Appendix U Power and Energy Technical Appendix

U.1 Background Information

This appendix describes the hydroelectric generation facilities and power demands for the Central Valley Project (CVP) and State Water Project (SWP) related to changes that could occur as a result of implementing the alternatives evaluated in this Environmental Impact Statement (EIS). Implementation of the alternatives could affect CVP and SWP power generation and energy demands through potential changes in operation of the CVP and SWP facilities. Changes in CVP and SWP operations are described in more detail in Appendix H, *Water Supply Technical Appendix*.

Potential actions that could be implemented under the alternatives evaluated in this EIS could affect CVP/SWP hydroelectric generation and electricity use. The changes in power production and energy use would need to be compliant with appropriate federal and state agency policies and regulations.

California first established a state Renewables Portfolio Standard (RPS) in 2002 under Senate Bill 1078, when it set a RPS standard of 20% before the year 2017 for investor-owned utilities. California later accelerated this RPS requirement in 2006 under Senate Bill 107, when it moved the date up to the year 2010. In 2011, California expanded this requirement to include publicly owned municipal power and increased the RPS requirement to 33% by the year 2020 (i.e., Sacramento Municipal Utility District) under Senate Bill X1-2. The RPS program requires investor-owned utilities, electric service providers, and community choice aggregators to increase procurement from eligible renewable resources to 33% of total procurement by 2020. In 2015, passage of SB 350 created a 50% RPS requirement by the year 2030. During the 2017 legislative session, SB 100 was enacted, and established a 60% RPS requirement by 2030 and established a state policy requirement of 100% carbon free by the year 2045. This was also captured in Governor Brown’s Gubernatorial Executive Order B-55-18 on carbon neutrality. For purposes of the state’s RPS requirements, renewable energy resources do not include hydropower facilities over 30 megawatts, in accordance with the California Public Utilities Code Section 399.12(e) and California Public Resources Code Section 25741. However, hydropower generation is not precluded from counting toward the state’s carbon free policy.

As described in Section 25741 (1) (a) of the Public Resources Code, a renewable electrical generation facility means a facility that meets all of the following criteria: the facility uses biomass, solar thermal, photovoltaic, wind, geothermal, fuel cells using renewable fuels, small hydroelectric generation of 30 megawatts or less, digester gas, municipal solid waste conversion, landfill gas, ocean wave, ocean thermal, or tidal current, and any additions or enhancements to the facility using that technology. Section 14 (1) (B) of the Public Utilities Code, as amended, states that an existing conduit hydroelectric facility of 30 megawatts or less, shall be an eligible renewable energy resource. A new conduit hydroelectric facility of 30 megawatts or less shall be an eligible renewable energy resource so long as it does not require a new or increased appropriation or diversion of water from a watercourse. Two facilities within the CVP, Lewiston Dam and Nimbus Dam, fall within this standard.

Small hydropower is a small and decreasing percentage of California’s renewable energy portfolio (CEC 2014a). Approximately 1,700 megawatts is from small hydropower facilities certified under the

Renewable Portfolio Standard Program. Large hydropower facilities owned by the U.S. Bureau of Reclamation total approximately 2,112 megawatts of capacity, more than the entire small hydropower (renewable) generation capacity in the state (CEC 2014b).

The study area includes CVP and SWP hydroelectric generation facilities at CVP and SWP reservoirs, transmission of the generated electricity, and the CVP/SWP facilities and other users throughout California that rely upon electricity generated by CVP and SWP hydroelectric facilities. These CVP/SWP energy generation facilities are located in the Trinity River and Central Valley regions. CVP and SWP energy use primarily occurs in the Central Valley, San Francisco Bay area, Central Coast, and Southern California regions, as defined below.

U.1.1 Central Valley Project and State Water Project Energy Generation and Usage

Most of the CVP and SWP dams have associated hydroelectric facilities. As water is released from the CVP and SWP reservoirs, the generation facilities produce power that is used by the CVP and SWP pumping plants, respectively. Hydropower is an important renewable energy and generally supplies between 14% and 28% of electricity generated in California depending upon the water year type (CEC 2014a). In 2015, at the end of the 2012–2015 drought, hydropower (both small hydro facilities, with less than 30 megawatts of generating capacity, and large hydro facilities, with more than 30 megawatts of generating capacity) provided approximately 7% of the electricity generated in California (CEC 2015). However, in 2017, one of the wettest years on record, hydropower provided approximately 21% of electricity generated in California (CEC 2018a).

U.1.1.1 *CVP Power and Energy Resources*

Power generated by the CVP is transmitted by Western Area Power Administration (WAPA) to CVP facilities. CVP facilities generally use around 25% to 30% of the power generated by the CVP. Under existing laws, WAPA markets the remaining power to Preference Customers, which includes four first preference customers (Calaveras Public Power Agency, California Department of Corrections: Sierra Conservation Center, Trinity Public Utilities District, and Tuolumne Public Power Agency), Indian tribes, federal agencies, military bases, municipalities, public utilities districts, irrigation and water districts, and state agencies (Reclamation 2012).

Central Valley Project plant-in-service costs are assigned to water users and power customers for repayment in accordance with their benefits resulting from Reclamation’s cost allocation study. Reclamation’s customers have requested a final CVP cost allocation, and Reclamation currently has a study underway to review and update CVP cost allocation factors as appropriate (Reclamation 2019l). In accordance with Reclamation’s most recent plant-in-service cost allocation (for fiscal year 2017), 22.3% of CVP plant-in-service costs, excluding CVPIA costs, are allocated to commercial power customers, and are repaid annually through the power revenue requirement methodology established by WAPA. Power customers pay their percentage share of total WAPA and Reclamation’s costs (including the power allocation of CVP plant-in-service, annual costs, and interest) for the right to receive a percentage share of the daily net (of project use) CVP power generation.

Consequently as CVP annual and plant-in-service power costs increase (including Central Valley Project Improvement Act [CVPIA] Environmental Restoration Funds), and available energy for sale decreases, the net unit cost of CVP power will increase. Alternatively, California renewable energy mandates and other factors have eroded the market price for power, thus decreasing its attractiveness as the price competitiveness of the federal hydropower product is affected.

On December 31, 2024, all of the WAPA's Sierra Nevada Region's long-term power sales contracts will expire. Power customers also have an opportunity to cancel their contracts as part of the rate filing/rate adjustment due on September 30, 2019, and before the start of the new marketing plan. These include all of the contracts outside of project loads. Given the increasing renewable portfolio standard, large hydropower is becoming less desirable, as energy utilities are required to have increasing percentages of their portfolios from renewable sources as defined by California. CVP power customers may choose not to renew power sales contracts in 2024, which would cause WAPA to market CVP power in the California Independent System Operator (ISO) market, and may or may not allow for recovery of CVP power costs, including the CVPIA. This could lead to financial issues for the Central Valley Project, increased costs for either federal taxpayers or water users, and wasted hydropower resources from California's existing large dams and hydropower facilities.

The CVP power facilities include 11 hydroelectric powerplants and have a total maximum generating capacity of 2,076 megawatts, as shown in Table U.1-1, *Central Valley Project Hydroelectric Powerplants*. Hydrology can vary substantially from year to year, which then affects the hydropower production. Typically, in an average water year, approximately 4,500 gigawatt-hours of energy is produced (Reclamation 2017b). Major factors that influence powerplant operations include required downstream water releases, electric system needs, and project use demand. The power generated from CVP powerplants is dedicated to first meeting the requirements of CVP facilities, then for water supply delivery and pumping. The remaining energy is marketed by WAPA to preference power customers in Northern California.

Table U.1-1. Central Valley Project Hydroelectric Powerplants

Facility	Installed Capacity (Megawatts)
Trinity Powerplant	140
Lewiston Powerplant	0.3
Judge Francis Carr Powerplant	154
Shasta Powerplant	710
Spring Creek Powerplant	180
Keswick Powerplant	117
Folsom Powerplant	207
Nimbus Powerplant	13.5
New Melones Powerplant	300
O'Neill Pump-Generating Plant	25
San Luis Powerplant (CVP portion of the William R. Gianelli/ San Luis Pump-Generating Plant)	202

Source: CEC 2018b.

Power generation at CVP and SWP hydropower facilities fluctuates in response to reservoir releases and conveyance flows. Reservoir releases are affected by hydrologic conditions, minimum stream flow requirements, flow fluctuation restrictions, water quality requirements, and non-CVP and non-SWP water rights, which must be met prior to releases for CVP water service contractors and SWP entitlement holders.

The CVP power generation facilities were developed to meet CVP energy use loads. Most of the energy used by the CVP is needed for pumping plants in the Sacramento–San Joaquin Delta (Delta), at San Luis Reservoir, and along the Delta-Mendota Canal and San Luis Canal portion of the California Aqueduct.

Table U.1-2, *Central Valley Project Facility Pumping Loads*, shows the pump load for each CVP pumping plant.

Table U.1-2. Central Valley Project Facility Pumping Loads

Facility	Pumping Load (Megawatts)
C.W. "Bill" Jones Pumping Plant	101
O'Neil Pumping-Generating Plant	27

Sources: Reclamation 2016a, 2019j.

Table U.1-3, *Hydropower Generation and Energy Use by Central Valley Project*, presents historical average annual CVP hydropower generation and use. Monthly power generation pattern follows seasonal reservoir releases, with peaks during the irrigation season. The hydropower generation between January and June decreases after 2007 because the potential to convey CVP water across the Delta during this period was reduced after 2007 to reduce reverse flows in Old and Middle River (OMR), in accordance with legal decisions and subsequently through implementation of the 2008 and 2009 biological opinions.

