Sustainability Roadmap 2018-2019: Energy

Progress Report and Plan Update
on Meeting the Governor's Sustainability Goals
for California State Agencies

Department of Water Resources

Edmund G. Brown Jr., Governor

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Department of Water Resources Sustainability Roadmap 2016-2017: Energy

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Acronyms

ADR	Automated Demand Response
ARRA	America Recovery and Reinvestment Act
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
CA	California
CALGREEN	California Green Building Code (Title 24, Part 11)
CEC	California Energy Commission
CRAC	Computer Room Air Conditioner
CRAH	Computer Room Air Handler
DGS	Department of General Services
EMS	Energy Management System (a.k.a., EMCS)
EMCS	Energy Management Control System (a.k.a., EMS)
EO	Executive Order
EPP	Environmentally Preferable Purchasing
EUI	Energy Use Intensity (source kBTU/sq. ft.)
EVSE	Electric Vehicle Supply Equipment (charging equipment)
GHGe	Greenhouse Gas Emissions
IEQ	Indoor Environmental Quality
JCI	Johnson Controls Incorporated
kBTU	Thousand British Thermal Units (unit of energy)
LEED	Leadership in Energy and Environmental Design
MM	Management Memo
OBF	On-Bill Financing
PPA	Power Purchase Agreement
PUE	Power Usage Effectiveness
SAM	State Administrative Manual
SCM	State Contracting Manual
SWP	State Water Project
ZEV	Zero Emission Vehicle
ZNE	Zero Net Energy

EXECUTIVE SUMMARY

In 1956, the Legislature passed a bill creating the California Department of Water Resources (DWR) to plan, design, construct, and oversee the building of the State Water Project (SWP), the nation's largest state-built water development and conveyance system. Today, DWR protects, conserves, develops, and manages much of California's water supply including the SWP. SWP water irrigates about 750,000 acres of farmland, mainly in the San Joaquin Valley. Approximately 25 million of California's estimated 37 million residents benefit from SWP water. The SWP facilities include 30 dams (29 of which impound water), 20 reservoirs, 29 pumping and generating plants, and approximately 700 miles of aqueducts.

The SWP is the largest single user of electrical energy in the State, accounting for 2 percent to 3 percent of all the electricity consumed in California and using a net average of 5,000 GWh per year (Wikerson, Wolff, Kost, & Shwom, 2006). The energy needed to operate the SWP comes from a combination of DWR owned hydroelectric and natural gas generating plants and power purchased from local power utilities. These sources produce enough electricity in a normal year to supply about 66 percent (3,300 GWh) of the SWP's necessary operating power.

DWR's major responsibilities include overseeing the statewide process of developing and updating the California Water Plan (Bulletin160 series); protecting and restoring the Sacramento-San Joaquin Delta; regulating dams, providing flood protection, assisting in emergency management; educating the public about the importance of water and efficient management; and providing technical assistance to service local water needs.

DWR also develops strategic goals, and near-term and long-term action plans to conserve, manage, develop, and sustain California's watersheds, water resources, and management systems. Further, DWR works to prevent and respond to floods, droughts, and catastrophic events that would threaten public safety and property, water resources and their management systems and the environment.

DWR owns and operates hundreds of buildings but, the Executive Orders (EOs) affect only 70, which are at over 25 separate facility locations for a total of 361,355 square feet of building space. In 2016, DWR consumed over 4 million kWh of retail energy at an annual cost of $936,356. Just three buildings represent 30 percent of DWR's total retail energy use. These buildings host large operations and maintenance yards for DWR field divisions and are energy intensive by their nature. Even so, recent energy efficiency projects at two of these locations have reduced their energy use by over 20 percent.

Overall, eleven buildings have achieved the 20 percent energy reduction goal, which accounts for 218,110 square feet of building space and 36 percent of DWR's total energy use. There are eleven buildings accounting for the remaining 64 percent of building space consuming retail energy.

DWR has been working on energy efficiency efforts since 2010 when the Department of General Services (DGS) used federal funding through the American Recovery and Reinvestment Act

(ARRA), to retrofit lighting and HVAC systems. The Sacramento Maintenance Yard is the second highest consumer of retail energy within the SWP and became one of four selected DWR facilities to participate in the ARRA program. A third-party contractor installed occupancy sensors, replaced interior T-12 fixtures with T-8's, and exterior fixtures with low wattage induction lights. Additionally, HVAC and cooling towers supplying the main office and chemical laboratory were also upgraded. This upgrade accounted for 7 percent of DWR's building area with an annual energy saving of 1,621,168 kBTU and $46,300.00 savings in annual energy cost. The other three ARRA projects were DWR visitor centers: Romero Overlook, Lake Oroville Visitor Center and Vista Del Lago Visitor Center. Together, the four projects represented 11 percent of DWR's building area and had an estimated annual savings of 2,314,157 kBTUs and over $78,000 annual savings in energy costs.

Since the issuance of Executive Order (EO) B 18-12, DWR has continued its energy efficiency efforts. Energy audits have been performed on all 26 DWR owned buildings subject to the EO. Energy audits fall into two categories, American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) level 1 and level 2. Level 1 is a physical walk through the site, taking notes on individual fixtures, while level 2 is a more detailed analysis using information provided by power utilities to access usage patterns over time and used to provide cost analysis projects. 83 percent of the energy audit surveys were level 1 and 72 percent were level two. These audits led to six additional energy efficiency projects completed with the collaboration of Pacific Gas and Electric utility company. Together, these six projects represent 33 percent of DWR's building area with an additional annual energy savings of 1,595,913 kBTUs and $89,600 annual savings in energy cost.

Although zero net energy buildings remain a challenge, DWR has several renewable energy projects planned that by 2025, over 150,000 of existing building space will met zero net energy targets.

DWR remains committed to achieving its energy efficiency goals and will continue to move forward in reducing its reliance on fossil fuels.

