce development and diversity mandates[88] and a host of in-house workforce development programs, ranging from high school internships like SSIP CityWorks and Youthworks to pre-apprenticeship and formal apprenticeship training programs.[89] In addition, the SFPUC has adopted a project labor agreement with local, regional, and national construction trade unions for its Water System Improvement Program that includes, among other things, a jobs training and opportunities component.[90]

Beginning in 2016, BAYWORK collaborated with Jewish Vocational Service (JVS) in San Francisco to reassess industry needs and training program offerings. A report released the following year found that water and wastewater agencies and utilities in six Bay Area counties projected that they would need to make more than 825 new hires in nine occupations—water treatment operator, water distribution operator, wastewater treatment operator, wastewater collections operator, machinist, electrician, electronic maintenance/instrument technician, high-voltage electrician, and heavy equipment operator—over the next three years, and more than one-half of these agencies and utilities were having trouble finding workers with the requisite skills.[91] The report also identified training gaps, such as a need for increased English, math, and science proficiency, among high school graduates interested in making the leap into the skilled trades. After securing funding through a California Workforce Development Board (CWDB) Accelerator grant, BAYWORK and JVS worked with Bay Area community colleges and other educational partners to assess existing certification, apprenticeship, and other training programs and worked to develop new curriculum, including applied learning, to help prepare prospective candidates for entry-level industry positions. JVS has also received funding for the project from the CWDB's High Road Training Partnership (HRTP) initiative which is funding development of partnerships with existing pre-apprenticeship programs and other community organizations focused on helping underrepresented job seekers (see Chapter 3).[92]

As in other sectors, there is a connection between skill standards and work quality. A North Carolina State University (NCSU) study demonstrates the link between proper training and successful outcomes in implementing new green infrastructure. The NCSU analysis found that prior to the launch of a green infrastructure worker certification program, roughly 95 percent of the 425 green infrastructure projects implemented in Cary, North Carolina, failed inspections because they were not properly maintained.[93] However, "After owners better appreciated the value of maintenance and hired workers certified by NCSU, roughly 95 percent of BMPs *passed* a second inspection."

Given the California Water Action Plan's identification of the need to invest in this area, the state should encourage efforts to define and standardize certification requirements. "Stackable" credentialing programs in particular, which help workers build skills over time, could help create a career ladder in this field.

d. Risk of Job Loss or Job Degradation

While data relating to labor impacts of the state's water conservation and efficiency strategies remain scant, there appears to be little risk of job loss or degradation in the sector based on state policies at this time. Due to the projected increase in state population and growth in infrastructure investment fueled by state mandates, it is more likely that the water sector workforce will continue to grow.

Two potential areas of concern bear further review, however. One is the SWRCB mandate to promote water system consolidation and regionalization initiatives.[94] The state should consider workforce impacts in cases that involve the absorption of water utilities from disadvantaged communities unable to supply a sufficient quantity of safe drinking water into larger, more viable systems.

The other is the state's intention, stated in the Draft 2018 Water Action Plan, to explore novel funding mechanisms to help cover the gap in funding for water infrastructure capital expenditures and operations maintenance.[95] To the extent that public/private partnerships are under consideration, labor standards governance and a just transition for workers at risk of job loss should be considered in any assessment.

Workers employed by water utilities will need training to be able to adapt as the state moves forward with mandates requiring the adoption of new technologies, such as those used in leak reduction. In the professional occupations, continuing education is a requirement for license renewal, there is often a strong monetary incentive for professional development, and established organizations and funding currently exists to provide such training. In most other occupations, the commitment of employers to training current workers is essential. To support incumbent worker training, the state could invest in the identification of skill gaps; curriculum upgrades and instructor professional development; and training itself. The high-road training partnership

BAYWORK, described above, is an example of an industry training partnership that could be replicated in other regions of the state.

2. Workforce Recommendations

a. Demand-Side Workforce Policy Levers for Job Quality and Access

As the state continues to implement mandates requiring water suppliers to meet lower water-use targets and invest heavily in water infrastructure improvements to promote efficiency, it should take steps to encourage partner agencies and local and regional government entities to employ best practices in choosing construction contractors and outside vendors.

Utility industry jobs in the water sector are good quality and largely union. Many of these workers are employed by public agencies, with good wages and benefits. The need in this segment is for better inclusion policies, more certified apprenticeship and pipeline programs, and incumbent worker training, addressed through High Road Training Partnerships, below.