Table U.1-3. Hydropower Generation and Energy Use by Central Valley Project

Calendar Year	Water Year Type[1]	Net CVP Hydropower Generation (Gigawatt-hours)[2]	CVP Facility Energy Used (Gigawatt-hours)
2000	Above normal	5,701	—
2001	Dry	4,169	957
2002	Dry	4,378	1,090
2003	Above normal	5,484	1,170
2004	Below normal	5,187	1,172
2005	Above normal	4,599	1,150
2006	Wet	7,285	1,037
2007	Dry	4,276	1,064
2008	Critically dry	3,673	923
2009	Dry	3,392	803
2010	Below normal	4,118	1,001
2011	Wet	5,629	1,276
2012	Below normal	4,423	990
2013	Dry	4,314	NA
2014	Critically dry	2,751	NA
2015	Critically dry	2,471	NA
2016	Below normal	3,605	NA
2017	Wet	6,253	NA
2018	Dry	3,939	NA

Sources: Reclamation 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016b, 2017a, 2018.

[1] Water year types are based on Sacramento Valley 40-30-30 Index, as described in Appendix H, *Surface Water Technical Appendix*.

[2] After station service. Includes federal share of San Luis.

NA = Not Available

The California Public Utilities Commission (CPUC) evaluated the "energy intensity" of several types of water supplies (CPUC 2010). The energy intensity is defined as the average amount of energy required to convey and/or treat water on a unit basis, such as per 1 acre-foot (AF). Substantial quantities of energy are required by the CVP pumping plants to convey large amounts of water over long distances with significant changes in elevation. The study indicated that the energy intensity of CVP water delivered to users downstream of San Luis Reservoir ranged from 0.292 megawatt-hours/AF for users along the Delta-Mendota Canal to 0.428 megawatt-hours/AF for users along the San Luis Canal/California Aqueduct to 0.870 megawatt-hours/AF in San Benito and Santa Clara Counties.

U.1.1.2 *State Water Project Power and Energy Resources*

The SWP also generates hydroelectricity along the California Aqueduct at energy recovery plants (DWR 2017). Power generated by the SWP is transmitted by Pacific Gas and Electric Company (PG&E), Southern California Edison, and California Independent System Operator through other facilities (DWR 2013a, 2013b). The SWP also markets energy in excess of the SWP demands to a utility and members of the Western Systems Power Pool.

The SWP power facilities are operated primarily to provide power for the SWP facilities (DWR 2017). The SWP power facilities and capacities are summarized in Table U.1-4, *State Water Project Hydroelectric Powerplants*. The SWP has power contracts with electric utilities and the California ISO that act as exchange agreements with utility companies for transmission and power sales and purchases. Each year, the SWP must purchase additional power to meet pumping requirements.

Table U.1-4. State Water Project Hydroelectric Powerplants

Facility	Installed Capacity (Megawatts)
Oroville Facilities	–
Hyatt Pumping-Generating Plant	645
Thermalito Diversion Dam Powerplant	3
Thermalito Pumping-Generating Plant	114
William R. Gianelli (San Luis) Pumping-Generating Plant (SWP share)	222
Alamo Powerplant	17
Mojave Siphon Powerplant	30
Devil Canyon Powerplant	276
Warne Powerplant	74
Total	1,381

Source: DWR 2017.
SWP = State Water Project

The SWP power generation facilities were developed to meet SWP energy use loads. The majority of the energy used by the SWP is needed for pumping plants located in the Delta, at the San Luis Reservoir, and along the California Aqueduct. Table U.1-5, *State Water Project Pumping Plant Loads*, shows the pump load for each of the SWP pumping plants.

Table U.1-5. State Water Project Pumping Plant Loads

Facility	Pumping Load (Megawatts)
Hyatt Pumping-Generating Plant	387
Barker Slough Pumping Plant	4
Cordelia Pumping Plant	NA
South Bay Pumping Plant	21
Del Valle Pumping Plant	1
Harvey O. Banks Pumping Plant	248
William R. Gianelli Pumping Plant	276
Dos Amigos Pumping Plant	179
Buena Vista Pumping Plant	108
John R. Teerink Pumping Plant	112
Ira J. Chrisman Pumping Plant	246
A.D. Edmonston Pumping Plant	836
Oso Pumping Plant	70
Alamo Pumping Plant	17
Pearblossom Pumping Plant	152
Las Perillas Pumping Plant	3
Badger Hill Pumping Plant	9
Devil's Den Pumping Plant	8
Bluestone Pumping Plant	8
Polonio Pass Pumping Plant	8
Greenspot Pump Station	3
Crafton Hills Pump Station	3
Cherry Valley Pump Station	0.2
Total	2,699

Source: DWR 2017.
NA = not available

Table U.1-6, *Hydropower Generation and Energy Use by the State Water Project*, presents historical average annual SWP hydropower generation and use for the period 2001–2018. Monthly power generation pattern follows seasonal reservoir releases, with peaks during the irrigation season. SWP power use and generation values indicate the SWP generates approximately 63% of the energy needed for deliveries (DWR 2002, 2004a, 2004b, 2005, 2006, 2007, 2008, 2012a, 2012b, 2013a, 2013b, 2014, 2015a, 2015b, 2016, 2017). The energy generation and purchases and energy use decreases after 2007 because the potential to convey SWP water across the Delta was reduced in accordance with legal decisions and subsequently through implementation of the 2008 and 2009 biological opinions.

Table U.1-6. Hydropower Generation and Energy Use by the State Water Project

Calendar Year	Water Year Type[1]	State Water Project Hydropower Generation (Gigawatt- hour)	Energy Acquired through Long-Term Agreements and Purchases (Gigawatt-hour)	Energy Used by State Water Project Facilities (Gigawatt-hour)
2000	Above normal	6,372	5,741	9,190
2001	Dry	4,295	4,660	6,656
2002	Dry	4,953	4,610	8,394
2003	Above normal	5,511	4,668	9,175
2004	Below normal	6,056	4,429	9,860
2005	Above normal	5,151	5,367	8,308
2006	Wet	7,056	5,811	9,158
2007	Dry	5,577	6,642	9,773
2008	Critically dry	3,541	4,603	5,745
2009	Dry	4,650	3,970	6,089
2010	Below normal	3,920	5,081	7,187
2011	Wet	4,846	4,895	8,549
2012	Below normal	4,198	3,741	7,406
2013	Dry	3,069	3,604	5,736
2014	Critically dry	1,133	1,691	2,791
2015	Critically dry	1,275	2,781	3,488
2016	Below normal	NA	NA	NA
2017	Wet	NA	NA	NA
2018	Dry	NA	NA	NA

Sources: DWR 2002, 2004a, 2004b, 2005, 2006, 2007, 2008, 2012a, 2012b, 2013a, 2013b, 2014, 2015a, 2015b, 2016, 2017.
[1] Water year types are based on Sacramento Valley 40-30-30 Index, as described in Appendix H, *Surface Water Technical Appendix*.
NA = not available

The energy intensity values calculated by CPUC for the SWP ranged from 1.128 megawatt-hours/AF for water users along the South Bay Aqueduct to 1.157 megawatt-hours/AF for water users in Kern County to 4.644 megawatt-hours/AF for water users at the terminal end of the East Branch Extension of the California Aqueduct (CPUC 2010).

U.1.2 Trinity River

The Trinity Powerplant is on the Trinity River (Reclamation 2019a). Primary releases of Trinity Dam are made through the powerplant. Trinity County has first preference to the power from this plant.

The Lewiston Powerplant is at the Lewiston Dam along the Trinity River (Reclamation 2019b). It is operated in conjunction with the spillway gates to maintain the minimum flow in the Trinity River downstream. Because the turbine capacity is less than the Trinity River minimum flow criteria, the turbine is usually set at maximum output with the spillway gates adjusted to regulate river flow. The Lewiston Powerplant provides power to the adjacent fish hatchery. Adjacent to Lewiston Dam is an intake to the Clear Creek Tunnel, which diverts Trinity River water to Carr Powerplant, where it discharges into Whiskeytown Reservoir.

U.1.3 Sacramento River

The Shasta Powerplant is a peaking powerplant located downstream of Shasta Dam along the Sacramento River (Reclamation 2019d). Until early 1990s, concerns with downstream temperatures resulted in the bypasses of outflows around the powerplant and lost hydropower generation. Installation of the Shasta Temperature Control Device enabled operators to decide the depth of the reservoir from which the water feeding into the penstocks originates. The system has shown success in controlling the water temperature of powerplant releases through Shasta Dam. The Shasta Powerplant also provides water supply for the Livingston Stone National Fish Hatchery.

The Spring Creek Powerplant is a peaking plant along Spring Creek (Reclamation 2019e) Water discharged via the Judge Francis Carr Powerplant flows into the Whiskeytown Reservoir and then provides the source of water for the Spring Creek Powerplant generation. Trinity County has first preference to the power benefits from Spring Creek Powerplant. Water from Spring Creek Powerplant is discharged into Keswick Reservoir. Releases from Spring Creek Powerplant also are operated to maintain water quality in the Spring Creek arm of Keswick Reservoir.

The Keswick Powerplant is located at Keswick Dam along the Sacramento River downstream of Shasta Dam. The powerplant regulates the flows into the Sacramento River from both Shasta Lake and Spring Creek releases; with minimal storage capacity, Keswick Dam is operated to allow for peaking operations at Shasta Dam and the Spring Creek powerhouse while maintaining relatively consistent flows to the Sacramento River below Keswick Dam (Reclamation 2019f).