Karla Nemeth
Executive Director

SUSTAINABILITY GOALS

The Governor has directed California State Agencies to demonstrate sustainable operations and to lead the way by implementing sustainability policies set by the state. Sustainability includes the following general initiatives:

- Greenhouse Gas Emissions Reductions
- Building Energy Efficiency and Conservation
- Indoor Environmental Quality (IEQ)
- Water Efficiency and Conservation
- Monitoring Based Building Commissioning (MBCx)
- Environmentally Preferable Purchasing (EPP)
- Financing for Sustainability
- Zero Emission Vehicle (ZEV) Fleet Purchases
- Electric Vehicle Charging Infrastructure
- Monitoring and Executive Oversight

The Governor has issued numerous executive orders directing sustainable state operations. The orders relevant to energy are:

Executive Order B-18-12

EO B-18-12 and the companion *Green Building Action Plan* require state agencies to reduce the environmental impacts of state operations by reducing greenhouse gas emissions, managing energy and water use, improving indoor air quality, generating onsite renewable energy when feasible, implementing environmentally preferable purchasing, and developing the infrastructure for electric vehicle charging stations at state facilities. The Green Building Action Plan also established two oversight groups; the staffs level Sustainability Working Group and the executive level Sustainability Task Force, to ensure these measures are met.

Executive Order B-30-15

EO B-30-15 declared climate change to be a threat to the well-being, public health, natural resources, economy, and environment of California. It established a new interim statewide greenhouse gas emission reduction target of 40 percent below 1990 levels by 2030, and reaffirms California's intent to reduce greenhouse gas emissions by 80 percent below 1990 levels by 2050. To support these goals, this order requires numerous state agencies to develop plans and programs to reduce emissions.

State Administrative Manual & Management Memos

The following sections of the State Administrative Manual (SAM), and associated Management Memos (MM), currently impose sustainability requirements on DWR under the Governor's executive authority:

- SAM Chapter 1800: Sustainability
- MM 15-06: State Buildings and Grounds Maintenance and Operation
- MM 15-04: Energy Use Reduction for New, Existing, and Leased Buildings
- MM 15-03: Minimum Fuel Economy Standards Policy
- MM 14-05: Indoor Environmental Quality: New, Renovated, And Existing Buildings
- MM 14-07: Standard Operating Procedures for Energy Management in State Buildings
- MM 14-09: Energy Efficiency in Data Centers and Server Rooms

ENERGY REPORT

In response to Executive Order B-18-12, DWR planned and implemented sustainability efforts at its facilities and in 2015 submitted to the Governor's Office a roadmap to achieve EO B-18-12's efficiency targets. In 2017, the Governor directed State agencies to further demonstrate sustainable operations by creating roadmaps that focus on current accomplishments, ongoing efforts, and outstanding challenges into 2020 for the following areas: climate adaptation, zero emission vehicles and infrastructure, energy, water, and green operations.

This Energy Report demonstrates to the Governor and the public the progress DWR has made toward meeting the Governor's sustainability goals related to energy. This report also identifies successful accomplishments, ongoing efforts, and outstanding challenges.

DWR Mission and Built Infrastructure

The Department of Water Resources (DWR) is responsible for managing and protecting California's water resources. DWR works with other agencies to benefit the State's people and to protect, restore, and enhance the natural and human environments. However, DWR has a significant role to play in the delivery of water and the production of hydropower as well as environmental restoration, protection and conservation duties. Additionally, DWR has construction authority to build water delivery infrastructure. This unique blend of duties gives DWR a very diverse set of mission objectives.

To accomplish its mission, DWR requires an extraordinary amount and variety of infrastructure. The SWP alone includes 34 storage facilities, reservoirs and lakes; 20 pumping plants; 4 pumping-generating plants; 5 hydroelectric power plants; and about 700 miles of open canals and pipelines. As an example of the type of facilities DWR owns and operates, Figure 1 shows the Devil Canyon Pumping Plant located at the southern base of the San Bernardino Mountains. Known as a power recovery facility, it generates electricity from water traveling through the plant from Silverwood Lake.

Figure 1: Devil Canyon Power Plant

(Low, 2014)

Significant Challenges

Building Age and Diversity

DWR buildings range in age over a period of more than 90 years, with the earliest building constructed in 1922, while the latest building was completed in 2012. (*This does not include the continuing reconstruction of the Thermalito plant, destroyed by fire in 2012.*) The SWP's aging infrastructure creates challenging business decisions to replace or refurbish and repurpose existing structures. Scarce state resources also require DWR to heavily rely on external funding to implement sustainability efforts.

Another significant challenge is the number and diversity of facilities DWR is responsible for planning, constructing, operating, and maintaining. The retail portfolio of 70 buildings does not represent the bulk of DWR facilities, nor does it represent the most energy intensive facilities, all of which are ***nonretail*** energy facilities. Due to this imbalance between retail and nonretail energy use, DWR must prioritize its limited resources toward achieving energy efficiency in the

nonretail facilities. However, although the EO covered facilities are a small component of DWR's total infrastructure and energy use; DWR is committed to achieving the EOs' water and energy efficiency goals.

Lack of a 5 Year Capital Improvement Plan

A less obvious challenge is that DWR is not obligated to have a 5-year capital improvement plan like most State agencies. Rather, DWR has legislative building authority and therefore, does not prepare or submit a 5-year capital plan. This means that there is no central location where plans for new building construction, upgrades or repairs are recorded, tracked and maintained. Tracking new construction is very difficult and new buildings may just appear during building inventory updates.

Water and Energy Efficiency (WEE) Branch

To help focus more specifically on building energy and water efficiency covered by the EO, DWR created a Water and Energy Efficiency (WEE) Branch within the SWP Power and Risk Office, whose responsibility is to collect and maintain the list of EO covered facilities, gather and maintain energy and water use data, plan, evaluate and prioritize sustainability projects, and find project funding.

WEE was fully staffed in July 2013 and has achieved a variety of notable accomplishments including updating building inventories, locating water and electricity meters, performing energy audits, energy benchmarking and implementing energy efficiency projects.