Utility industry jobs, however, represent less than one-fifth of all water workers. Many of the rest are in the overwhelmingly private construction industry, sometimes in companies that do not pay family-supporting wages and benefits. Not all construction jobs are good jobs. To protect taxpayer-funded investments and to ensure that construction contractors are employing a reliable, well-trained workforce, projects that utilize state funds should come with attached responsible contractor requirements and inclusionary hiring practices.

There are a number of ways in which public water utilities can take steps to ensure and improve job quality and job access for disadvantaged workers:

❖ Use community workforce agreements (CWAs) when utilities award contracts for large-scale water infrastructure construction projects

As described in Chapter 2, CWAs that include language to broaden access to good jobs can be used to ensure access for disadvantaged communities. These are pre-hire c ollective bargaining agreements with one or more labor unions that set the terms and conditions for the project including wages and working conditions, and set goals for the hiring of workers from disadvantaged communities. A common minimum threshold for CWAs is projects over one million dollars.

❖ Use inclusive procurement policies in contracts for public services.

Government entities like utilities can encourage contractors to enter into community benefit agreements (contracts between developers and community groups that require the developer to provide specific amenities or mitigations in exchange for community support of the project). Contractors can boost their bid scores by committing to strong community benefits standards in their proposal, by incorporating the U.S. Employment Plan or similar policies into solicitations for public procurement, discussed in Chapters 2 and 7. This is a way to encourage service providers to provide job and other benefits to the local community and for awarding agencies to identify the "best in class" proposals, rather than prescribing a specific wage or other labor standard. For water utilities providing grant funding for the installation of water efficiency measures, utilities can set minimum criteria that ensures that vendors meet threshold job quality standards. These steps would help ensure better working conditions for entry-level, low-wage workers in the water sector. This is particularly important for projects designed to promote increased water efficiency in disadvantaged communities, where the state expects to reap some of its biggest water efficiency gains.

❖ Use job impact metrics to measure the effect of climate policies on job numbers, job quality, and job access.

As California implements new data collection and reporting requirements for state water suppliers and operators, it should consider incorporating labor equity data metrics. One program that could serve as a model is RePower LA, a community-based coalition that promotes clean energy and increased access to good jobs at the Los Angeles Department of Water and Power (LADWP), which succeeded in persuading the agency to implement an Equity Metrics Data Initiative (EMDI).[96] The EMDI semi-annually tracks and posts data on the DWP's programs, jobs, and services in low-income communities.[97]

❖ Incorporate workforce analysis into emerging technology support programs addressing water conservation, reuse, and other low carbon practices.

California's Draft 2018 Water Action Plan highlights the need for the state to identify funding for ongoing operations and maintenance to maximize the benefits of new "green" and "gray" technologies and infrastructure investments.[98] The state is establishing several task forces to consider needs in this area. Identifying workforce training and certification needs and assessing potential sources of funding should be part of this discussion to ensure the state is protecting and maximizing its investment in infrastructure.

b. Supply-Side Workforce Development Strategies

❖ Participate in the CWDB's High Road Training Partnership and High Road Construction Careers initiatives.

California's water industry can create pathways to the middle class for workers who traditionally have not been well represented in the industry and those from disadvantaged communities through investment in workforce training tied to job placement agreements. The state is encouraging the regional-scale development of pre-apprenticeship and certified apprenticeship training programs, as discussed in Chapter 3. These can apply to the water sector and could integrate industry-recognized credentials such as the Green Infrastructure Certification described above. Such apprenticeships could incorporate partnership with the California Conservation Corps and other pipeline programs to reduce barriers to entry for job seekers and provide additional connections to career-track jobs in the water sector.

Industry-led partnerships like the JVS BAYWORK initiative, which have been successful in fostering collaborative efforts to create bridge programs to identify and train workers interested in water careers, can help expand the existing pipeline of skilled and experienced workers ready to replace those retiring.

B. Water Agency Emissions Reductions

Senate Bill 350 (de León, Chapter 547, Statutes of 2015)[99] requires that half the state's electricity come from renewable resources by 2030.[100] Meeting this mandate will lead to increased use by state agencies of Renewables Portfolio Standard-eligible resources, such as solar, wind, biomass, and geothermal energy. In line with this mandate, the California Department of Water Resources (DWR) is implementing efforts to reduce the agency's environmental impacts and lead by example through its approved, department-wide Climate Action Plan. DWR has set a goal for itself of cutting its emissions levels to 80 percent below 1990 levels by 2050.[101] DWR estimates that its total greenhouse gas emissions in 1990 were nearly 3.5 MMTCO2e, roughly the equivalent of the emissions produced by 680,000 automobiles. DWR has identified 11 greenhouse gas emissions reduction measures it will take to meet its goals, including the termination of its ownership interest in the coal-powered Reid Gardner Power Station in Nevada; increasing the proportion of renewable energy used to run the State Water Project (SWP); exploring new ways of developing renewable energy on DWR-owned land; and increasing the energy efficiency of pumps and turbines through the SWP.