U.1.4 Clear Creek

The Judge Francis Carr Powerplant is a peaking powerplant located on the Clear Creek Tunnel (Reclamation 2019c). It generates power from water exported from the Trinity River Basin via the intake to the Clear Creek Tunnel adjacent to Lewiston Dam. The plant discharges into Whiskeytown Reservoir. Similar to Trinity Powerplant, Trinity County has first preference to the power benefit from this facility.

U.1.5 Feather River

The Hyatt Pumping-Generating Plant is on the channel between Lake Oroville and the Thermalito Diversion Pool (DWR 2007). Water in the Thermalito Diversion Pool can be pumped back to Lake Oroville to be released through the Hyatt Pumping-Generating Plant and generate more electricity, released through the Thermalito Diversion Dam Powerplant for delivery to the low flow channel upstream of Thermalito Forebay, or conveyed to Thermalito Forebay for subsequent release through the Thermalito Pumping-Generating Plant. The combined Hyatt Pumping-Generating Plant and Thermalito Pumping-Generating Plant generate approximately 2,200 gigawatt-hours of energy in a average water year, while the 3 megawatts generated by Thermalito Diversion Dam Powerplant adds another 24 gigawatt-hours per year (DWR 2017).

U.1.6 American River

The Folsom Powerplant is a peaking powerplant at Folsom Dam along the American River (Reclamation 2019g). The Folsom Powerplant is operated in an integrated manner with flood control and storage management operations at Folsom Reservoir. One of the integrated operations is related to coordinating early flood control releases with power generation. It also provides power for the pumping plant that supplies the multiple local municipal water systems. Folsom Powerplant supports voltage regulation for the Sacramento region during summer heavy load times.

The Nimbus Powerplant is located at Nimbus Dam along the American River, downstream of Folsom Dam (Reclamation 2019h). The Nimbus Powerplant regulates releases from Folsom Dam into the American River and can be considered a run-of-the river powerplant.

U.1.7 Stanislaus River

The New Melones Powerplant is a peaking powerplant located along the Stanislaus River (Reclamation 2019i). Primary reservoir releases are made through the powerplant. This plant provides substantial voltage support to the PG&E system during summer heavy load periods.

U.1.8 San Joaquin River

This analysis does not include powerplants along the San Joaquin River. Their operations would be expected to be consistent between all action alternatives.

U.1.9 Central Valley Project and State Water Project Service Areas (South to Diamond Valley)

U.1.9.1 *San Luis Reservoir Powerplants (Federal Share)*

The O'Neill Pump-Generating Plant is on a channel that conveys water between the Delta-Mendota Canal and the O'Neill Forebay (Reclamation 2019j). This pump-generating plant only generates power when water is released from the O'Neill Reservoir to the Delta-Mendota Canal. When water is conveyed from the Delta-Mendota Canal to O'Neill Forebay, the units serve as pumps, not hydroelectric generators. The generated power is used to support CVP pumping and irrigation actions of the CVP.

The William R. Gianelli (San Luis) Pump-Generating Plant is along the along the western boundary of the O'Neill Forebay at the San Luis Dam (Reclamation 2019k). This pump-generating plant is owned by the federal government but is operated as a joint federal-state facility that is shared by the CVP and SWP. Energy is generated when water is needed to be conveyed from San Luis Reservoir back into O'Neill Forebay for continued conveyance to the Delta-Mendota Canal. The plant is operated in pumping mode when water is moved from O'Neill Forebay to San Luis Reservoir for storage until heavier water demands develop. The generated power is used to offset CVP and SWP pumping loads. The powerplant can generate up to 424 megawatts, with the CVP share of the total capacity being 202 megawatts. This facility is operated and maintained by the State of California under an operation and maintenance agreement with the U.S. Department of the Interior, Bureau of Reclamation (Reclamation).

U.1.9.2 *San Luis Reservoir Powerplant (State Share)*

As described above, the William R. Gianelli (San Luis) Pump-Generating Plant is owned by the federal government and is operated as a joint federal-state facility shared by the CVP and SWP. The SWP water flows from the California Aqueduct into O'Neill Forebay downstream of the CVP's O'Neill Pump-Generating Plant. The pump-generating plant is located along the western boundary of the O'Neill Forebay at the San Luis Dam (DWR 2013a, 2013b). Electricity is generated when water is transferred from San Luis Reservoir back to O'Neill Forebay for continued conveyance in the California Aqueduct. The plant acts as a pumping plant when water is transferred from O'Neill Forebay to San Luis Reservoir. The generated power is used to offset CVP and SWP pumping loads. The powerplant can generate up to 424 megawatts, with the SWP share of the total capacity being 222 megawatts. This facility is operated and maintained by the State of California under an operation and maintenance agreement with Reclamation.

U.1.9.3 *East Branch and West Branch Powerplants*

Downstream of the Antelope Valley, the California Aqueduct divides into the East Branch and West Branch. The Alamo Powerplant, Mojave Powerplant, and Devil Canyon Powerplant are located along the East Branch, which conveys water into San Bernardino County (DWR 2017). The Warne Powerplant is located along the West Branch, which conveys water into Los Angeles County. The generation rates vary at these powerplants depending upon the amount of water conveyed.

U.1.9.4 *Other Energy Resources for the State Water Project*

Other energy supplies have been obtained by California Department of Water Resources (DWR) from other utilities and energy marketers under agreements that allow DWR to buy, sell, or exchange energy on a short-term hourly basis or a long-term multiyear basis (DWR 2017).

For example, DWR jointly developed the 1,254-megawatt Castaic Powerplant on the West Branch with the Los Angeles Department of Water and Power (DWR 2017). The power is available to DWR at the Sylmar Substation.

DWR has a long-term purchase agreement with the Kings River Conservation District for the approximately 400 million kilowatt-hours of energy from the 165-megawatt hydroelectric Pine Flat Powerplant (DWR 2017). DWR also purchases energy from five hydroelectric plants with 30 megawatts of installed capacity that are owned and operated by Metropolitan Water District of Southern California (DWR 2017).

DWR also purchases energy under short-term purchase agreements from utilities and energy marketers of the WSPP (DWR 2017). In addition, the 1988 Coordination Agreement between DWR and Metropolitan Water District of Southern Californian enables DWR to purchase and exchange energy (DWR 2017) from Metropolitan's Colorado River Aqueduct System.

U.1.10 Other Hydroelectric Generation Facilities

Hydroelectric facilities in addition to CVP and SWP hydroelectric facilities in the study area are owned by investor-owned utility companies, such as PG&E and Southern California Edison; municipal agencies, such as Sacramento Municipal Utility District (SMUD); and by local and regional water agencies. Some of the larger facilities outside the CVP and SWP systems and within or adjacent to the study area include (CEC 2014b; YCWA 2012):

- PG&E
    - Helms Pumped Storage (1,200 megawatts) in Fresno County.
    - Pit System (320 megawatts) and McCloud-Pit System (370 megawatts, total) in Shasta County.
    - Upper North Fork Feather River System (360 megawatts) in Plumas County.
- SMUD Upper American River Project System (688 megawatts) in El Dorado County.
- City and County of San Francisco Hetch Hetchy Power System (390 megawatts) in Tuolumne County.
- Southern California Edison
    - Big Creek System and Eastwood Pump Storage (approximately 1,000 megawatts) in Fresno and Madera Counties.

  - Mammoth Pool Project (187 megawatts) in Fresno and Madera Counties.
- Turlock Irrigation District and Modesto Irrigation District New Don Pedro Project (203 megawatts) in Tuolumne County.
- Yuba Water Agency Yuba River Development Project (390 megawatts) in Yuba County.

U.1.11 Energy Demands for Groundwater Pumping

Groundwater provided approximately 38% of the state's agricultural, municipal, and industrial water supply of the average water needs between 2005 and 2010, or over 16 million acre-feet/year (AFY) of groundwater (DWR 2015c). The use of groundwater varies regionally throughout the state.

The amount of energy used statewide to pump groundwater is not well quantified (CPUC 2010). CPUC estimated groundwater energy use by hydrologic region and by type of use to evaluate the water and energy relationships. Groundwater pumping estimates were calculated in each DWR Planning Area for agricultural and municipal water demands. Groundwater energy use was estimated based upon assumptions of well depths and pump efficiencies. Some wells use natural gas for individual engines instead of electricity; however, the amount of natural gas pumping versus electric pumping is generally unknown. Between 2005 and 2010, average groundwater use in the state was approximately 16.5 million AF, or 38% of total agricultural, municipal, and industrial water supplies (DWR 2015c). In 2010, CPUC estimated that, statewide groundwater pumping accounted for more electricity use between May and August than the total electricity use by CVP and SWP during that same time period (CPUC 2010). Over the entire year, it was estimated that groundwater pumping used approximately 10% more electricity than the SWP and approximately 5% less than CVP and SWP combined.

U.2 Evaluation of Alternatives

This section describes the potential mechanisms for change in energy generation and analytical methods, results of the impact analyses, potential mitigation measures, and cumulative effects.

U.2.1 Methods and Tools

The environmental consequences assessment considers changes in energy resources conditions related to changes in CVP and SWP operations under the alternatives compared to the No Action Alternative.

U.2.1.1 Changes in Energy Resources Related to Central Valley Project and State Water Project Water Users

Energy generation is limited on a monthly basis by the average power capacity of each generation facility based upon reservoir elevations and water release patterns. The majority of the CVP and SWP energy use is for the conveyance facilities located in the Delta and south of the Delta. Energy use would change with changes in CVP and SWP deliveries.

