Sustainability Roadmap 2018-2019: Energy

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

Department of Technology

Edmund G. Brown Jr., Governor

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California Department of Technology Sustainability Roadmap 2018-2019: Energy

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Acronyms

ADR	Automated Demand Response
CA	California
CALGREEN	California Green Building Code (Title 24, Part 11)
CEC	California Energy Commission
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
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
ZEV	Zero Emission Vehicle
ZNE	Zero Net Energy

EXECUTIVE SUMMARY

The California Department of Technology (CDT) Gold Camp Data Center provides information technology services to many state, county, federal and local government entities throughout California. As the department's only state-owned facility, the CDT Gold Camp Data Center supports a scalable, reliable and secure statewide network. Combined with expertise in voice and data technologies, CDT delivers comprehensive, cost-effective computing, networking, electronic messaging, and training solutions to benefit the people of California.

As power consumption, and the resulting Green House Gas (GHG) emissions from computer rooms and IT equipment continue to increase at a time when the power production industry is in a fundamental state of change, striving towards sustainability continues to be a challenge for all departments and their facilities. As the state's Information Technology (IT) leader, CDT continues to lead efforts to reduce total state department IT energy equipment use by at least 20 percent, as required by Assembly Bill 2408 (Smyth and Huber, Chapter 404, Statutes of 2010). To meet required energy reductions, many state departments consolidated their IT equipment into CDT's LEED Gold and ENERGY STAR rated Gold Camp Data Center, including IT equipment from two of CDT's data centers, which were decommissioned in 2010. Although energy, water, and GHG emissions increased at CDT's data center as a result of these consolidation efforts. Because of strong initiative efforts since 2014, there has been a decrease in energy intensity and water consumption totals in the data center operations

As part of the Governor's 10-year plan to reduce carbon emissions at the state level, state agencies have been directed to demonstrate sustainable operations and lead the way by implementing various sustainable policies set by the Governor's office. To support this standard, the Gold Camp data center's 2016 purchased energy for the computer room directly supporting the data processing and critical cooling systems consumed 91% of the electricity and 49% of the natural gas used by the entire facility. The single largest challenge CDT faces in meeting the Governor's goals for the Gold Camp data center facility is the large percentage of process energy used in support of the IT systems operating in the computer room.

CDT has led efforts to reduce total state department IT energy equipment use by no less than 20 percent, as required by Assembly Bill 2408 (Smyth and Huber, Chapter 404, Statutes of 2010). To reduce energy consumption, CDT invested in cold aisle containment and installed a Vigilent Dynamic Cooling Management system. In addition, CDT's 5 year capital improvement plan factors energy efficiency for infrastructure upgrades and new projects for the Gold Camp Data Center.

CDT will meet the ZNE requirements when isolating the office space from the computing facility at the Gold Camp data center campus.

CDT is complying or in the process of complying with the Management Memos and sections of the State Administrative Manual (SAM) that provide specific directions and support for reducing grid-based energy purchased by 20%. A major upcoming project for CDT will be the installation

of solar panels at the Gold Camp Data Center facility parking lot. The panels are being financed via a power purchase agreement (PPA). Since the Gold Camp Data Center is a 24/7 mission critical operation, the department is unable to participate in an automated demand response program because participation would compromise CDT's computing services to its customers.

From the first day of operation, CDT incorporated an energy monitoring control system (EMCS) from Automated Logic Corp (power) and Alerton (HVAC). These original EMCS systems gave facility and engineering staff insight into where power and natural gas is used. This enabled set point changes to both increase reliability, availability, and energy savings for the building. Over time, the department has made upgrades to the EMCS system to ensure optimal efficiency.

The Department also actively pursues utility provider's incentive programs when practical and has periodic meetings with SMUD representative to discuss future incentive programs. CDT considers financing of projects targeted on its 5-year infrastructure plan.

Amy Tong
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 staff 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 the Department 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

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

Department Mission and Built Infrastructure

Under the direction of the California Government Operations Agency, the California Department of Technology (CDT) maintains statutory authority over Information Technology (IT) projects and operates the state's data centers. CDT provides information technology services to many state, county, federal and local government entities throughout California. Through the use of a scalable, reliable and secure statewide network, combined with expertise in voice and data technologies, CDT delivers comprehensive, cost-effective computing, networking, electronic messaging and training solutions to benefit the people of California.