The vast majority of the DWR's climate pollutant emissions (about 98 percent) stem from the generation of electricity needed to move water through the SWP, which DWR

owns and operates.[102] The SWP is one of the largest single users of electricity in California,[103] accounting for around 3 percent of all electricity consumed in the state.[104] DWR uses the hydroelectric power it generates throughout the system to power most of its needs and sells the surplus.[105] When the hydroelectric energy on hand is not enough, DWR uses the energy market to fill the gap. By being more conscious in its choices of energy purchases—for example, by terminating its participation and delivery of energy from a coal-fired power plant in Nevada—DWR has already exceeded the state's goal of reducing 1990 emission levels by a third by 2020. DWR expects it will achieve greenhouse gas emissions reductions of more than 60 percent below 1990 levels by 2020.

Construction is another component of DWR efforts to cut emissions. Though construction only accounts for a little more than 1 percent of total DWR emissions, it is the department's second-largest source of emissions.[106] (All other DWR operations account for less than 1 percent of the agency's emissions.) The primary source of DWR construction emissions is the operation of diesel-powered construction equipment. The DWR has adopted best management practices for construction and maintenance activities and made significant changes to its construction project specifications requirements that will lead to important reductions in construction emissions. In addition, improvements in statewide regulations governing construction equipment and fuel standards, driven by Assembly Bill 32 (Núñez, Chapter 488, Statutes of 2006)[107] and other initiatives, will also contribute to the adoption of new technologies that will further reduce emissions.

DWR efforts to reduce emissions are extensive, but given the department's relatively small 1990-level emissions footprint, its main contribution to reducing emissions in the water sector lies in being an industry leader and early adopter of new technologies. The DWR also can serve as an industry model for good labor policy and practice.

1. Workforce Outcomes

a. Job Growth

Labor impacts from DWR water-related emissions initiatives are largely unknown at this point, as many of the department's initiatives are in the early stages or have yet to be implemented. Ultimately, DWR efforts to procure renewable electricity—like those of every state agency—are likely to stimulate employment in construction, particularly solar installation. Efforts to improve the energy efficiency of pumps and turbines throughout the SWP system may also have a positive impact on employment in construction occupations such as electricians, mechanics, and maintenance and repair workers, as well as manufacturing, albeit indirectly. None of these initiatives are likely to have a major impact on the utility industry, as they involve infrastructure and energy sources rather than water treatment, transport, or distribution.

b. Job Quality

Water sector construction jobs—the jobs mostly likely to be created by DWR emissions reduction measures—are good paying jobs that generally fall under the state's prevailing wage and apprenticeship standards for public works construction. Through the state-certified apprenticeship system, construction is an industry where workers with less formal education can gain access to jobs with family-supporting wages and a full benefits package, with training and wage increases as skills are acquired in a "earn while you learn" model (see Chapters 2 and 3).

As detailed in Chapter 6 on Energy, job quality in the construction of utility-scale renewables—another segment likely to be stimulated by the DWR initiative—is high, encompassing middle-class careers built on skills acquired in a state-certified apprenticeship system. Job quality has been ensured because most utility-scale renewable energy construction projects in California have been governed by collectively bargained PLAs (see Chapters 2 and 6).[108] Under these PLAs, workers have received a compensation package that includes prevailing wage rates, full benefits (pension and healthcare contributions), and ongoing funding for apprentice training. Wages for journey-level workers averaged about $37.00 per hour in 2015.[109]

c. Job Access

Prospective construction workers in California's water sector can face significant barriers to entry, including lack of relevant work experience. However, there are pre-apprentice programs in place that have proved successful in increasing the number of underrepresented workers in apprenticeship, and the state is expanding funding for these programs through its High Road Construction Careers initiative, discussed in Chapter 3.

d Risk of Job Loss or Job Degradation

There is little to no risk of job loss or degradation as a result of the water sector's emissions reduction efforts. Nearly all of the emissions reduction measures detailed in the DWR's Water Action Plan are constructive rather than eliminatory. The only negative impact likely to follow from any of these initiatives would be at the Reid Gardner Power Station, a coal-powered plant in Nevada, where DWR terminated its ownership stake.[110] The plant ceased operations entirely in 2015.[111]

2. Workforce Recommendations

The greenhouse gas reduction measures pursued by the DWR in its California Water Action Plan are in keeping with those of all other state agencies charged with similar mandates, and the DWR should follow the best practices outlined for those agencies in other chapters of this report. See the renewables section of Chapter 6 on low-carbon energy for an example of these best practices.