WEE routinely analyzes the energy consumption for 26 DWR owned facilities and 4 leased facilities. Table 1 summarizes the total retail energy consumption in 2016. The combined electricity and gas consumption is over 6.1 GWh with a total energy cost of $936,356.

Table 1: Total Purchased Energy 2016

Purchased Utility	**Quantity**	**Cost ($)**
Electricity	4,050,556 kWh	$857,790
Natural Gas	73,592 Therms	$ 78,566
Propane	0 Gallons	$ 0
TOTAL COST	---	**$ 936,356.00**

Breaking down facilities with the largest energy consumptions allowed WEE to prioritize project needs. Table 2 shows the top 3 owned facilities and top 3 leased facilities that make the biggest impact on grid based energy purchases.

Basic Energy Units and Terms Explained

A *British thermal unit* (Btu) is a measure of the heat content of fuels or energy sources. It is the quantity of heat required to raise the temperature of one pound of liquid water by 1 degree Fahrenheit at the temperature that water has its greatest density (approximately 39 degrees

Fahrenheit). One Btu is approximately equal to the energy released by burning a match. This is a very small amount, so typically, energy usage is expressed in thousands (kilo) of BTU or kBTU.

Figure 2: One Burning Match is Equivalent to 1 BTU

(WolfBlur, 2009)

Table 1B: Common Energy Conversion Factors

Electricity	1 kilowatt-hour = 3,412 Btu ≈ 3.4 kBTU
Natural Gas	1 cubic foot = 1,037 Btu ≈ 1 kBTU 1 therm = 100,000 Btu = 100 kBTU

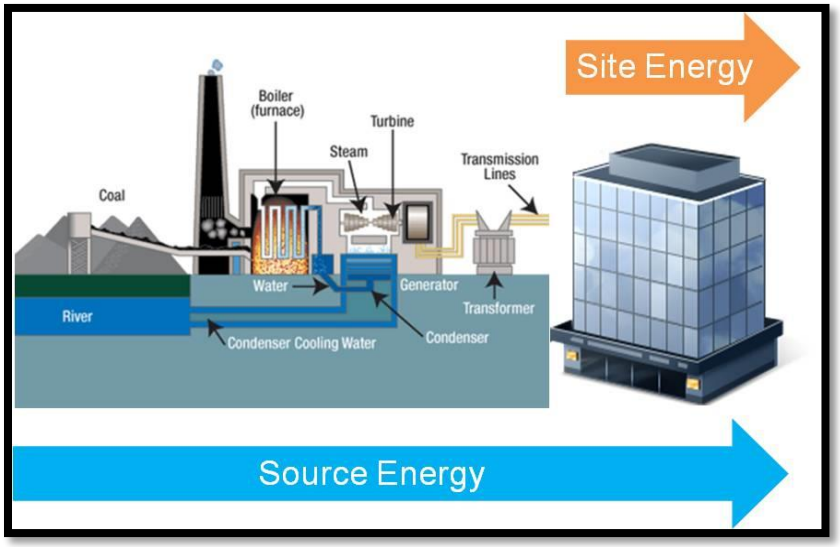
(EnergyStar.gov)

Source Energy and Site Energy

Key energy concepts include the difference between source energy and site energy. Site energy is the amount of heat and electricity consumed by a building. Source energy is the total amount of raw fuel required to operate the building. Site energy may be delivered to a building in one of two forms: primary or secondary energy. Primary energy is the raw fuel that is burned to create heat and electricity, such as natural gas or fuel oil used in onsite generation. Secondary energy is the energy product (heat or electricity) created from a raw fuel, such as electricity purchased from the grid or heat received from a district steam system. A unit of primary and a unit of secondary energy consumed at the site are not directly comparable because one represents a raw fuel while the other represents a converted fuel.

When primary energy is consumed on site, the conversion to source energy must account for losses that are incurred in the storage, transport, and delivery of fuel to the building. When secondary energy is consumed on site, the conversion must account for losses incurred in the production, transmission, and delivery to the site. The factors used to restate primary and secondary energy in terms of the total equivalent source energy units are called the source-site ratios.

Figure 3: Illustration of Source and Site Energy

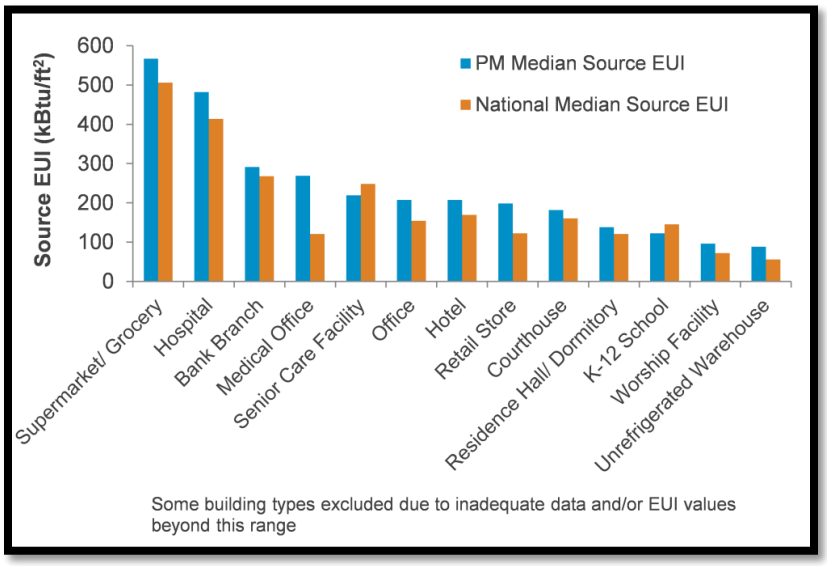


(EnergyStar.gov)

Building EUI

Energy use intensity (EUI) expresses a building's energy use as a function of its size or other characteristics. It's calculated by dividing the total energy consumed by the building in one year (measured in kBTU or GJ) by the total gross floor area of the building. Generally, a low EUI signifies good energy performance. However, certain property types will always use more energy than others. For example, an elementary school uses relatively little energy compared to a hospital. Figure 2 below shows some typical EUI values based on research EPA conducted on more than 100,000 buildings.