Reservoir elevations and flow patterns through pumping facilities output from the CalSim II model (Appendix F, *Model Documentation*) are used with LTGen and SWP power tools, as described in Appendix U, Attachment 1, *Power Model Documentation*. These tools estimate average annual peaking power capacity, energy use, and energy generation at CVP and SWP facilities, respectively. The tools estimate average monthly and annual energy generation and use and net generation. (Net generation is the difference between energy generation and use; a negative net generation means more energy is used than generated.) When net generation values are negative, the CVP or SWP would purchase power from other generation facilities. Because California's energy system must always be balanced, purchasing power from other generation facilities would imply that additional generation is needed. This additional generation could come from reduced curtailments of renewable generation, existing thermal generation, or increased import of energy from out of state (primarily from the Pacific Northwest or from Arizona and Nevada). When net generation values are positive, power would be available for use by both CVP preferential power customers (for available CVP power) and non-CVP and SWP electricity users for available SWP power, and would allow for either less generation from thermal generating plants, or less imported power from outside the state.

When CVP and SWP water deliveries change, water users are anticipated to change their use of groundwater, recycled water, and/or desalinated water, as described in Appendix H and Appendix I, *Groundwater Technical Appendix*. Specific responses by water users to changes in CVP and SWP water deliveries are not known; therefore, energy use for the alternate water supplies cannot be quantified in this analysis. It is not known whether the net change in energy use for the CVP and SWP would or would not be similar to the net change in energy use for alternate water supplies (e.g., groundwater pumping, water treatment, water conveyance).

U.2.2 No Action Alternative

Due to the climate change, sea-level rise, and increased water demands in the Sacramento Valley, CVP and SWP energy generation may be less in the summer months, and therefore less generation is available for sale to CVP preference power customers, when energy demand is high for water conveyance and air conditioning equipment throughout the state. Water deliveries could also change in 2030, which could result in less energy use for CVP and SWP water conveyance facilities.

U.2.3 Alternative 1

Alternative 1 is compared to the No Action Alternative to evaluate changes in both CVP and SWP net generation.

U.2.3.1 *Project-Level Effects*

Potential changes in Central Valley Project net generation

Changes in CVP operations under Alternative 1 compared to the No Action Alternative would result in an increase of CVP water deliveries to areas located south of the Delta; therefore, annual energy use would result in changes in CVP energy resources, as summarized in Table U.2-1, *Simulated Annual Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 1 Compared to the No Action Alternative*. The CVP net generation over the long-term would be slightly lower by 3% and 2% higher in dry and critically dry years, under Alternative 1 compared to the No Action Alternative.

Table U.2-1. Simulated Annual Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 1 Compared to the No Action Alternative

Water Year		Alternative 1 (GWh)	No Action Alternative (NAA) (GWh)	Changes between Alternative 1 and NAA (percent change)[2] (GWh)
Long-Term Average	Energy Use	1,322	1,207	115 (10%)
	Generation	4,539	4,533	6 (0%)
	Net Generation	3,217	3,326	-109 (-3%)
Dry and Critically Dry Water Years[1]	Energy Use	1,070	974	96 (10%)
	Generation	3,515	3,377	138 (4%)
	Net Generation	2,445	2,403	42 (2%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 1 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; NAA = No Action Alternative

Table U.2-2, *Simulated Monthly CVP Energy Generation, Energy Use, and Net Generation under Alternative 1 Compared to the No Action Alternative*, shows the breakdown of the monthly energy use, generation, and net generation, by long-term average and for dry and critically dry years, for the CVP facilities. The model output shows that there is an average decrease in net generation under Alternative 1 compared to the No Action Alternative in October through December, and April and May for all years, and a decrease in October, and February through May for dry and critically dry years. The decreases in net generation tend to be a result of both increase in energy use and decreases in generation in those months.

Table U.2-2. Simulated Monthly Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 1 Compared to the No Action Alternative

			Oct (GWh)	Nov (GWh)	Dec (GWh)	Jan (GWh)	Feb (GWh)	Mar (GWh)	Apr (GWh)	May (GWh)	Jun (GWh)	Jul (GWh)	Aug (GWh)	Sep (GWh)
Average All Years	NAA	Energy Use	82	112	127	132	115	109	44	52	93	125	121	96
		Generation	287	266	258	313	316	329	308	474	489	622	476	396
		Net Generation	205	154	131	181	201	220	264	422	397	498	355	299
	Alt 1	Energy Use	96	103	119	135	125	116	77	85	102	128	130	105
		Generation	281	218	282	337	333	347	303	474	517	641	490	316
		Net Generation	184	115	163	201	208	231	225	390	415	513	361	212
	Change from NAA (percent change)[2]	Energy Use	15	-10	-8	3	11	7	33	33	10	3	9	8
		Generation	-6	-48	24	24	18	18	-6	0	28	18	14	-79
		Net Generation	-21 (-10%)	-38 (-25%)	31 (24%)	21 (11%)	7 (3%)	11 (5%)	-39 (-15%)	-32 (-8%)	18 (5%)	15 (3%)	6 (2%)	-87 (-29%)
Dry and Critically Dry Years1	NAA	Energy Use	70	80	106	122	105	85	35	40	57	103	92	79
		Generation	198	155	213	248	270	168	216	363	429	517	383	217
		Net Generation	128	75	107	126	165	83	180	323	372	414	291	138
	Alt 1	Energy Use	73	77	104	129	122	107	47	58	71	101	98	82
		Generation	198	165	219	257	279	183	218	377	451	543	398	228
		Net Generation	125	88	115	128	157	76	171	319	380	442	300	146
	Change from NAA (percent change)[2]	Energy Use	3	-3	-2	7	17	22	12	18	14	-2	6	3
		Generation	0	10	6	9	9	15	2	14	22	26	15	11
		Net Generation	-4 (-3%)	13 (17%)	8 (7%)	2 (1%)	-8 (-5%)	-7 (-9%)	-10 (-5%)	-4 (-1%)	8 (2%)	28 (7%)	8 (3%)	8 (6%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting No Action Alternative value from Alternative 1 value. Percent change is the change divided by No Action Alternative value.
GWh = Gigawatt-hours; Alt 1 = Alternative 1; NAA = No Action Alternative

Under Alternative 1, annual energy generation would be higher for both long-term average and in dry and critically dry years, but the energy required to move the water would also be higher for both long-term average and in dry and critically dry years, compared to the No Action Alternative for the CVP. The trend is also maintained at a monthly level; the CVP would expect increased generation under Alternative 1 compared to the No Action Alternative, but similarly would expect increases in energy usage. While decreases in monthly net generation would occasionally be relatively small (reductions in CVP net generation in dry and critically dry years in October and May would both be less than 5%), monthly reductions in net generation would likely require alternative sources of energy; increases in net generation in one month would not necessarily benefit a month with a reduction in net generation because no opportunities for large-scale energy storage are available.

Potential changes in State Water Project net generation

Changes in SWP operations under Alternative 1 compared to the No Action Alternative would result in an increase SWP water deliveries to areas located south of the Delta; therefore, annual energy use would result in changes in SWP energy resources, as summarized in Table U.2-3, *Simulated Annual State Water*

Project Energy Generation, Energy Use, and Net Generation under Alternative 1 Compared to the No Action Alternative. The changes to SWP net generation would be much greater under Alternative 1, relative to the No Action Alternative; long-term average net generation would be 25% lower, and dry and critically dry year net generation would be 19% lower.

Table U.2-3. Simulated Annual State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 1 Compared to the No Action Alternative

Water Year		Alternative 1 (GWh)	No Action Alternative (NAA) (GWh)	Changes between Alternative 1 and NAA (percent change)[2] (GWh)
Long-Term Average	Energy Use	8,377	7,304	1,073 (15%)
	Generation	4,349	4,074	275 (7%)
	Net Generation	-4,028	-3,230	-798 (25%)
Dry and Critically Dry Water Years[1]	Energy Use	5,217	4,685	532 (11%)
	Generation	2,670	2,489	182 (7%)
	Net Generation	-2,547	-2,197	-350 (16%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 1 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; NAA = No Action Alternative

Table U.2-3, *Simulated Monthly State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 1 Compared to the No Action Alternative*, shows the monthly energy use, generation, and resulting net generation for SWP facilities for No Action Alternative and Alternative 1, both as long-term average of all years, and as an average for dry and critically dry years. Simulated SWP net generation would be decreased in all months for both the average of all years and for dry and critically dry years. For both timeframes, the decrease in net generation is a result of increased energy use; the average generation of all years and dry and critically dry years would also increase, but not by as much.