V. Recommendations for the Water Sector

Exhibit 10.4. Key Recommendations for the Water Sector

Water Conservation—Utility Operations	**Demand Side** ❖ Use inclusive procurement policies for public procurement of large capital equipment, contracts for services, and in grants programs. ❖ Incorporate workforce analysis into support for emerging technologies addressing water conservation, reuse, and other low carbon practices. **Supply Side** ❖ Expand high-road training partnerships and participate in the state's High Road Construction Careers initiative to promote inclusion of workers from disadvantaged communities.
Water Conservation—Utility Infrastructure Construction	**Demand Side** ❖ Use community workforce agreements (CWAs) when utilities award contracts for water infrastructure construction projects or renewable generation on water utility land. ❖ Use job impact metrics to measure the effect of climate policies on job numbers, job quality, and job access. **Supply Side** ❖ Participate in statewide initiative for pre-apprenticeship for construction careers. ❖ Expand High-road industry training partnerships. ❖ Provide funding for ongoing identification of skills gaps and development of plans to fill gaps.
All Water Sectors	❖ Use job impact metrics to measure the impact of climate incentive and investment programs on quantity of jobs, job quality and job access. ❖ Incorporate workforce analysis into emerging technology support programs. ❖ Track training program outcomes for graduation rates, attainment of industry-recognized credentials, job placement, retention, wages and wage progression.

Endnotes

1 The 19 percent electricity use in the water sector breaks down as follows: 11 percent residential, commercial, and industrial water end use; 3 percent residential, commercial, and industrial water supply and treatment; 3 percent agricultural end use; 1 percent agricultural water supply and treatment; and 1 percent wastewater treatment. California Public Utilities Commission, "Water/Energy Nexus," accessed September 24, 2018, http://www.cpuc.ca.gov/nexus_calculator/. The 19 percent was originally formulated in this report: Gary Klein et al., "California's Water-Energy Relationship," Final Staff Report (California Energy Commission, November 2005), http://large.stanford.edu/courses/2012/ph240/spearrin1/docs/CEC-700-2005-011-SF.PDF.

2 Jon Zerolnick, "Liquid Assets: How Stormwater Infrastructure Builds Resilience, Health, Jobs, & Equity" (LAANE: A New Economy For All, March 2018), http://laane.org/wp-content/uploads/2018/03/LAANE_Liquid-Assets_Stormwater-Report.pdf.

3 PPIC Water Policy Center, "Energy and Water" (Public Policy Institute of California, October 2016), http://www.ppic.org/content/pubs/report/R_1016AER.pdf.

4 Andrew Schwarz, "Climate Action Plan Phase 1: Greenhouse Gas Emissions Reduction Plan" (California Department of Water Resources, May 2012), https://water.ca.gov/LegacyFiles/climatechange/docs/Final-DWR-ClimateActionPlan.pdf.

5 California Air Resources Board, "California's 2017 Climate Change Scoping Plan," November 2017, 92, https://ww3.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf.

6 Klein et al., "California's Water-Energy Relationship."

7 Klein et al.

8 California Department of Finance, "Population Projections (Baseline 2016)," accessed September 24, 2018, http://www.dof.ca.gov/Forecasting/Demographics/projections/.

9 Klein et al., "California's Water-Energy Relationship."

10 California Air Resources Board, "California's 2017 Climate Change Scoping Plan," 92.

11 Klein et al., "California's Water-Energy Relationship."

12 Joseph Kane and Adie Tomer, "Renewing the Water Workforce: Improving Water Infrastructure and Creating a Pipeline to Opportunity" (The Metropolitan Policy Program at Brookings, June 2018), https://www.brookings.edu/research/water-workforce/.

13 California Air Resources Board, "California's 2017 Climate Change Scoping Plan," 92–95.

14 Darrell Steinberg, "SBX7-7 Water Conservation," Chapter 4, Statutes of 2009 § (2009), https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=200920107SB7.

15 Unless otherwise noted, information on the policies listed in this section is taken from: California Air Resources Board, "California's 2017 Climate Change Scoping Plan Appendix H Major Climate Statutes and Regulations," November 2017, https://ww3.arb.ca.gov/cc/scopingplan/2030sp_apph_climatestatutesref_final.pdf.

16 Lois Wolk, "SB-555 Urban Retail Water Suppliers: Water Loss Management," Chapter 679, Statues of 2015 § (2015), https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB555.