Figure 4: Typical EUI Values by Building Type



(EnergyStar.gov)

DWR Energy Trends

Table 2: Properties with Largest Energy Consumption

Building Name	Floor Area (ft^2)	Site Energy (kBTU)	Source EUI ($kBTU/ft^2$-yr)
Oroville Operations and Maintenance Center	51,413	4,241,948	83
Sacramento Maintenance Yard	32,100	2,908,580	91
Southern California Operations and Maintenance Center	48,395	1,110,197	23
Sacramento Training Center - Leased Space	31,684	146,507	5
Sacramento Warehouse - Leased Space	46,500	93,362	2
Lancaster Warehouse –Leased Space	16,290	36,055	2
Total for Buildings in This Table	226,382 ft2	8,536,649	---
Total for All DWR Buildings	455,883 ft2	21,179,742	---
Percent of Totals	50 %	40 %	---

DWR owned properties with the largest energy consumption are DWR's operations and maintenance yards, which are energy intensive by their nature. These facilities are mixture of shops and warehouse spaces that make temperature control difficult since bay doors need to be open for routine daily operations. Energy intensive activities also take place in these buildings including such items as hydraulic lifts, industrial lighting and other industrial power uses.

Zero Net Energy (ZNE)

The Governor has set forth the following milestones for state ZNE buildings:

2020 – 50 percent of new construction & major renovations will be ZNE

2025 – 100 percent of new construction & major renovations will be ZNE

2025 – 50 percent of total existing building area will be ZNE

(*note: At the writing of this report, DGS MM 17-04 was released, stating that "All new state buildings, major renovations, and build-to-suit leases beginning design after* ***October 23, 2017****, and as many as possible already begun, shall be designed and built following cost-effective energy efficiency strategies for achieving ZNE")*

ZNE buildings are a challenge for DWR. As stated previously, DWR's overall number of facilities is far greater than those covered by the EOs. Additionally, of those covered, most are of an age to make zero net energy upgrades very difficult and very expensive. To address this challenge,

DWR reviewed all retail energy buildings for possible solar energy installation. Preliminary solar installation project scoping is now completed to identify all possible locations for solar installation. DWR's business cases and implementation plans for these projects assume any proposed project size will be limited to 80 percent of a facility's annual generation. This will prevent unnecessary energy over-generation and potential excess energy to the power grid. These initial scopings show that ZNE is possible at most of DWR's operation and maintenance yards and visitor centers. The next phase is the review of initial project plans with facility managers for final project approval.

Regarding new construction, DWR has several renewable energy projects planned that are scheduled for completion by 2025. Instead of constructing new facilities, these projects will affect existing building space to meet ZNE goals. Table 3 shows the DWR status for ZNE buildings.

Table 3: Zero Net Energy Buildings

Status of ZNE Buildings	Number of Buildings	Floor Area (ft2)
Under Construction or Completed	0	0
Building in Design	0	0
Existing Building Projects Proposed for prior 2025 (but not yet in design)	7	217,208
Totals for ZNE Buildings	7	217,208
Totals for All D Buildings	26	361,355
percent ZNE	32 percent	60 percent

New Construction Exceeds Title 24 by 15 percent

All new state buildings and major renovations beginning design after July 1, 2012, must exceed the current California Code of Regulations (CCR) Title 24, energy requirements by 15percent or more.

- SWP Maintenance Yards are constantly expanding and improving their aging infrastructure. DWR is in the process of acquiring surrounding land for an expansion project at a facility within the Division of Flood Management. The business case and implementation plan request construction of a warehouse and office building for storage of equipment needed for flood maintenance and emergency response. SWP facilities are required to coordinate with DWR's Division of Engineering (DOE) after approval to develop building plans and designs that are compliant with local, state and federal policies.
- The construction of the Thermalito Plant is further in design and construction. DOE spend years in design to ensure the new Plant will be energy efficient and technologically updated.

Table 4: New Construction Exceeding Title 24 by 15 percent

Buildings Exceeding Title 24 by 15 percent	Number of Buildings	Floor Area (ft2)
Completed Since July 2012	1	3,024
Under Design or Construction	2	11,424
Proposed Before 2025	1	8,400

Title 24 affected two facilities that were constructed in late 2012. The policy changed ensured DWR recognized the need to create energy efficiency spaces.

Reduce Grid-Based Energy Purchased by 20 percent by 2018

Executive Order B-18-12 requires state agencies to reduce grid-based energy purchased by 20 percent by 2018, compared with a 2003 baseline. One major component of that goal is to have Energy Management Control Systems (EMCS) in place.

DWR does not have any existing Energy Management Control Systems (EMCS). As previously discussed under the building portfolio section, installing EMCS is not feasible due the age of DWR's buildings and the expense of such systems. The lack of EMCS creates a problem for participation in the Demand Response initiatives as it is difficult to respond to energy reduction requests in a timely manner. However, DWR has done a review of Demand Response initiatives and the results are discussed later in this document in the Demand Response section.

All DWR computers, monitors, copiers and printers are set to utilize their Energy Saver mode during periods of inactivity. It is DWR policy to purchase only Energy Star rated equipment. DWR’s power management system is DhaaniStar.

Management Memo 14-07 “Standard Operating Procedures for Energy Management in State Buildings” and the associated Standard Operating Procedures:

DWR has a challenge in meeting MM14-07. Many of its owned buildings are not office space in the typical sense. Employees may check in the morning and then spend the day in the field or on construction or building sites, performing inspections or monitoring or other tasks that occur out of doors. Frequently, they may go straight home and not return to the office.