The Gold Camp facility, which is owned by the Department of Technology, is 154,250 square feet and divided into a computer room space (41,544 sq. ft.) and an office/computer room support space (112,706 sq. ft). The computer room and support space that directly support the data processing and critical cooling systems for the computer room consume 91% of the electricity and 49% of the natural gas used by the facility.

Table 1: Total Purchased Energy 2016

Purchased Utility	Quantity	Cost ($)
Electricity	20,098,225 kWh	$ 2,078,948
Natural Gas	11,786 Therms	$ 13,272
TOTAL COST	---	**$ 2,092,220**

Table 2: Properties with Largest Energy Consumption

Building Name	Floor Area (ft^2)	Site Energy (kBTU)	Source EUI ($kBTU/ft^2$-yr)
Department of Technology- Gold Camp	154,250	472	1466
Total for Buildings in This Table	N/A	N/A	N/A
Total for All CDT Buildings	154,250 ft^2	472 kBTU	1466
% of Totals	100 %	100 %	100 %

Table 3: Adjusted Energy Consumption for GC with Data Processing Usage Removed

Building Name	Floor Area (ft^2)	Site Energy (kBTU)	Source EUI ($kBTU/ft^2$-yr)
Department of Technology- Gold Camp Office	92,444	76	226
Total for Buildings in This Table	N/A	N/A	N/A
Total for All Department Buildings	154,250 ft^2	472 kBTU	1466
% of Totals	100 %	100 %	100 %

- For table 3 the computer room and central plant square footage, that directly supports data processing, has been removed from the building total. The remaining square footage for office space and circulation is 92,444 sq. ft.
- CDT directly measures the circuit breakers that provide power to the office for air conditioning, lighting and plug loads. For the energy used by the chiller to support the office air conditioning; CDT measures the flow and entering/exit temperature of the water and converts it to tonnage and then to kW.
- The sum of the office usage is applied to the modified office floor area to calculate adjusted Site and Source kBTU.
- The single largest challenge CDT faces in meeting the Governors goals for the GC facility is the large percentage of process energy used in support of the IT systems housed in computer room. Table 3 above illustrates the impact to the energy use profile for the building when it is divided between traditional office and data center.

  CDT has led efforts to reduce total state department IT energy equipment use by at least 20 percent, as required by Assembly Bill 2408 (Smyth and Huber, Chapter 404, Statutes of 2010). To meet required energy reductions, many state departments consolidated their IT equipment into GC, including equipment from two of CDT's data centers (in the amount of 62,000 sq. ft.), which were decommissioned in 2010. Although energy, water, and GHG emissions increased at CDT's state-owned data center as a result of these consolidation efforts, departmental totals from data center operations were significantly reduced.
- CDT's Gold Camp Data Center facility is mission critical and provides information technology services to many state, county, federal and local government entities throughout California. To meet required energy reductions, many state departments consolidated their IT equipment into Gold Camp's ENERGY STAR® rated data center, including equipment from two of CDT's data centers, which were decommissioned in 2010. Although energy increased at CDT's state-owned data center as a result of these consolidation efforts, departmental totals from data center operations were significantly reduced. CDT implemented significant energy efficiency strategies which include site-wide power, lighting, and computer room equipment mechanical upgrades and real-time cooling tower control and monitoring equipment installation. Future energy improvement initiatives include server virtualization through cloud computing, improved computer room cooling efficiencies, replacement of cooling towers with more water-efficient models, and solar panel installation in the parking lot.
- California Department of Technology invested in cold aisle containment. This project involved the installation of barriers to separate different parts of the data center, to help maximize efficiency by containing the hot air produced by the data center equipment. This project has resulted in improved the power utilization effectiveness (PUE) by 7%.