17 Mike Gatto, "AB-2282 Building Standards: Recycled Water Systems," Chapter 606, Statutes of 2014 § (2014), https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201320140AB2282.

18 Shirley Weber, "AB-2515 Water Conservation in Landscaping Act: Model Water-Efficient Landscaping Ordinance," Chapter 576, Statutes of 2016 § (2016), https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160AB2515.

19 California Department of Water Resources, "Model Water Efficient Landscape Ordinance" (California Code of Regulations, 2015), https://water.ca.gov/Programs/Water-Use-And-Efficiency/Urban-Water-Use-Efficiency/Model-Water-Efficient-Landscape-Ordinance.

20 Fran Pavley, "SB-1168 Groundwater Management," Chapter 346, Statutes of 2014 § (2014), https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB1168.

21 Roger Dickenson, "AB-1739 Groundwater Management," Chapter 347, Statutes of 2014 § (2014), https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB1739.

22 Fran Pavley, "SB-1319 Groundwater," Chapter 348, Statutes of 2014 § (2014), https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB1319.

23 University of California, Division of Agriculture and Natural Resources, "Sustainable Groundwater Management Act," accessed September 24, 2018, http://groundwater.ucdavis.edu/SGMA.

24 California Department of Water Resources, "Groundwater Sustainability Plans," accessed September 24, 2018, https://water.ca.gov/Programs/Groundwater-Management/SGMA-Groundwater-Management/Groundwater-Sustainability-Plans.

25 Fran Pavley and Roger Dickenson, "Sustainable Groundwater Management Act [And Related Statutory Provisions from SB1168 (Pavley), AB1739 (Dickinson), and SB1319 (Pavley) as Chaptered]" (2016), https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Files/2014-Sustainable-Groundwater-Management-Legislation-with-2015-amends-1-15-2016.pdf?la=en&hash=ADB3455047A2863D029146E9A820AC7DE16B5CB1.

26 California Department of Water Resources Sustainable Groundwater Management Program, "Groundwater Sustainability Plan Emergency Regulations" (2016), https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/GSP_Emergency_Regulations.pdf.

27 California Department of Water Resources, "Clean Energy for the State Water Project," May 12, 2016, https://water.ca.gov/LegacyFiles/climatechange/docs/2016/CleanEnergyforSWPFinal.5.19.16.pdf.

28 PPIC Water Policy Center, "Energy and Water."

29 California Department of Water Resources, "Producing and Consuming Power" (California Department of Water Resources), accessed September 24, 2018, https://water.ca.gov/What-We-Do/Power.

30 California Department of Water Resources, "Clean Energy for the State Water Project."

31 Ricardo Lara, "SB-605 Short-Lived Climate Pollutants," Chapter 523, Statutes of 2014 § 39730 (2014), https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB605.

32 Ricardo Lara, "SB-1383 Short-Lived Climate Pollutants: Methane Emissions: Dairy and Livestock: Organic Waste: Landfills," Chapter 395, Statutes of 2016 § (2016), https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB1383.

33 John Laird, "AB-2466 Local Government Renewable Energy Self-Generation Program," Chapter 540, Statutes of 2008 § (2008), https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200720080AB2466.

34 U.S. Environmental Protection Agency, "What Is Green Infrastructure?," accessed September 24, 2018, https://www.epa.gov/green-infrastructure/what-green-infrastructure.

35 Only one of the eight industries is at the five-digit level: Plumbing, Heating, and Air-Conditioning Contractors (NAICS 23822). The others are: Water, Sewage, and Other Systems (NAICS 2213); Utility System Construction (NAICS 2371); Other Heavy and Civil Engineering Construction (NAICS 2379); Other Specialty Trade Contractors (NAICS 2389); Management, Scientific, and Technical Consulting Services (NAICS 5416); and Remediation and Other Waste Management Services (NAICS 5629). Kane and Tomer, "Renewing the Water Workforce: Improving Water Infrastructure and Creating a Pipeline to Opportunity."

36 Only one of the eight industries is at the five-digit level: Plumbing, Heating, and Air-Conditioning Contractors (NAICS 23822). The others are: Water, Sewage, and Other Systems (NAICS 2213); Utility System Construction (NAICS 2371); Other Heavy and Civil Engineering Construction (NAICS 2379); Other Specialty Trade Contractors (NAICS 2389); Management, Scientific, and Technical Consulting Services (NAICS 5416); and Remediation and Other Waste Management Services (NAICS 5629). Kane and Tomer, "Renewing the Water Workforce: Improving Water Infrastructure and Creating a Pipeline to Opportunity."