Table U.2-3. Simulated Monthly State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 1 Compared to the No Action Alternative

			Oct (GWh)	Nov (GWh)	Dec (GWh)	Jan (GWh)	Feb (GWh)	Mar (GWh)	Apr (GWh)	May (GWh)	Jun (GWh)	Jul (GWh)	Aug (GWh)	Sep (GWh)
Average All Years	NAA	Energy Use	696	635	683	301	334	424	453	593	666	846	833	841
		Generation	312	268	278	198	235	284	306	396	407	537	433	419
		Net Generation	-384	-366	-405	-102	-99	-140	-146	-197	-260	-309	-400	-422
	Alt 1	Energy Use	767	774	759	366	419	539	608	733	727	907	898	880
		Generation	318	300	320	227	274	332	330	431	447	558	457	356
		Net Generation	-449	-474	-439	-139	-144	-207	-279	-303	-280	-349	-441	-524
	Change from NAA (percent change)[2]	Energy Use	71	139	76	65	85	115	156	140	60	61	65	39
		Generation	6	32	42	28	39	49	23	34	40	21	24	-64
		Net Generation	-65 (17%)	-108 (29%)	-34 (8%)	-37 (36%)	-45 (46%)	-66 (47%)	-133 (91%)	-106 (54%)	-20 (8%)	-40 (13%)	-41 (10%)	-103 (24%)
Dry and Critically Dry Years[1]	NAA	Energy Use	433	446	474	179	231	159	211	380	489	604	512	567
		Generation	180	166	193	124	162	73	146	247	344	383	249	221
		Net Generation	-253	-280	-280	-56	-68	-86	-65	-133	-145	-222	-264	-346
	Alt 1	Energy Use	457	468	507	248	291	196	270	428	535	637	585	596
		Generation	188	175	203	142	180	77	156	263	380	390	279	237
		Net Generation	-269	-293	-304	-106	-111	-119	-114	-165	-155	-247	-306	-359
	Change from NAA (percent change)[2]	Energy Use	23	22	33	69	61	37	59	48	46	33	73	29
		Generation	7	9	10	19	18	3	10	16	36	7	30	16
		Net Generation	-16 (6%)	-13 (5%)	-23 (8%)	-50 (91%)	-43 (63%)	-33 (38%)	-49 (76%)	-32 (24%)	-10 (7%)	-26 (12%)	-42 (16%)	-13 (4%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 1 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; Alt 1 = Alternative 1; NAA = No Action Alternative

Under Alternative 1, annual energy generation would be 7% higher for both long-term average and in dry and critically dry years, but the energy required to move the water would also be higher for both long-term average and in dry and critically dry years, compared to the No Action Alternative for the SWP, resulting in a reduction in net generation. The trend is also maintained at a monthly level; the SWP would expect increased generation under Alternative 1 compared to the No Action alternative, but similarly would expect increases in energy usage. Alternative sources of energy would be needed in response to the decreased net generation in most months.

U.2.3.2 *Program-Level Effects*

Construction-related actions that are analyzed at a program level would not affect power or energy resources.

U.2.4 Alternative 2

Alternative 2 is compared to the No Action Alternative to evaluate changes in both CVP and SWP net generation.

U.2.4.1 *Project-Level Effects*

Potential changes in Central Valley Project net generation

Changes in CVP operations under Alternative 2 compared to the No Action Alternative would result in an increase of CVP water deliveries to areas located south of the Delta; therefore, annual energy use would result in changes in CVP energy resources, as summarized in Table U.2-4, *Simulated Annual Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 2 Compared to the No Action Alternative*. The CVP annual net generation over the long-term conditions would be slightly lower by 4%, but there would be no change in the dry and critically dry year net generation under Alternative 2 compared to the No Action Alternative.

Table U.2-4. Simulated Annual Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 2 Compared to the No Action Alternative

Water Year		Alternative 2 (GWh)	No Action Alternative (NAA) (GWh)	Changes between Alternative 2 and NAA (percent change)[2] (GWh)
Long-Term Average	Energy Use	1,420	1,207	213 (18%)
	Generation	4,609	4,533	75 (2%)
	Net Generation	3,189	3,326	-137 (-4%)
Dry and Critically Dry Water Years[1]	Energy Use	1,139	974	165 (17%)
	Generation	3,542	3,377	165 (5%)
	Net Generation	2,402	2,403	0 (0%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 2 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; NAA = No Action Alternative

Table U.2-5, *Simulated Monthly Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 2 Compared to the No Action Alternative*, shows the breakdown of the monthly energy use, generation, and net generation, by long-term average and for dry and critically dry years, for the CVP facilities. The model output shows that there is an average decrease in net generation under Alternative 2 compared to the No Action Alternative in September, October, November, and February through May for all years, and a decrease in November through April for dry and critically dry years. The decreases in net generation tend to be a result of both increase in energy use and decreases in generation in those months.

Table U.2-5. Simulated Monthly Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 2 Compared to the No Action Alternative

			Oct (GWh)	Nov (GWh)	Dec (GWh)	Jan (GWh)	Feb (GWh)	Mar (GWh)	Apr (GWh)	May (GWh)	Jun (GWh)	Jul (GWh)	Aug (GWh)	Sep (GWh)
Average All Years	NAA	Energy Use	82	112	127	132	115	109	44	52	93	125	121	96
		Generation	287	266	258	313	316	329	308	474	489	622	476	396
		Net Generation	205	154	131	181	201	220	264	422	397	498	355	299
	Alt 2	Energy Use	98	111	137	146	137	119	73	90	114	146	139	109
		Generation	278	212	270	332	338	337	299	485	558	660	512	329
		Net Generation	180	100	133	185	200	217	226	395	445	514	374	219
	Change from NAA (percent change)[2]	Energy Use	16	-1	10	14	23	11	30	38	21	21	18	13
		Generation	-9	-54	11	19	22	8	-9	11	69	37	37	-67
		Net Generation	-25 (-12%)	-53 (-35%)	1 (1%)	5 (3%)	-1 (0%)	-3 (-1%)	-39 (-15%)	-27 (-6%)	48 (12%)	16 (3%)	19 (5%)	-80 (-27%)
Dry and Critically Dry Years[1]	NAA	Energy Use	70	80	106	122	105	85	35	40	57	103	92	79
		Generation	198	155	213	248	270	168	216	363	429	517	383	217
		Net Generation	128	75	107	126	165	83	180	323	372	414	291	138
	Alt 2	Energy Use	59	88	122	137	131	112	50	65	74	116	95	90
		Generation	191	159	211	245	274	171	222	392	474	558	406	239
		Net Generation	132	72	90	107	142	58	173	327	400	443	310	149
	Change from NAA (percent Change)[2]	Energy Use	-10	8	16	15	26	28	14	25	17	13	4	11
		Generation	-7	4	-2	-4	4	3	7	29	45	42	23	22
		Net Generation	3 (3%)	-4 (-5%)	-17 (-16%)	-19 (-15%)	-22 (-14%)	-25 (-30%)	-8 (-4%)	4 (1%)	28 (8%)	29 (7%)	19 (7%)	11 (8%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 2 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; Alt 2 = Alternative 2; NAA = No Action Alternative

Under Alternative 2, annual energy generation would be higher for both long-term average and in dry and critically dry years, but the energy required to move the water would also be higher for both long-term average and in dry and critically dry years, relative to the No Action Alternative for the CVP. This would result in a reduction in annual net generation for the average of all years, but no change in annual generation for dry and critically dry years. At a monthly level, the CVP would similarly expect increased generation under Alternative 2 compared to the No Action Alternative, but also increases in energy usage, resulting in decreases in monthly net generation in multiple months. While decreases in monthly net generation would occasionally be relatively small (reductions in CVP net generation for all years in February and March, and in dry and critically dry years in April would be less than 5%), alternative sources of energy would be needed in response to the decreased net generation in many months.

Potential changes in State Water Project net generation

Changes in SWP operations under Alternative 2 compared to the No Action Alternative would result in an increase of SWP water deliveries to areas located south of the Delta; therefore, annual energy use would result in changes in SWP energy resources, as summarized in Table U.2-6, *Simulated Annual State Water*

Project Energy Generation, Energy Use, and Net Generation under Alternative 2 Compared to the No Action Alternative. The changes to SWP net generation would be much greater under Alternative 2, relative to the No Action Alternative; long-term average net generation would be 53% lower, and dry and critically dry year net generation would be 61% lower.

Table U.2-6. Simulated Annual State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 2 Compared to the No Action Alternative.

Water Year		Alternative 2 (GWh)	No Action Alternative (NAA) (GWh)	Changes between Alternative 2 and NAA (percent change)[2] (GWh)
Long-Term Average	Energy Use	9,630	7,304	2,326 (32%)
	Generation	4,679	4,074	605 (15%)
	Net Generation	-4,951	-3,230	-1,721 (53%)
Dry and Critically Dry Water Years[1]	Energy Use	6,596	4,685	1,910 (41%)
	Generation	3,064	2,489	575 (23%)
	Net Generation	-3,532	-2,197	-1,336 (61%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).

[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 2 value. Percent change is the change divided by the No Action Alternative value.

GWh = Gigawatt-hours; NAA = No Action Alternative

Table U.2-7, *Simulated Monthly State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 2 Compared to the No Action Alternative*, shows the monthly energy use, generation, and resulting net generation for SWP facilities for No Action Alternative and Alternative 2, both as long-term average of all years, and as an average for dry and critically dry years. Simulated SWP net generation would be decreased in all months for both the average of all years and for dry and critically dry years. For both timeframes, the decrease in net generation is a result of increased energy use; the average generation of all years and dry and critically dry years would also increase, but not by as much.