- CDT on track to install solar panels at the Gold Camp Data Center facility parking lot. The panels are being financed via a power purchase agreement (PPA). Once installed, the solar panels would contribute 9% of total energy demand.
- CDT participated and later expanded on a DOE grant for the Installation of a Vigilent Dynamic Cooling Management system. System monitors temperatures throughout computer room and allocates cooling from the 36 computer room air handlers to efficiently respond, with real time pinpoint precision, to the demands of IT equipment. It is estimated that the Vigilent system has reduced computer room air handler fan energy usage by 50% versus a traditionally controlled mechanical system.
- CDT has worked extensively with SMUD and is a participant in various SMUD incentive programs. SMUD produced a video highlighting Gold Camp Data Center facility's major energy efficiency achievements. (SMUD video https://youtu.be/8cAMi7Cj-DE)
- CDT's 5 year capital improvement plan include the following projects at the Gold Camp Data Center:

Project	Project Scope of Work
Rebuild/improve chiller	Recharge refrigerant. Rebuild to allow temperature for chilled water supply to be increased from 44 to 48 degrees to address need for higher HVAC setting ranges. Consider adding tubes to condenser to increase water and temperature heat exchange coefficient to prepare for higher outside air mean temperatures. 1 chiller and then 2 the following FY
Cooling Tower Replacement	Replacement of cooling towers is estimated to save $32,896 per year. Incentive of $23,695 available from SMUD. New Cooling towers will be designed for a mean maximum wet bulb temperature of 105 degrees versus original as built temp of 103 degrees. Upper Tower fill and filtration estimated to save 800,000 gallons of water per year
HVAC Package Units	AHU 1 and AHU 2 most crucial for energy savings. Research if indirect evaporative cooling with two stage vapor-compression

	units can replace existing chilled water based units.
Add VFD's on Primary Chilled Water Pumps	Energy Savings estimated at $6,400 per year. Incentive of up to $6,400 available from SMUD
Data Center Chilled Loop Water Balancing	Ties in with Smart Valves for CRAH's. Combined efforts should enable tuning of loops and CRAH units to save $12,000 per year in chiller energy use

Zero Net Energy (ZNE)

The Governor has set forth the following milestones for state zero net energy buildings:

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

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

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

CDT Gold Camp campus is separated into two construction types and separated by a 4 hour fire wall. The total building area is 154,250 sq. ft. and is broken down as so:

- First and Second Floor, main building type II F.R.: 133,988 sq. ft.
- Single story Central plant, type II-N: 20,262 sq. ft.
- CDT's total building area: 154,250 sq. ft.
- However, on the first floor of the main building, 41,544 square feet is dedicated to the computer room. Therefore there is 92,444 sq. ft. of office space, exceeding the 50% existing building area requirement. (133,988 – 41,544 = 92,444 of office space only)

The solar PPA CDT is working on has guaranteed the first year EEO at 2,008,315 kWh. CDT's office space 2016 kWH usage was 1,888,490, which is 119,825 kWh less than the estimated solar generation.

The chart below provides a breakdown of CDT's energy use profile of the Gold Camp campus office space and data center. In addition, provided below is ZNE calculator provided by DGS.

Gold Camp Facility (Office Space and Data Center)	**2016**
Total Electricity Use (kWH)	20,983,225
Total Gas Use (therms)	11,786
Square Footage	154,250
kBtu Site	72,773,364
kBtu Source	226,110,975
Site EUI	472
Source EUI	1466

State of California Zero Net Energy Calculator

Gold Camp Data Center + Office Space

National Average Source Energy Conversion Factors	
Energy Form	Source Energy Conversion Factor (r)
Imported Electricity	3.15
Exported Renewable Electricity	3.15
Natural Gas	1.09
Fuel Oil (1,2,4,5,6,Diesel, Kerosene)	1.19
Propane & Liquid Propane	1.15
Steam	1.45
Hot Water	1.35
Chilled Water	1.04

Energy Conversion Factors	
kBtu/kWh (Electricity)	3.412
kBtu/Therm (Natural Gas)	100
kBtu/Gal (Propane)	91.5
kBtu/pound (Steam)	1.04
kBtu/MBtu (Hot Water)	1000
kBtu/MBtu (Chilled Water)	1000

PV Assumptions		
Site Annual kWh per Installed kW	1,500	This may vary, higher output better*

State Building Results - Enter 12 months actual or estimated data (in outlined green boxes below)		
Building Area (sq. ft.)	154,250	sq. ft.
Total Electricity Consumed	20,983,225	kWh (EV charging excluded)
Total Natural Gas Consumed	11,786	Therms
Total Propane Consumed	0	Gallons
Total Steam Consumed	0	Pounds
Total Hot Water Consumed	0	MBtu
Total Chilled Water Consumed	0	MBtu
Total Source Energy Consumed	226,808,180	kBtu Source
EUI (Source)	1,470	kBtu/sq. ft. (source)**
ZNE Source PV Required to Offset Natural Gas	73	kW
ZNE Total Source PV Required	14,069	kW
Total Electricity Generated On-Site (kWh)	2,008,315	kWh
Total Source Energy Generated On-Site (kBTU)	21,584,968	kBtu Source
ZNE Source Over generation	-90%	

* Typical fixed PV's in CA range from 1,500-1,800 kWh/kW (Tracking PV's ~2,200 kWh/kW)

** See ref Source EUI for Exist. Bldgs tab for ZNE energy efficiency targets for existing buildings

Note for Table 3: See Workbook Tab C, "Zero Net Energy Buildings".