However, DWR has performed energy audits on all its locations and has prioritized energy projects. DWR also purchases Energy Star equipment via DWR's purchasing contracts. Lighting sensors in appropriate locations help reduce lighting requirements and occupancy sensors have been installed at DWR visitor’s centers during energy efficiency retrofits in 2010. DWR also installed occupancy sensors in offices, hallways, restrooms, laboratories, and various other spaces in Field Division buildings during energy efficiency upgrades from 2014 - 2016. In addition, DWR's power control software through its data centers assures that computers and printers are put into low energy mode.

Temperature control is maintained by setting HVAC controls to allow for a +2 or -2-degree fluctuation from the building set temperature. DWR has maintenance contracts and/or on-site staff who maintain the HVAC. However, documentation exists for only six buildings and the latest documentation is over three years old. Other energy efficiency projects that help compliance with MM14-07 include:

1. Lighting fixtures and controls have been upgraded to higher efficiency light bulbs (LED lamps) and ballasts at various Field Division facilities. Both indoor and outdoor lighting have been upgraded.
2. Post installation of TLED lighting fixtures, most facilities delamped fixtures where dimmable lighting was not present. When requested by employees, smaller office spaces and hallways with sufficient natural lighting were also delamped.
3. PG&E approved contractors conducted walk-throughs and measured lighting levels of different building spaces. The contractors also provided recommendations to de-lamp areas where lighting was overdesigned. Upon consultation with Field Division management and agreement by individual occupants, DWR approved these energy efficient recommendations. These divisions have also had complete lighting retrofits that changed the following:
    a. exterior flood lights to daylight-sensor, low wattage LED fixtures,
    b. exterior wallpacks to low wattage LED lamps, and
    c. incandescent, T-12 and T-8 compact fluorescent tubes to tubular TLED lighting.
4. Magnetic ballasts have been replaced with LED-compatible electronic ballasts and controls for safety and maximum performance.

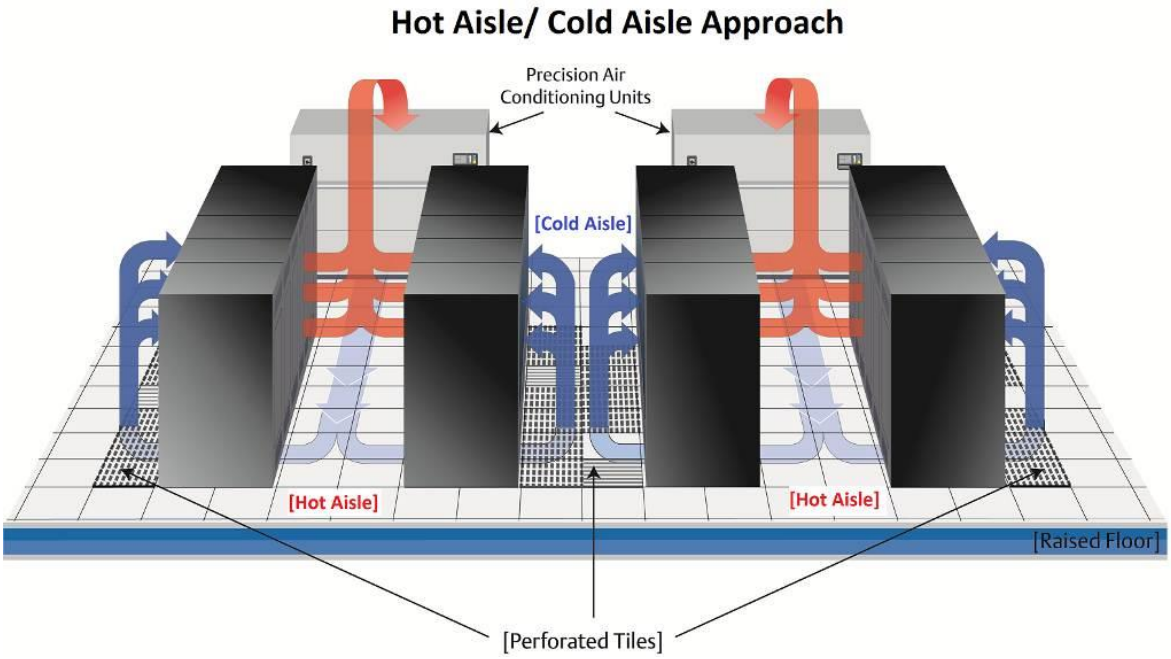
    Facilities within Southern California Edison territory are currently being considered for upgrade, and are expected to be completed in 2018.

Figure 5: DWR 2014 Energy Retrofits

Management Memo 14-09 “Energy Efficiency in Data Centers and Server Rooms”:

Heat management is an energy intensive aspect of data centers using as much as 48 percent of all data room energy (Ries, 2017). Modern data centers use several strategies to manage heat. Some of these strategies include reducing actual physical equipment, using energy efficient equipment and proper room design, with space underneath the floor as well as adequate ceiling clearance and aisle space to manage heat and humidity.

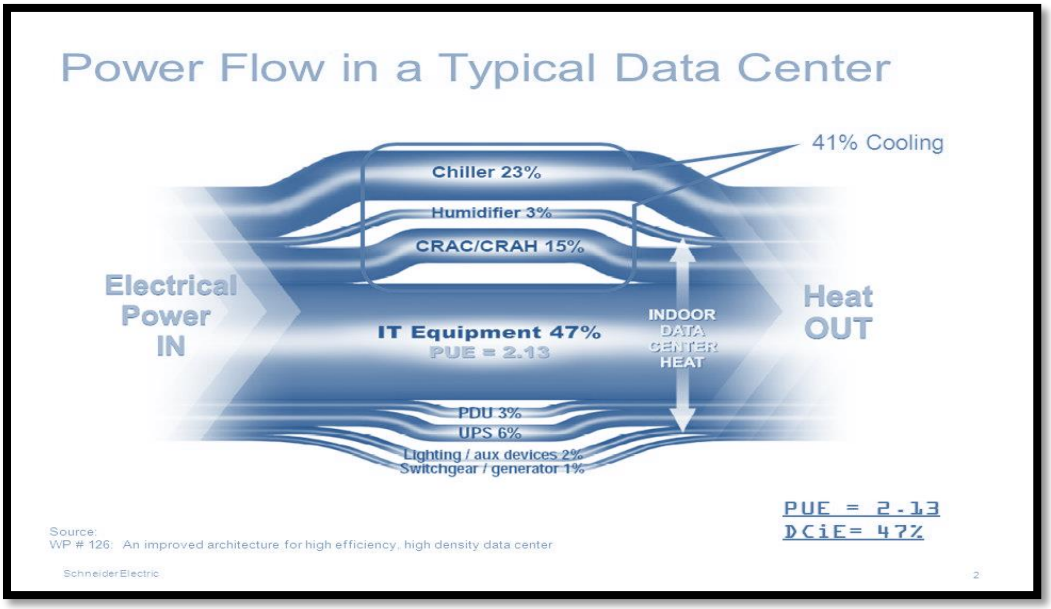
Figure 6: Data Center Design



(Chube, 2011)