37 The ten metropolitan areas are: Bakersfield, Fresno, Los Angeles-Long Beach-Anaheim, Oxnard-Thousand Oaks-Ventura, Riverside-San Bernardino-Ontario, Sacramento-Roseville-Arden-Arcade, San Diego-Carlsbad, San Francisco-Oakland-Hayward, San Jose-Sunnyvale-Santa Clara, and Stockton-Lodi. Kane and Tomer.

38 Patrick Burns and Daniel Flaming, "Water Use Efficiency and Jobs" (Economic Roundtable, 2011), https://economicrt.org/wp-content/uploads/2011/12/Water_Use_Efficiency_and_Jobs_2011.pdf.

39 California Department of Water Resources et al., "Making Water Conservation a California Way of Life: Implementing Executive Order B-37-16," April 2017, https://water.ca.gov/LegacyFiles/wateruseefficiency/conservation/docs/20170407_EO_B-37-16_Final_Report.pdf.

40 Electro Scan Inc., "New Law for Reporting Water Loss (SB 555): Electro Scan Applauds New California Law for Reporting Water Losses; Senate Bill 555 to Require Water Suppliers to Meet New Performance Standards," October 12, 2015, https://www.electroscan.com/new-law-for-reporting-water-loss-sb-555/.

41 California Air Resources Board, "California's 2017 Climate Change Scoping Plan."

42 Wolk, SB-555 Urban retail water suppliers: water loss management.

43 Robert Hertzberg, "SB-606 Water Management Planning," Chapter 14, Statutes of 2018 § (2018), https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB606.

44 Laura Friedman, "AB-1668 Water Management Planning," Chapter 15, Statutes of 2018 § (2018), https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB1668.

45 California Water Efficiency Partnership, "Fact Sheet on Long-Term Conservation Legislation," June 22, 2018, http://www.allianceforwaterefficiency.org/uploadedFiles/Resource_Center/Library/United_States/California/CalWEP-FAQ-Fact-Sheet-on-Long-Term-Conservation-Legislation.pdf.

46 California Air Resources Board, "California's 2017 Climate Change Scoping Plan."

47 California Natural Resources Agency, California Department of Food and Agriculture, and California Environmental Protection Agency, "California Water Action Plan: 2016 Update," 2016, http://resources.ca.gov/docs/california_water_action_plan/Final_California_Water_Action_Plan.pdf.

48 California Air Resources Board, "California's 2017 Climate Change Scoping Plan."

49 California Air Resources Board.

50 California Public Utilities Commission, "Water/Energy Nexus."

51 California Air Resources Board, "California's 2017 Climate Change Scoping Plan."

52 Legislative Analyst's Office, "2017-18 Cap-and-Trade Expenditure Plan," August 24, 2017, http://www.lao.ca.gov/handouts/resources/2017/Senate-Cap-and-Trade-Expenditure-Plan-082417.pdf.

53 Kings Basin Water Authority, "DWR Announce Solicitation for 2016 Water-Energy Grant Program," September 7, 2016, http://www.kingsbasinauthority.org/dwr-announce-solicitation-for-2016-water-energy-grant-program/.

54 California Department of Water Resources, "Water Energy Grant Program," accessed September 24, 2018, https://water.ca.gov/Work-With-Us/Grants-And-Loans/Water-Energy-Grant-Programs.

55 Legislative Analyst's Office, "2017-18 Cap-and-Trade Expenditure Plan."

56 California Department of Food and Agriculture, "State Water Efficiency and Enhancement Program," accessed October 9, 2018, https://www.cdfa.ca.gov/oefi/sweep/.

57 Legislative Analyst's Office, "2017-18 Cap-and-Trade Expenditure Plan."

58 Legislative Analyst's Office; Autumn Burke, "AB 2722, Burke. Transformative Climate Communities Program," Chapter 371, Statutes of 2016 (chaptered September 14, 2016), https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160AB2722.

59 California Department of Finance, "Governor's Budget Summary 2018-19 (Proposed): Climate Change," January 10, 2018, http://www.ebudget.ca.gov/2018-19/pdf/BudgetSummary/ClimateChange.pdf.

60 According to Kamyar Guivetchi, Division Chief and Manager of the Statewide Integrated Water Management Division for the Department of Water Resources: "Unlike the last two or three where we let the deadlines slip, the deadline can't slip. It has to be out by the end of December of 2018 under this administration. When the recall happened in 2003, it added two years to the release of the Water Plan because the new administration came in and they needed time to get their arms and minds around the Water Plan. This one, we have a hard stop at the end of 2018." Chris Austin, "California Water Plan Update 2018: Envisioning Statewide Water Sustainability," *Maven's Notebook* (blog), November 29, 2017, https://mavensnotebook.com/2017/11/29/california-water-plan-update-2018-envisioning-statewide-water-sustainability/.