Table 3: Zero Net Energy Buildings

Status of ZNE Buildings	Number of Buildings	Floor Area (ft^2)
Under Construction or Completed	0	0
Building In Design	0	0
Building Proposed for Before 2025 (but not yet in design)	0	0
Totals for ZNE Buildings	0	0
Totals for All Department Buildings	0	0
% ZNE	0%	0%

The chart below provides a breakdown of CDT's energy use profile of the **Gold Camp campus office space only.** In addition, provided below is ZNE calculator provided by DGS. The reason this data was included is to show that if it were not for the data center, the Department of Technology would be a ZNE building.

Gold Camp Facility (Office Space Only)	**2016**
Total Electricity Use (kWH)	1,888,490
Total Gas Use (therms)	6,000
Square Footage	92,444
kBtu Site	7,043,529
kBtu Source	20,868,610
Site EUI	76
Source EUI	226

State of California Zero Net Energy Calculator

CDT Gold Camp Facility Office Space Only

National Average Source Energy Conversion Factors	
Energy Form	Source Energy Conversion Factor (r)
Imported Electricity	3.15
Exported Renewable Electricity	3.15
Natural Gas	1.09
Fuel Oil (1,2,4,5,6,Diesel, Kerosene)	1.19
Propane & Liquid Propane	1.15
Steam	1.45
Hot Water	1.35
Chilled Water	1.04

Energy Conversion Factors	
kBtu/kWh (Electricity)	3.412
kBtu/Therm (Natural Gas)	100
kBtu/Gal (Propane)	91.5
kBtu/pound (Steam)	1.04
kBtu/MBtu (Hot Water)	1000
kBtu/MBtu (Chilled Water)	1000

PV Assumptions	

Site Annual kWh per Installed kW	1,500	This may vary, higher output better*
State Building Results - Enter 12 months actual or estimated data (in outlined green boxes below)		
Building Area (sq. ft.)	92,444	sq. ft.
Total Electricity Consumed	1,888,490	kWh (EV charging excluded)
Total Natural Gas Consumed	6,000	Therms
Total Propane Consumed	0	Gallons
Total Steam Consumed	0	Pounds
Total Hot Water Consumed	0	MBtu
Total Chilled Water Consumed	0	MBtu
Total Source Energy Consumed	20,951,113	kBtu Source
EUI (Source)	227	kBtu/sq. ft. (source)**
ZNE Source PV Required to Offset Natural Gas	37	kW
ZNE Total Source PV Required	1,300	kW
Total Electricity Generated On-Site (kWh)	2,008,315	kWh
Total Source Energy Generated On-Site (kBTU)	21,584,968	kBtu Source
ZNE Source Over generation	3%	

* Typical fixed PV's in CA range from 1,500-1,800 kWh/kW (Tracking PV's ~2,200 kWh/kW)

** See ref Source EUI for Exist. Bldgs tab for ZNE energy efficiency targets for existing buildings

New Construction Exceeds Title 24 by 15%

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 15% or more.

Table 4: New Construction Exceeding Title 24 by 15%

Buildings Exceeding Title 24 by 15%	Number of Buildings	Floor Area (ft^2)
Completed Since July 2012	N/A	N/A
Under Design or Construction	N/A	N/A
Proposed Before 2025	N/A	N/A

The California Department of Technology has no plans of constructing new buildings or designing new major renovations. Additionally, CDT did not complete any new construction or major building renovations prior to 2012.

Reduce Grid-Based Energy Purchased by 20% by 2018

Executive Order B-18-12 requires state agencies to reduce grid-based energy purchased by 20% by 2018, compared with a 2003 baseline.