Table U.2-7. Simulated Monthly State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 2 Compared to the No Action Alternative

			Oct (GWh)	Nov (GWh)	Dec (GWh)	Jan (GWh)	Feb (GWh)	Mar (GWh)	Apr (GWh)	May (GWh)	Jun (GWh)	Jul (GWh)	Aug (GWh)	Sep (GWh)
Average All Years	NAA	Energy Use	696	635	683	301	334	424	453	593	666	846	833	841
		Generation	312	268	278	198	235	284	306	396	407	537	433	419
		Net Generation	-384	-366	-405	-102	-99	-140	-146	-197	-260	-309	-400	-422
	Alt 2	Energy Use	819	845	865	596	625	746	666	799	828	953	952	936
		Generation	340	321	334	276	322	395	340	455	508	559	458	372
		Net Generation	-479	-524	-531	-320	-304	-351	-325	-344	-320	-394	-494	-564
	Change from NAA (percent change)[2]	Energy Use	123	210	182	296	291	322	213	206	161	107	119	95
		Generation	27	53	56	77	87	111	34	59	101	22	26	-48
		Net Generation	-95 (25%)	-158 (43%)	-125 (31%)	-218 (214%)	-205 (207%)	-211 (150%)	-179 (123%)	-147 (75%)	-60 (23%)	-85 (28%)	-94 (23%)	-143 (34%)
Dry and Critically Dry Years[1]	NAA	Energy Use	433	446	474	179	231	159	211	380	489	604	512	567
		Generation	180	166	193	124	162	73	146	247	344	383	249	221
		Net Generation	-253	-280	-280	-56	-68	-86	-65	-133	-145	-222	-264	-346
	Alt 2	Energy Use	486	581	675	384	443	367	338	488	618	740	760	716
		Generation	201	207	237	155	212	128	175	289	424	419	341	275
		Net Generation	-285	-375	-438	-229	-231	-239	-163	-199	-194	-321	-418	-441
	Change from NAA (percent change)[2]	Energy Use	53	135	201	205	212	207	127	109	129	136	247	150
		Generation	21	41	43	31	49	55	29	43	80	37	93	54
		Net Generation	-32 (13%)	-94 (34%)	-158 (56%)	-173 (312%)	-163 (238%)	-153 (177%)	-98 (151%)	-66 (50%)	-49 (34%)	-99 (45%)	-155 (59%)	-96 (28%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 2 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; Alt 2 = Alternative 2; NAA = No Action Alternative

Under Alternative 2, annual energy generation would be higher for both long-term average and in dry and critically dry years, but the energy required by the SWP to move the water would also be higher for both long-term average and in dry and critically dry years, relative to the No Action Alternative. The trend is also maintained at a monthly level; the SWP would expect increased generation under Alternative 2 compared to the No Action alternative in all months, but greater increases in energy usage resulting in reductions in net generation in all months. Alternative sources of energy would be needed in response to the decreased net generation because increased net generation in one month would not generally benefit a different month.

U.1.1.1 Program-Level Effects

Construction-related actions that are analyzed at a program level would not affect power or energy resources.

U.2.5 Alternative 3

Alternative 3 is compared to the No Action Alternative to evaluate changes in both CVP and SWP net generation.

U.2.5.1 *Project-Level Effects*

Potential changes in Central Valley Project net generation

Changes in CVP operations under Alternative 3 compared to the No Action Alternative would result in an increase of CVP water deliveries to areas located south of the Delta; therefore, annual energy use would result in changes in CVP energy resources, as summarized in Table U.2-8, *Simulated Annual Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 3 Compared to the No Action Alternative*. Similar to Alternative 2, the CVP annual net generation over the long-term conditions would be slightly lower by 4%, but there would be no change in the dry and critically dry year net generation under Alternative 3 compared to the No Action Alternative.

Table U.2-8. Simulated Annual Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 3 Compared to the No Action Alternative

Water Year		Alternative 3 (GWh)	No Action Alternative (NAA) (GWh)	Changes between Alternative 3 and NAA (percent change)[2] (GWh)
Long-Term Average	Energy Use	1,415	1,207	208 (17%)
	Generation	4,610	4,533	77 (2%)
	Net Generation	3,195	3,326	-131 (-4%)
Dry and Critically Dry Water Years[1]	Energy Use	1,135	974	161 (17%)
	Generation	3,538	3,377	161 (5%)
	Net Generation	2,403	2,403	0 (0%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 3 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; NAA = No Action Alternative

Table U.2-9, *Simulated Monthly Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 3 Compared to the No Action Alternative*, shows the breakdown of the monthly energy use, generation, and net generation, by long-term average and for dry and critically dry years, for the CVP facilities. The model output shows that there is an average decrease in net generation under Alternative 3 compared to the No Action Alternative in September, October, November, and February through May for all years, and a decrease in November through April for dry and critically dry years. The decreases in net generation tend to be a result of both increase in energy use and decreases in generation in those months.

Table U.2-9. Simulated Monthly Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 3 Compared to the No Action Alternative

			Oct (GWh)	Nov (GWh)	Dec (GWh)	Jan (GWh)	Feb (GWh)	Mar (GWh)	Apr (GWh)	May (GWh)	Jun (GWh)	Jul (GWh)	Aug (GWh)	Sep (GWh)
Average All Years	NAA	Energy Use	82	112	127	132	115	109	44	52	93	125	121	96
		Generation	287	266	258	313	316	329	308	474	489	622	476	396
		Net Generation	205	154	131	181	201	220	264	422	397	498	355	299
	Alt 3	Energy Use	97	112	139	146	139	117	72	89	113	144	139	109
		Generation	287	213	275	330	336	335	299	483	554	659	511	327
		Net Generation	191	101	136	184	197	218	227	394	441	515	373	218
	Change from NAA (percent change)[2]	Energy Use	15	0	12	14	24	8	28	37	20	19	18	13
		Generation	1	-53	16	18	21	7	-9	9	65	37	36	-68
		Net Generation	-14 (-7%)	-53 (-34%)	4 (3%)	3 (2%)	-4 (-2%)	-2 (-1%)	-37 (-14%)	-28 (-7%)	44 (11%)	18 (4%)	18 (5%)	-81 (-27%)
Dry and Critically Dry Years[1]	NAA	Energy Use	70	80	106	122	105	85	35	40	57	103	92	79
		Generation	198	155	213	248	270	168	216	363	429	517	383	217
		Net Generation	128	75	107	126	165	83	180	323	372	414	291	138
	Alt 3	Energy Use	60	85	124	140	133	108	49	64	74	113	95	91
		Generation	205	154	212	243	272	169	223	392	471	554	403	240
		Net Generation	145	70	87	103	139	61	174	328	397	441	309	149
	Change from NAA (percent change)[2]	Energy Use	-10	5	18	18	28	23	14	24	17	10	3	12
		Generation	7	-1	-2	-6	1	1	8	29	42	38	21	23
		Net Generation	17 (13%)	-6 (-8%)	-20 (-18%)	-23 (-18%)	-26 (-16%)	-22 (-27%)	-6 (-3%)	5 (2%)	25 (7%)	27 (7%)	17 (6%)	11 (8%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).

[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 3 value. Percent change is the change divided by the No Action Alternative value.

GWh = Gigawatt-hours; Alt 3 = Alternative 3; NAA = No Action Alternative

Under Alternative 3, annual CVP energy generation would be higher for both long-term average and in dry and critically dry years, but the energy required by the CVP to move the water would also be higher for both long-term average and in dry and critically dry years, relative to the No Action Alternative. At a monthly level, the CVP would similarly expect increased generation under Alternative 3 compared to the No Action Alternative, but also increases in energy usage. While decreases in monthly net generation would occasionally be relatively small (reductions in CVP net generation for all years in February and March, and in dry and critically dry years in April, would be less than 5%), alternative sources of energy would be needed in response to the decreased net generation in many months.

Potential changes in State Water Project net generation

Changes in SWP operations under Alternative 3 compared to the No Action Alternative would result in an increase of SWP water deliveries to areas located south of the Delta; therefore, annual energy use would result in changes in SWP energy resources, as summarized in Table U.2-10, *Simulated Annual State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 3 Compared to the No Action Alternative*. The decreases to SWP net generation would be much greater under Alternative 3, relative to the No Action Alternative; long-term average net generation would be 52% lower, and dry and critically dry year net generation would be 58% lower.

Table U.2-10. Simulated Annual State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 3 Compared to the No Action Alternative

Water Year		Alternative 3 (GWh)	No Action Alternative (NAA) (GWh)	Changes between Alternative 3 and NAA (percent change)[2] (GWh)
Long-Term Average	Energy Use	9,557	7,304	2,253 (31%)
	Generation	4,658	4,074	584 (14%)
	Net Generation	-4,898	-3,230	-1,668 (52%)
Dry and Critically Dry Water Years[1]	Energy Use	6,507	4,685	1,821 (39%)
	Generation	3,038	2,489	549 (22%)
	Net Generation	-3,469	-2,197	-1,272 (58%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 3 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; NAA = No Action Alternative

Table U.2-11, *Simulated Monthly State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 3 Compared to the No Action Alternative*, shows the monthly energy use, generation, and resulting net generation for SWP facilities for No Action Alternative and Alternative 3, both as long-term average of all years, and as an average for dry and critically dry years. Simulated SWP net generation would be decreased in all months but October for both the average of all years and for dry and critically dry years. For both timeframes, decreases in net generation is a result of increased energy use; the average monthly generation of all years and dry and critically dry years would also increase, but not by as much, except in October, when the increase in October generation exceeds the increase in energy use.

Table U.2-11. Simulated Monthly State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 3 Compared to the No Action Alternative

			Oct (GWh)	Nov (GWh)	Dec (GWh)	Jan (GWh)	Feb (GWh)	Mar (GWh)	Apr (GWh)	May (GWh)	Jun (GWh)	Jul (GWh)	Aug (GWh)	Sep (GWh)
Average All Years	NAA	Energy Use	696	635	683	301	334	424	453	593	666	846	833	841
		Generation	312	268	278	198	235	284	306	396	407	537	433	419
		Net Generation	-384	-366	-405	-102	-99	-140	-146	-197	-260	-309	-400	-422
	Alt 3	Energy Use	796	839	871	588	620	744	656	793	818	946	951	932
		Generation	335	320	338	275	321	396	338	450	501	557	456	371
		Net Generation	-461	-520	-534	-313	-299	-348	-318	-343	-317	-388	-495	-560
	Change from NAA (percent change)[2]	Energy Use	100	205	188	288	286	321	204	200	152	100	118	90
		Generation	23	51	60	77	86	113	31	54	95	20	24	-48
		Net Generation	-77 (20%)	-154 (42%)	-128 (32%)	-211 (207%)	-200 (202%)	-208 (148%)	-172 (118%)	-146 (74%)	-57 (22%)	-80 (26%)	-95 (24%)	-139 (33%)
Dry and Critically Dry Years[1]	NAA	Energy Use	433	446	474	179	231	159	211	380	489	604	512	567
		Generation	180	166	193	124	162	73	146	247	344	383	249	221
		Net Generation	-253	-280	-280	-56	-68	-86	-65	-133	-145	-222	-264	-346
	Alt 3	Energy Use	445	574	683	365	447	355	332	484	612	734	755	721
		Generation	193	206	239	148	211	123	172	289	420	416	343	276
		Net Generation	-251	-369	-444	-217	-236	-232	-160	-194	-192	-317	-412	-445
	Change from NAA (percent change)[2]	Energy Use	11	128	210	185	217	196	122	104	124	129	242	154
		Generation	13	40	46	24	49	50	26	43	76	34	94	55
		Net Generation	2 (-1%)	-88 (32%)	-163 (58%)	-161 (289%)	-167 (245%)	-146 (169%)	-96 (147%)	-61 (46%)	-48 (33%)	-96 (43%)	-148 (56%)	-99 (29%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).