Figure seven below shows the power flow typical of data centers/server rooms. With the configuration of modern data centers heat management is essential.

Figure 7: Power Flow in a Typical Data Center



(Austin, 2016)

MM14-09 requires that all state owned and leased data centers and server rooms greater than 200 square feet must be operated within the 2011 ASHREA guidelines for temperature and humidity in addition to all applicable 2013 title 24 Building Energy Standards. All state data centers greater than 1,000 square feet are required to measure and report their power use effectiveness (PUE) to the Department of Technology. The PUE must be 1.5 or lower.

Further, when purchasing network switches and routers, all state agencies must specify the Energy Efficient Ethernet IEEE (Institute of Electrical and Electronics Engineers) 802.3-2012 Section 6 standard to the maximum extent possible. Additionally, all state agencies must consider virtualization options when refreshing equipment or standing up new systems. (*Virtualization is the creation of a virtual rather than actual version of something such as an operating system a server a storage device or network resources.*) Use of the most energy efficient power supplies available should be included in the purchase of new IT equipment.

Per MM 14-09, DWR has listed the DWR/CNRA Data Center at 1416 Ninth Street that services DWR and thirty other Natural Resources Agency organizations with the Government Technology Agency. The Natural Resources Data Center is approximately 6,000 square feet with temperature control maintained between 76 – 84 degrees and operates under the Class A1-A4 guidelines referred to in the above paragraph. DWR network switches purchased and deployed switches meet Energy Efficient standards. DWR/CNRA Data Center is 97 percent virtualized and 3 percent physical.

In 2015, the PUE was 1.6. In 2017, DWR took the following steps to reduce the PUE to 1.46:

- Consolidation of storage racks and devices.

- Replaced and decommissioned an older SCADA Control System backup environment that ran on inefficient energy hardware.
- Replaced two HVAC systems with highly-efficient thermal hybrids management systems.
- Added louvers under the chillers to strategically direct cold air to desired locations.
- Implemented various airflow improvement actions which allowed the– Computer Room Air Conditioner (CRAC) and the Computer Room Air Handler (CRAH) to slow down and use less electricity to operate.
- Decommissioned and removed unused cabling under the floor to improve cold air flow.

Energy Use Efficiency and EUI

Table 4 shows the building comparisons from the baseline year of 2003 to the current year of 2016. Any increases in EUI are shown in red. As discussed in the following section, when the temporary Thermalito retail load is removed from the 2016-year data, the EUI shows a nearly 50 percent DWR-wide reduction. Romero, Lost Hills, Coalinga, and Vista Del Lago EUI reductions are the direct result of significant energy efficiency projects. Those facilities listed in red saw increases in their EUI due to increased workloads, but these facilities have had energy audits, while both Sutter and West Sacramento have had energy efficiency projects as well.

Table 4: Comparison of EUI per Facility 2003/2016

All DWR Facilities	2003 EUI	2016 EUI	2016 EUI w/o Thermalito
Beckwourth Subcenter	5	19	
Sutter Maintenance Yard	21	25	
Water Quality Test Building	28	37	
Water Operations - Pearblossom	23	49	
Coating Facility	64	66	
West Sacramento Storage Yard	205	234	
Thermalito Annex	65	1653	
Lake Oroville Visitors Center	1	2	
Cedar Springs Dam Maintenance Station	27	8	
Monument Hill Boat Launch	19	17	
Tehachapi East Afterbay Laboratory	64	17	
Southern California Operations and Maintenance Center	55	23	

Romero Overlook	72	26	
North Bay Maintenance Center	47	27	
Delta Operations and Maintenance Center	40	28	
Vista Del Lago Visitors Center	50	29	
Lost Hills Operations and Maintenance Subcenter	64	30	
Coalinga Operations and Maintenance Subcenter	82	54	
Vaquero Water Treatment Plant	121	70	
Oroville Operations and Maintenance Center	88	83	
Sacramento Maintenance Yard	95	91	
San Joaquin Operations and Maintenance Center	126	101	
Totals	**60**	**58**	**44**

From 2003 to 2016, DWR reduced its EUI from 60 to 44 (when removing the temporary retail load from the Thermalito repairs). Where energy efficiencies have been achieved, the results are an impressive 36 percent reduction in retail energy use in eleven buildings with a total of 218,110 square feet for a EUI of 44.

Table 5: DWR Wide Energy Trends

Year	Floor Area (ft2)	Total kBTU Consumption	DWR Average EUI
Baseline Year	361,355	21,546,795	60 avg.
2012	361,355	19,061,404	53 avg.
2013	361,355	20,742,647	57 avg.
2014	361,355	19,708,496	55 avg.
2015	361,355	19,849,539	55 avg.
2016	361,355	20,903,800* * Reflects on-going repair work at Thermalito	58 avg.
2016 w/o Thermalito Repair	361,355	15,904,303	44 avg.
2018 Goal			

However, but for an extraordinary event in November 2012, DWR has met the 20 percent reduction DWR-wide. In November 2012, the Thermalito power plant caught fire and the plant was destroyed.