61 California Department of Water Resources, "Water Plan Update 2018 Draft Reviewer's Guide," January 9, 2018, https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/California-Water-Plan/Water-Plan-Updates/Files/Update-2018/Water-Plan-Update-2018-Working-Draft.pdf.

62 California Department of Water Resources.

63 California Natural Resources Agency, California Environmental Protection Agency, and California Department of Food and Agriculture, "California Water Action Plan Implementation Report: 2016 Summary of Accomplishments," January 9, 2017, http://resources.ca.gov/docs/california_water_action_plan/CA_WAP_Impl_Rpt_2016.pdf.

64 California Department of Water Resources, "Water Plan Update 2018 Draft Reviewer's Guide."

65 David Mitchell, Thomas Chesnutt, and David Pekelney, "Transforming Water: Water Efficiency as Infrastructure Investment," Position Paper (Alliance for Water Efficiency, December 2017), http://www.allianceforwaterefficiency.org/Transforming-Water.aspx.

66 Burns and Flaming, "Water Use Efficiency and Jobs."

67 California Department of Water Resources, "Water Plan Update 2018 Draft Reviewer's Guide."

68 Burns and Flaming, "Water Use Efficiency and Jobs."

69 Burns and Flaming.

70 California Department of Water Resources, "Water Plan Update 2018 Draft Reviewer's Guide."

71 Kane and Tomer, "Renewing the Water Workforce: Improving Water Infrastructure and Creating a Pipeline to Opportunity."

72 Kane and Tomer.

73 These percentages exclude those occupations with fewer than 250 employees in the utility industry. Kane and Tomer.

74 California Department of Industrial Relations, Division of Apprenticeship Standards, "Apprenticeship Program Information: Water Treatment Plant Operator," accessed November 9, 2018, https://www.dir.ca.gov/databases/das/results_aigdetail.asp?varOccId=550.

75 California Department of Industrial Relations, Division of Apprenticeship Standards, "Find an Apprenticeship Program," September 23, 2018, https://www.dir.ca.gov/databases/das/aigstart.asp?Flag1=NR.

76 Wes Strickland, "The Organization of Water Utilities in California," *Private Water Law* (blog), September 25, 2013, https://privatewaterlaw.com/2013/09/25/the-organization-of-water-utilities-in-california/.

77 Kane and Tomer, "Renewing the Water Workforce: Improving Water Infrastructure and Creating a Pipeline to Opportunity."

78 Burns and Flaming, "Water Use Efficiency and Jobs."

79 Burns and Flaming.

80 Zerolnick, "Liquid Assets: How Stormwater Infrastructure Builds Resilience, Health, Jobs, & Equity."

81 Kane and Tomer, "Renewing the Water Workforce: Improving Water Infrastructure and Creating a Pipeline to Opportunity."

82 Kane and Tomer.

83 Zerolnick, "Liquid Assets: How Stormwater Infrastructure Builds Resilience, Health, Jobs, & Equity."

84 Ashley K. Thomas, "Successes of Construction Careers" (LAANE: A New Economy For All, August 2014), https://www.laane.org/wp-content/uploads/2015/04/Successes-of-Construction-Careers-Report.pdf.

85 Water Systems Optimization, Inc. and Cavanaugh & Associates, "Water Loss Technical Assistance Program Final Report," prepared for The California Nevada Section of the American Water Works Association, 2018, https://ca-nv-awwa.org//canv/downloads/2018/WLTapFinalReport.pdf; California State Water Resource Control

Board, "Water Loss Control," September 18, 2018, https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/water_loss_control.html; Sue Mosburg, "Implementing SB 555: Validated Water Loss Audits and Reporting," http://www.calwaterassn.com/wp-content/uploads/2016/11/Implementing-SB-555.pdf.

86 Pat Lenius, "Los Angeles Offers Free Delivery of Low-Flow Toilets to Homes," *Supply House Times*, September 12, 1999, https://www.supplyht.com/articles/86340-los-angeles-offers-free-delivery-of-low-flow-toilets-to-homes; Business Wire, "LADWP Provides Water-Saving Toilets and Installation Service Free of Charge; Program Also Supports Jobs in Diverse Communities," September 25, 2003, https://www.businesswire.com/news/home/20030925005452/en/LADWP-Water-Saving-Toilets-Installation-Service-Free-Charge.

87 Zerolnick, "Liquid Assets: How Stormwater Infrastructure Builds Resilience, Health, Jobs, & Equity."

88 San Francisco Public Utilities Commission, "SFPUC Community Benefits Program Social Impact Partnerships," May 10, 2018, https://sfwater.org/Modules/ShowDocument.aspx?documentid=11622.