[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 3 value. Percent change is the change divided by the No Action Alternative value.

GWh = Gigawatt-hours; Alt 3 = Alternative 3; NAA = No Action Alternative

Under Alternative 3, annual SWP energy generation would be higher for both long-term average and in dry and critically dry years, but the energy required by the SWP to move the water would also be higher for both long-term average and in dry and critically dry years, relative to the No Action Alternative. The trend is also maintained at a monthly level; the SWP would expect increased generation under Alternative 3 compared to the No Action Alternative in all months for both the average of all years and for the average of dry and critically dry years, but larger increases in energy usage, resulting in reductions in net generation for all months except October of dry and critically dry years. Alternative sources of energy would be needed in response to the decreased net generation in most months.

U.2.5.2 *Program-Level Effects*

Construction-related actions that are analyzed at a program level would not affect power or energy resources.

U.2.6 Alternative 4

Alternative 4 is compared to the No Action Alternative to evaluate changes in both CVP and SWP net generation.

U.2.6.1 *Project-Level Effects*

Potential changes in Central Valley Project net generation

Changes in CVP operations under Alternative 4 compared to the No Action Alternative would result in an decrease of CVP water deliveries to areas located south of the Delta; therefore, annual energy use would result in changes in CVP energy resources, as summarized in Table U.2-12, *Simulated Annual Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 4 Compared to the No Action Alternative*. The CVP annual net generation over the long-term conditions would be slightly higher by 1%, and there would be a 8% increase in the dry and critically dry year net generation under Alternative 4 compared to the No Action Alternative.

Table U.2-12. Simulated Annual Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 4 Compared to the No Action Alternative

Water Year		Alternative 4 (GWh)	No Action Alternative (NAA) (GWh)	Changes between Alternative 4 and NAA (percent change)[2] (GWh)
Long-Term Average	Energy Use	1,117	1,207	-90 (-7%)
	Generation	4,489	4,533	-45 (-1%)
	Net Generation	3,372	3,326	46 (1%)
Dry and Critically Dry Water Years[1]	Energy Use	848	974	-126 (-13%)
	Generation	3,453	3,377	76 (2%)
	Net Generation	2,605	2,403	202 (8%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 4 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; NAA = No Action Alternative

Table U.2-13, *Simulated Monthly Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 4 Compared to the No Action Alternative*, shows the breakdown of the monthly energy use, generation, and net generation, by long-term average and for dry and critically dry years, for the CVP facilities. The model output shows that there is an average decrease in net generation under Alternative 4 compared to the No Action Alternative in September, October, and November for the average of all years, and a decrease in January for dry and critically dry years. The decreases in net generation tend to be a result of decreases in generation in those months.

Table U.2-13. Simulated Monthly Central Valley Project Energy Generation, Energy Use, and Net Generation under Alternative 4 Compared to the No Action Alternative

			Oct (GWh)	Nov (GWh)	Dec (GWh)	Jan (GWh)	Feb (GWh)	Mar (GWh)	Apr (GWh)	May (GWh)	Jun (GWh)	Jul (GWh)	Aug (GWh)	Sep (GWh)
Average All Years	NAA	Energy Use	82	112	127	132	115	109	44	52	93	125	121	96
		Generation	287	266	258	313	316	329	308	474	489	622	476	396
		Net Generation	205	154	131	181	201	220	264	422	397	498	355	299
	Alt 4	Energy Use	94	98	119	134	115	49	46	51	91	111	111	96
		Generation	280	212	280	327	327	353	323	474	494	629	479	310
		Net Generation	186	114	161	193	212	304	276	423	403	518	368	214
	Change from NAA (percent change)[2]	Energy Use	12	-14	-8	2	0	-60	2	-1	-1	-13	-10	-1
		Generation	-6	-54	21	14	11	24	14	0	5	7	4	-85
		Net Generation	-19 (-9%)	-40 (-26%)	29 (22%)	12 (7%)	11 (5%)	84 (38%)	12 (5%)	1 (%)	6 (2%)	20 (4%)	14 (4%)	-85 (-28%)
Dry and Critically Dry Years[1]	NAA	Energy Use	70	80	106	122	105	85	35	40	57	103	92	79
		Generation	198	155	213	248	270	168	216	363	429	517	383	217
		Net Generation	128	75	107	126	165	83	180	323	372	414	291	138
	Alt 4	Energy Use	67	76	102	130	98	30	25	30	59	80	77	73
		Generation	206	160	221	246	273	185	227	374	433	514	388	225
		Net Generation	139	84	119	116	174	155	202	344	374	434	311	151
	Change from NAA (percent change)[2]	Energy Use	-3	-4	-5	8	-7	-55	-10	-10	2	-23	-14	-6
		Generation	8	5	7	-2	3	18	12	11	4	-3	6	8
		Net Generation	11 (8%)	9 (11%)	12 (11%)	-10 (-8%)	10 (6%)	72 (87%)	22 (12%)	21 (7%)	3 (1%)	20 (5%)	20 (7%)	14 (10%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 4 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; Alt 4 = Alternative 4; NAA = No Action Alternative

Under Alternative 4, annual CVP energy generation would be lower for long-term average and higher in dry and critically dry years, but the energy required by the CVP to move the water would also be lower for both long-term average and in dry and critically dry years, relative to the No Action Alternative, resulting in increased net generation for both long-term average and dry and critically dry years. At a monthly level, the CVP would similarly expect decreased generation for long-term average under Alternative 4 compared to the No Action Alternative in most months, but also small decreases in energy usage. Decreases in monthly net generation would occasionally be relatively small, alternative sources of energy would be needed in response to the decreased net generation in a few months.

Potential changes in State Water Project net generation

Changes in SWP operations under Alternative 4 compared to the No Action Alternative would result in a decrease in SWP water deliveries to areas south of the Delta and also lower average annual generation, resulting in changes to SWP power and energy resources, as summarized in Table U.2-14, *Simulated Annual State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 4 Compared to the No Action Alternative*. The decreases to SWP net generation would be reduced under

Alternative 4, relative to the No Action Alternative; long-term average net generation would be 7% higher, and dry and critically dry year net generation would be 16% higher.

Table U.2-14. Simulated Annual State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 4 Compared to the No Action Alternative

Water Year		Alternative 4 (GWh)	No Action Alternative (NAA) (GWh)	Changes between Alternative 4 and NAA (percent change)[2] (GWh)
Long-Term Average	Energy Use	6,972	7,304	-332 (-5%)
	Generation	3,971	4,074	-103 (-3%)
	Net Generation	-3,001	-3,230	229 (-7%)
Dry and Critically Dry Water Years[1]	Energy Use	4,197	4,685	-488 (-10%)
	Generation	2,344	2,489	-145 (-6%)
	Net Generation	-1,853	-2,197	343 (-16%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 4 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; NAA = No Action Alternative

Table U.2-15, *Simulated Monthly State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 4 Compared to the No Action Alternative*, shows the monthly energy use, generation, and resulting net generation for SWP facilities for No Action Alternative and Alternative 4, both as long-term average of all years, and as an average for dry and critically dry years. Simulated average annual SWP net generation would be decreased in October, November, January, February, and September months, and in January and February for dry and critically dry years. For long-term average of all years, decreases in net generation is a result of decreased generation in September, October and November, and increased energy usage in January and February; in dry and critical the average monthly generation for January and February would be increased, but the increase in energy use in those months would exceed the increase in generation.