Figure 8: Thermalito Fire, Thanksgiving Day 2012

(Roose & Stewart, 2014)

Previously, this plant provided energy to support its station load to the SWP. When the plant shut down, the plant's station load relied entirely on temporary retail energy service for on-going repair work to recover the plant, which added an average of 90,000 kWh per month to DWR's retail energy use. DWR expects to complete the repair work by the end of 2018, at which time the plant will resume supplying energy to it station load, and retail energy use will return to normal levels. Table 6 summarizes the number of facilities that have reached the 20 percent reduction goal required in EO B-18-12. Since the added energy consumption at Thermalito is temporary, analysis with and without the repair work is considered. When Thermalito's load of nearly 5million kBTUs is subtracted from the 2016 data, DWR's total retail energy use reduction is 26 percent.

Table 6a: Energy Reductions Achieved Including Thermalito Repairs

Purchased Energy Compared to Baseline	Number of Buildings	Floor Area (ft^2)	Current Year Energy Use (kBTU)	Percent of Total Energy
20 % Reduction Achieved	11	218,110	7,422,100	36%
Less than 20% Reduction	11	143,245	13,481,700	64%
Totals	**22**	**361,355**	**20,903,800**	100%
DWR-Wide Reduction	**-3 percent**			

Table 7b: Energy Reductions Achieved Minus Thermalito Temporary Load

Purchased Energy Compared to Baseline	Number of Buildings	Floor Area (ft2)	Current Year Energy Use (kBTU)	Percent of Total Energy
20% Reduction Achieved Minus Thermalito Temporary Load	11	218,110	7,422,100	47%
Less than 20% Reduction Minus Thermalito Temporary Load	11	143,245	8,482,203	53%
Totals	22	361,355	15,904,303	100%
Totals Minus Thermalito Temporary Load	22	361,355	15,904303	100 %
DWR-Wide Reduction Minus Thermalito Temporary Load	**26 %**			

The remaining eleven buildings totaling 143,245 square feet have not achieved the 20 percent reduction per building. Accounting for nearly 66 percent of all building space, these building only consume 15 percent of DWR's total retail use and have been lower on the energy efficiency priority list.

Since 2010, DWR has completed 10 major energy efficiency projects for a one-time cost of $228,081 with an annual savings of $168,394. The costs were financed first by ARRA and by a zero-interest On-Bill Financing (OFB) program through Pacific Gas and Electric (PG&E), with an average payback of three years per project. Through this program, PG&E hired and paid a third-party contractor to upgrade the existing T-8's to TLED lighting and DWR will reimburse PG&E through its monthly utility bill. After the payback period, the dollar savings continue with the added benefit of improved lighting and visibility at the facility. When the parking lot lighting improvement project at the Sacramento Maintenance facility was complete, the staff was amazed at how the visibility and security improved. Additionally, Southern California Edison (SCE) recently released their OBF program in the summer of 2017, and is working with DWR to implement an energy efficiency project. Table 7 summarizes the energy savings on a per year basis after completed energy projects.

Table 8: Summary of Energy Projects Completed or In Progress

Year Funded	Energy Saved (kBTU/yr)	Floor Area Retrofit (ft2)	Percent of DWR Floor Area
2010	2,314157	53,000	11%
2012	0	0	0
2013	0	0	0

2014	222,593	21,200	4%
2015	860,899	102,713	21%
2016	33,842	800	0%
2017	478,597	32,100	7%
Totals	3,910,088	209,813	43%

DWR has completed energy surveys on all its retail energy buildings and energy efficiency projects on 43 percent of its building space over the last four years due to the efforts of its WEE Branch. Through these energy surveys, DWR could determine high priority projects and determine where it was most feasible to begin energy efficiency projects.

Energy audits vary depending on potential upgrades a site can accommodate and the project parameters. The American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) set standards throughout the industry for types of audits that are performed. ASHRAE level 1 audits consist of a walk-through analysis of the site. It is a basic audit that involves interviews with personnel and an inspection of existing energy using fixtures and appliances. Information is then used for potential capital improvements with cost analysis spreadsheets. ASHRAE level 2 audits involve a more detailed energy analysis of utility bills and energy consumption. DWR has used local power utilities and contractors to conduct level 2 audits to prepare detailed analysis on energy usage patterns for potential energy efficiency projects. Through its energy surveys and completed projects, DWR has achieved an annual energy savings of nearly four million kBTUs. Table 8 summarizes ASHRAE level 1 and level 2 audits DWR has completed.

Table 9: ASHRAE Energy Surveys

Year	Total DWR Floor Area (ft2)	ASHRAE Energy Surveys Under Way (ft2)		Percent of DWR Floor Area (ft2)	
		Level 1	Level 2	Level 1	Level 2
2013	49,000	49,000	0	10%	0%
2014	91,500	91,500	91,500	19%	19%
2015	166,346	165,466	166,346	34%	34%
2016	34,836	34,836	13,136	7%	3%
2017	82,073	66,841	82,073	14%	17%

Demand Response

EO B-18-12 directed all State agencies to participate in available Demand Response (DR) programs and to obtain financial incentives for reducing peak electrical loads when called upon, to the maximum extent cost-effective. These programs are offered directly from power utility companies and are voluntary.

The age and nature of DWR's electrical equipment is such that DR programs are not feasible in most cases. DWR reviewed all its retail energy buildings with the appropriate power utilities, SCE and PG&E to verify eligibility requirements. For SCE's Summer Discount Plan (SDP), 3 kW of potential savings was identified by shutting down the compressor on HVAC units when SCE declares an energy event. SDP runs from June 1 thru October 1 each year. 2018 will be the first year that DWR participates.

Table 10: Demand Response

Demand Response Participation	Number of Buildings/Sites	Estimated Available Energy Reduction (kW)
Number of Buildings Participating in 2017	0	0
Number of Buildings That Will Participate in 2018	8	21
All DWR Buildings (Totals)	26	1,696
All DWR Buildings (Percent)	31 %	0

Two other DR programs by PG&E peak day pricing and manage your own power, have been identified as having 13 kW and 5 kW potential energy savings. DWR will participate in these two programs in 2018.