89 San Francisco Public Utilities Commission, "Internships, Apprenticeships and Youth Employment," accessed February 12, 2018, http://sfwater.org/index.aspx?page=888.

90 San Francisco Public Utilities Commission, "Project Labor Agreement," accessed September 24, 2018, https://sfwater.org/index.aspx?page=113.

91 Jewish Vocational Service, Baywork, and The Centers of Excellence, "Water and Wastewater Career Pathways: Connecting People to Water Industry Jobs in the Bay Area," 2016, https://www.jvs.org/wp-content/uploads/2018/07/BAYWORK-JVS-Water-Report-2017.pdf.

92 Stephanie Colosi, "The Future of (Water) Work" (Jewish Vocational Service, July 16, 2018), https://www.jvs.org/search/baywork/; California Workforce Development Board, "Model High Road Training Partnership Awards," December 21, 2017, https://cwdb.ca.gov/wp-content/uploads/sites/43/2018/01/HRTPAmendedAwardAnnouncement122117.pdf.

93 Zerolnick, "Liquid Assets: How Stormwater Infrastructure Builds Resilience, Health, Jobs, & Equity."

94 Michelle Frederick and Caitlin Juarez, "Consolidation and Regionalization Efforts" (State Water Resources Control Board, Division of Drinking Water, 2017), https://calafco.org/sites/default/files/resources/2017_Staff_Workshop/Water%20Consolidations_SWRCB%20presentation.pdf.

95 California Department of Water Resources, "Water Plan Update 2018 Draft Reviewer's Guide."

96 LAANE: A New Economy for All, "Repower LA," accessed September 26, 2018, https://laane.org/blog/campaigns/energy-and-water/.

97 Los Angeles Department of Water and Power, "Equity Metrics Data Initiative," accessed September 26, 2018, https://www.ladwp.com/ladwp/faces/wcnav_externalId/au-fr-corporateperformance-emdi;jsessionid=Fp8qbrnBDd22rGZL19TZTTBlJMvc-9mvF4n7v0w3pSXpvJ3bvxPfY!210892335?_afrWindowId=null&_afrLoop=9966663789852&_a%29%29=&_afrWindowMode=0&_adf.ctrl-state=18bc96x2hu_4#%40%3F_afrWindowId%3Dnull%26_afrLoop%3D9966663789852%26_a%2529%2529%3D%26_afrWindowMode%3D0%26_adf.ctrl-state%3D3877zxy63_4.

98 California Department of Water Resources, "Water Plan Update 2018 Draft Reviewer's Guide."

99 Kevin de León, "SB-350 Clean Energy and Pollution Reduction Act of 2015," Chapter 547, Statutes of 2015 § (2015), https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB350.

100 California Energy Commission, "Clean Energy & Pollution Reduction Act: SB 350 Overview," accessed February 26, 2018, http://www.energy.ca.gov/sb350/.

101 Schwarz, "Climate Action Plan Phase 1: Greenhouse Gas Emissions Reduction Plan."

102 Schwarz.

103 California Department of Water Resources, "Power," accessed September 26, 2018, https://water.ca.gov/Programs/State-Water-Project/SWP-Power.

104 Lon W. House, "Water Supply-Related Electricity Demand in California," prepared for Public Interest Energy Research, California Energy Foundation (Water and Energy Consulting and the Demand Response Research Center, November 2007), https://drrc.lbl.gov/publications/water-supply-related-electricity.

105 Schwarz, "Climate Action Plan Phase 1: Greenhouse Gas Emissions Reduction Plan."

106 Schwarz.

107 Fabian Núñez, "AB-32 Air Pollution: Greenhouse Gases: California Global Warming Solutions Act of 2006," Chapter 488, Statutes of 2006 § (2006), https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200520060AB32.

108 Betony Jones, Peter Philips, and Carol Zabin, “The Link Between Good Jobs and a Low Carbon Future” (UC Berkeley Donald Vial Center on Employment in the Green Economy, July 2016), http://laborcenter.berkeley.edu/the-link-between-good-jobs-and-a-low-carbon-future/.

109 Jones, Philips, and Zabin.

110 Schwarz, “Climate Action Plan Phase 1: Greenhouse Gas Emissions Reduction Plan.”

111 Nevada Division of Environmental Protection, “Reid Gardner Power Station,” accessed July 8, 2019, https://ndep.nv.gov/environmental-cleanup/site-clean-up-program/active-cleanup-sites/reid-gardner-power-station.