Table U.2-15. Simulated Monthly State Water Project Energy Generation, Energy Use, and Net Generation under Alternative 4 Compared to the No Action Alternative

			Oct (GWh)	Nov (GWh)	Dec (GWh)	Jan (GWh)	Feb (GWh)	Mar (GWh)	Apr (GWh)	May (GWh)	Jun (GWh)	Jul (GWh)	Aug (GWh)	Sep (GWh)
Average All Years	NAA	Energy Use	696	635	683	301	334	424	453	593	666	846	833	841
		Generation	312	268	278	198	235	284	306	396	407	537	433	419
		Net Generation	-384	-366	-405	-102	-99	-140	-146	-197	-260	-309	-400	-422
	Alt 3	Energy Use	673	625	615	348	401	349	399	546	634	791	811	781
		Generation	284	255	272	221	265	304	332	399	399	508	418	314
		Net Generation	-389	-371	-343	-127	-137	-44	-66	-147	-235	-283	-392	-466
	Change from NAA (percent change)[2]	Energy Use	-23	-9	-68	47	67	-75	-54	-47	-33	-55	-22	-60
		Generation	-29	-14	-5	22	30	21	26	3	-8	-29	-14	-105
		Net Generation	-5 (1%)	-5 (1%)	63 (-16%)	-25 (25%)	-38 (38%)	96 (-68%)	80 (-55%)	50 (-25%)	25 (-9%)	26 (-8%)	8 (-2%)	-45 (11%)
Dry and Critically Dry Years[1]	NAA	Energy Use	433	446	474	179	231	159	211	380	489	604	512	567
		Generation	180	166	193	124	162	73	146	247	344	383	249	221
		Net Generation	-253	-280	-280	-56	-68	-86	-65	-133	-145	-222	-264	-346
	Alt 3	Energy Use	371	359	425	241	304	105	126	331	448	517	500	471
		Generation	159	144	174	135	182	79	124	237	332	341	249	187
		Net Generation	-212	-215	-251	-106	-122	-25	-2	-94	-116	-176	-251	-283
	Change from NAA (percent change)[2]	Energy Use	-62	-87	-49	62	73	-55	-85	-49	-41	-87	-12	-96
		Generation	-21	-22	-19	12	19	6	-22	-10	-12	-42	0	-34
		Net Generation	41 (-16%)	65 (-23%)	29 (-10%)	-50 (90%)	-54 (79%)	61 (-71%)	63 (-97%)	39 (-29%)	29 (-20%)	45 (-20%)	13 (-5%)	62 (-18%)

[1] Dry and critically dry years are defined by Sacramento Valley Index (March–February).
[2] Change from No Action Alternative was computed by subtracting the No Action Alternative value from the Alternative 4 value. Percent change is the change divided by the No Action Alternative value.
GWh = Gigawatt-hours; Alt 4 = Alternative 4; NAA = No Action Alternative

Under Alternative 4, annual SWP energy generation would be lower for both long-term average and in dry and critically dry years, but the energy required by the SWP to move the water would also be lower for both long-term average and in dry and critically dry years, relative to the No Action Alternative. The trend is also maintained at a monthly level; the SWP would expect decreased generation under Alternative 4 compared to the No Action Alternative in most months for both the average of all years and for the average of dry and critically dry years, but also decreases in energy usage, resulting in reductions in net generation for several months. Alternative sources of energy would be needed in response to the decreased net generation in certain months.

U.2.6.2 *Program-Level Effects*

Construction-related actions that are analyzed at a program level would not affect power or energy resources.

U.2.7 Mitigation Measures

Mitigation measures are presented in this section to avoid, minimize, rectify, reduce, eliminate, or compensate for adverse environmental effects of Alternatives 1 through 3 compared to the No Action Alternative.

Changes under Alternatives 1 through 4 compared to the No Action Alternative would result in decreased net energy generation, and increased potential energy use by CVP and SWP water users for alternate water supplies. Therefore, there could be adverse impacts to energy resources compared to the No Action Alternative, and mitigation measures could be applicable. There are several opportunities to reduce the effect of the action alternatives on net generation. If generating plants' efficiencies were improved, additional generation could be made at each of the plants. Similarly, improvements to the CVP and SWP pumping plants' efficiencies would reduce the energy needed to move water throughout the state. However, as the CVP and SWP plants' equipment is replaced through normal operations and maintenance, improvements in performance and efficiency are a primary consideration. The capital expense associated with making performance upgrades outside of normal operations and maintenance would make the upgrades infeasible.

There may be some opportunities for the CVP and SWP to increase generation through operational modifications, such as reducing the bypass of powerplants for fall temperature management. However, these modifications would not be of sufficient magnitude to address all of the potential effects on net generation associated with Alternatives 1 through 3, as indicated by the modeling. Changes in timing of the CVP generation, whether weekly, daily, or hourly, were not modeled and are important, and may require analysis.

Unlike the SWP, which requires significantly more generation than the SWP generates, CVP generation is sold to CVP preference power customers only after project use needs are met (approximately 25%). As CVP use needs increase from the No Action Alternative, CVP preference power customers receive less generation at a higher cost. CVP preference power customers incur additional costs from (1) the cost of replacement generation, and (2) if replacement generation has a difference emission factor, an emission charge.

Additionally, CVP preference power's effective rate also increases not only due to less generation but also because Reclamation requires that the CVPIA power restoration fund charges be paid by preference power customers and not project use power. It will be important to recognize and monitor the change in project use consumption as a share of the CVP resource when allocating CVP capital and annual costs.

U.2.8 Summary of Impacts

The results of the environmental consequences of implementation of Alternatives 1 through 4 compared to the No Action Alternative are presented in Table U.2-16, *Comparison of Alternatives 1 through 4 to No Action Alternative*.

Table U.2-16. Comparison of Alternatives 1 through 4 to No Action Alternative

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
Potential changes in Central Valley Project net generation (Project-Level)	No Action Alternative	Potential for less energy available for CVP and SWP operation	--
	Alternative 1	3% reduction in annual net generation for the average of all years for CVP facilities and a 2% increase in net generation in dry and critically dry years would occur. At a monthly level, reductions of greater than 5% in average CVP net generation would occur in September (29%), October (10%), November (25%), April (15%), and May (8%). In dry and critically dry years, there would be monthly average reductions greater than 5% in net CVP generation in February (5%), March (9%), and April (5%).	--
	Alternative 2	4% reduction in annual net generation for both the average of all years for CVP facilities and no change in dry and critically dry year average annual generation would occur. At a monthly level, reductions in average CVP net generation greater than 5% would occur in September (27%), October (12%), November (35%), April (15%), and May (6%). In dry and critically dry years, there would be monthly average reductions greater than 5% in November (5%), December (16%), January (15%), February (14%), and March (30%).	--
	Alternative 3	4% reduction in annual net generation for both the average of all years and no change for dry and critically dry years for CVP facilities would occur. At a monthly level, reductions in average CVP net generation greater than 5% would occur in September (27%), October (7%), November (34%), April (14%), and May (7%). In dry and critically dry years, there would be monthly average reductions greater than 5% in November (8%), December (18%), January (18%), February (16%), and March (27%).	--

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
	Alternative 4	1% increase in annual net generation for the average of all years and 8% increase for dry and critically dry years for CVP facilities would occur. At a monthly level, reductions in average CVP net generation greater than 5% would occur in September (28%), October (9%), November (26%), and November (34%) In dry and critically dry years, there would be monthly average reductions greater than 5% in January (8%).	--
Potential changes in State Water Project net generation (Project-Level)	No Action Alternative	Potential for less energy available for CVP and SWP operation	--
	Alternative 1	25% reduction in annual net generation for both the average of all years and 16% reduction annual net generation in dry and critically dry years for SWP facilities would occur. Average monthly SWP monthly net generation would be reduced for the average of all years from 8% in June to 47% in March, and dry and critically dry years from 4% in September to 91% in January.	--
	Alternative 2	53% reduction in annual net generation for the average of all years and 16% reduction in annual net generation for dry and critically dry years for SWP facilities would occur. Average monthly SWP net generation would be reduced by 23% in August to 214% in January for the average of all years, and in dry and critically dry years from 13% in October to 312 in January.	--
	Alternative 3	52% reduction in annual net generation for the average of all years and 58% reduction in net generation for dry and critically dry years for SWP facilities. Average monthly SWP net generation would be reduced by 22% in June to 207% in January for the average of all years, and in all months but October for dry and critically dry years, ranging from 29% in September to 289% in January.	--

Impact	Alternative	Magnitude and Direction of Impacts	Potential Mitigation Measures
	Alternative 4	7% reduction in annual net generation for the average of all years and 16% reduction annual net generation in dry and critically dry years for SWP facilities would occur. Average monthly SWP monthly net generation would be reduced by more than 5% for the average of all years in January (25%), February (38%), and September (11%); and in dry and critically dry years in January (90%) and February (79%).	--

Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of less than 5% between action alternatives and the No Action Alternative are considered to be "similar."

U.2.9 Cumulative Effects Analysis

As described in Appendix Y, *Cumulative Methodology*, the cumulative effects analysis considers projects, programs, and policies that are not speculative, and are based upon known or reasonably foreseeable long-range plans, regulations, operating agreements, or other information that establishes them as reasonably foreseeable. Not all cumulative projects in Appendix Y would result in effects related to power and energy that are related to the types of impacts from the action alternatives. The projects that have the potential to result in cumulative impacts with the action alternatives include:

- Bay-Delta Water Quality Control Plan Update
- FERC Relicensing Projects
- Bay Delta Conservation Plan (including the California WaterFix alternative)
- Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations
- El Dorado Water and Power Authority Supplemental Water Rights Project
- Sacramento River Water Reliability Project
- Semitropic Water Storage District Delta Wetlands
- North Bay Aqueduct Alternative Intake
- Irrigated Lands Regulatory Program
- San Luis Reservoir Low Point Improvement Project
- Westlands Water District v. United States Settlement
- Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)

The cumulative effects of these projects would be the same under all action alternatives.

Most of the future reasonably foreseeable actions are anticipated to improve water supplies in California to reduce impacts due to climate change, sea-level rise, increased water allocated to improve habitat conditions, and future growth. If CVP and SWP water supply reliability increases, energy use for conveyance of CVP and SWP water supplies also would increase.

Some of the future reasonably foreseeable actions are anticipated to potentially reduce CVP and SWP water supply reliability (e.g., Water Quality Control Plan Update and FERC Relicensing Projects).

Future water supply projects are anticipated to both improve water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans. It is anticipated that some of these projects could increase energy use, such as implementation of desalination projects.

However, other projects, such as water recycling, would not substantially increase energy use because most of the energy use was previously required for wastewater treatment. It is anticipated that energy required for water treatment of alternative water supplies would be similar to treatment for CVP and SWP water supplies. Increased use of groundwater pumps would increase energy use; however, this energy use would be similar or less than the energy used for CVP and SWP water conveyance.

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