Table 9 summarizes DWR's participation status in various DR Programs.

Table 9a: Review of Demand Response Programs

Demand Response Program Name	Utility	kW Potential	DWR Participates?	Incentives Available	Number of Times Implemented 2016	Equipment Controlled	Positive or Negative Experience
Summer Discount Plan (SDP)	Southern California Edison	3	Yes		0	Compressor on HVAC units	Program runs June 1 - October 1. Participation will begin 2018.

Demand Response Program Name	Utility	kW Potential	DWR Participates?	Incentives Available	Number of Times Implemented 2016	Equipment Controlled	Positive or Negative Experience
Automated Demand Response (ADR)	Southern California Edison	Not feasible. Aggregated accounts can't shed the minimum load requirement of 100-200 kW. Potential/future solar projects were not considered feasible for program					
Permanent Load Shifting (PLS)	Southern California Edison	Not feasible. Requires 60-month commitment to shift on-peak cooling loads to off-peak. Facilities have traditional HVAC systems.					
Capacity Bidding Program (CBP)	Southern California Edison	Not feasible. Requires customer to be an ADR customer					
Critical Peak Pricing (CPP)	Southern California Edison						
Peak Day Pricing (PDP)	Pacific Gas and Electric	13	Yes		0	Alter costs during peak hours	
Manage Your Power (MYP)	Pacific Gas and Electric	5	Yes		0		
Scheduled Load Reduction Program (SLR)	Pacific Gas and Electric	Not feasible. Participating accounts do not have a minimum monthly demand of 100 kW					
Automated Demand Response (ADR)	Pacific Gas and Electric	Not feasible. Aggregated accounts can't shed the minimum load requirement of 100-200 kW. Potential/future solar projects were not considered feasible for program					
Permanent Load Shifting (PLS)	Pacific Gas and Electric	Not feasible. Requires 60-month commitment to shift on-peak cooling loads to off-peak. Facilities have traditional HVAC systems.					

Renewable Energy

EO B 18-12 requires new or major renovated state buildings over 10,000 square feet must use clean, on-site power generation, and clean back-up power supplies, if economically feasible. Facilities with available open land must consider large scale distributed generation through various financing methods, including, but not limited to, third party power purchase agreements (PPAs).

Although there are no specific kW goals for renewable energy, renewable energy does count towards meeting: (1) Zero Net Energy goal for 2025 and; (2) 20 percent grid based energy use reduction by 2018.

By 2025, DWR proposes to install renewable energy at nine sites generating 1,155 kW of renewable energy. Table 10 shows the proposal for on-site renewable energy at DWR facilities. For each facility, business case development and preliminary scoping is complete. The WEE Branch is undergoing the next phase needed to begin drafting contracts.

Table 11: On-Site Renewable Energy

Status	Number of Sites	Capacity (kW)	Estimated Annual Power Generation (kWh)
Renewables In Operation or Construction	0	0	0
Renewables Proposed	9	1,155	1,821,435
Renewable Totals	9	1,155	1,821,435
DWR Wide Totals	22	1,696	5,791,123
DWR Wide Renewable Percentage	41 %	68 %	31 %

Monitoring Based Commissioning (MBCx)

New and existing state buildings must incorporate Monitoring Based Commissioning (MBCx) to support cost effective and energy efficient building operations, using an Energy Management Control System (EMCS). State agencies managing state-owned buildings must pursue MBCx for all facilities over 5,000 square feet with EUIs exceeding thresholds described in Management Memo 15-04. The following table is from MM15-04 describing the requirements.

Table 11: Building Commissioning Criteria for Existing State Buildings

Building Type	Building Area (gsf)	EUI (kBTU/sq. ft.)	Required Commissioning
All existing state buildings	>50,000 gsf	EUI >20	Monitoring-based commissioning (MBCx)
	>5,000 gsf	EUI >100	MBCx
Metered state buildings	>10,000 gsf	EUI >30	MBCx

DWR has no buildings over 50,000 square feet so the first condition does not apply. As previously discussed, DWR does not have EMCS in any of its retail energy space. However, despite not having EMCS, DWR has only four buildings with a EUI greater than 30. All those facilities have undergone energy efficiency projects, with a subsequent drop in EUI as shown in Table 11. Additionally, new construction at these facilities will use renewable energy and be ZNE buildings.

Table 12a: Planned MBCx Projects

Building	Location	Floor Area (ft2)	EMCS Exists? (MBCx Capable, MBCx Difficult, No EMCS)	MBCx Projected to Start	Projected Cost ($)

Table 13b: DWR Buildings with a EUI >30

Building	Floor Area (ft2)	2003 EUI	2016 EUI
Coalinga Operations and Maintenance Subcenter	13,700	82	54
Oroville Operations and Maintenance Center	51,413	88	83
Sacramento Maintenance Yard	32,100	95	91
San Joaquin Operations and Maintenance Center	16,400	126	101

Financing

State agencies are required to pursue all available financing and project delivery mechanisms to achieve these goals including, but not limited to: state revolving loan funds, utility On-Bill Financing (OBF), Power Purchase Agreements (PPAs), GS $Mart, Energy Service Contractors (ESCOs), or other available programs.

DWR has used OBF through PG&E for 6 energy efficiency projects totaling over $228,000 covering 156,813 square feet of retail energy building space. These projects achieved an annual energy savings of 1,595,913 kBTU of energy with a net savings of $89,605 annually.

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DWR STAKEHOLDERS

Zero Net Energy (ZNE)	
Golam Kibrya	Senior HEP Utility Engineer
New Construction Exceeds Title 24 by 15 percent	
Golam Kibrya	Senior HEP Utility Engineer
Reduce Grid-Based Energy Purchased by 20 percent by 2018	
Golam Kibrya	Senior HEP Utility Engineer
Demand Response	
Beatrice Rocha	Electrical Engineer
Renewable Energy	
Golam Kibrya	Senior HEP Utility Engineer