All computers, printers, and copiers go into energy saving mode when not utilized. Microsoft power saving mode is used for power management. Monitors and computers automatically utilize an energy saving mode when not in use after 15 minutes. Multifunction printers utilize an energy saving mode when not in use after 2 minutes.

Gold Camp Data Center facility has installed occupancy sensors in all overhead lighting. All offices and the data center computer room have motion activated lights. As a 24/7 facility, some lights and equipment remain on at all times. Office areas have been measured for light levels and de-lamped, which has reduced the light level to exceed title 24 requirements by 7 percent. CDT will replace all incandescent light bulbs in the office spaces and data center computer room with LED lights by the end of 2017.

Procurement unit purchases Energy Star rated equipment whenever practical and participates in the DGS Environmentally Preferred Purchasing program.

On-site building engineers conduct daily inspections to ensure the department is in compliance for its single, 65 gallon hot water tank. Boilers are not used at the Gold Camp Data Center facility.

Alerton Building Management Software (BMS) automatically places the office mechanical system in an unoccupied mode outside normal building hours. Some HVAC is needed in areas where 24/7 staffing is maintained. Controls are currently set at a +2 and -2 deadband using our BMS software listed above. Alerton BMS system actively controls outside air economizers to take advantage of temperatures under 68 degrees. If temperatures fail to drop below 68 degrees, the air economizers wouldn't be used. Preventative maintenance is conducted on monthly, quarterly, semi-annual, and annual basis by the on-site building engineers to ensure the effectiveness of all HVAC components. CDT is currently researching for feasibility of integrating a lighting control system into the EMCS/BMS.

CDT has facility guidelines in place to ensure that employees are not using personal heaters without written permission. CDT will reject any refrigerators manufactured prior to the year 2000 and lacking the energy star rating due to safety and energy concerns. All appliances are inspected prior to accepting them into the facility per department guidelines. The Department has made a formal request to the Department of Rehabilitation to enforce compliance with their vending machine contractor. Facility guidelines require automatic shut-off of coffee makers. CDT ensures that kitchen, break room, and lunch room equipment is cleaned regularly and maintained to optimize efficiency. Gold Camp Data Center facility is a 24/7 operation and therefore snack vending machines, shredders, and water cooler timers will not be used. CDT will consider using timers for the above appliances for less traffic areas. CDT is currently drafting an annual email on the importance of minimizing electrical plug loads.

CDT utilizes temperature sensors at the bottom and top of the computer room cabinets to measure and control the amount of cooling delivered through perforated floor tiles. The average temperature measured at the upper cabinet IT equipment inlets, for the GC data center is 74 degrees. CDT Building Engineering and Operations staff are currently evaluating increasing the average computer room temperature to save additional energy. The most

significant barrier to increasing temperatures is the multi-tenant colocation design of the room and the requirement to host legacy customer equipment that is not designed for modern hot/cold aisle cooling configuration. Lower than industry standard temperature operating ranges and the placement of side blowing cooling fans are all factors that currently require the computer room as a whole to be set at a lower than optimal average temperature.

CDT measures and reports on the PUE for the CDT 42,000 sq. ft. Gold Camp data center. The Gold Camp data center reported a PUE of 1.34 for 2016 (the lowest PUE out of 27 state-operated computer rooms required to report by MM 14-09). For PUE measurement purposes, total facility energy consumed (kWh) is measured at the SMUD utility meter. Office plug, lighting, and HVAC kW loads are separately monitored and trended in the BMS system. Flow and temperature meters for the office chilled water loop are trended in the BMS system to determine kW. The two categories of office kW loads are added together for a specified period of time, converted to kWh, and then subtracted from total facility energy. Remaining kWh are then divided by IT load (kWh) for the specified time period to calculate PUE. Annual natural gas usage has been measured and determined to be evenly distributed between the computer room and office and thus is used for PUE calculation.

CDT GC currently meets the MM 14-09 requirement, however the department is actively working to lower PUE through energy efficiency and optimization projects. Completing cold aisle containment for the computer room, increasing the average supply air and water temperature, and the replacement of central plant equipment with more efficient units are projects currently underway at the facility.

All CDT purchases of network equipment meet IEE 802.3-2012 Section 6 standards. CDT is one of the leading departments in the state for server virtualization. The department offers 3 separate virtualized environments: On premise private cloud, VMware Managed Cloud Services, and a HyperV managed services offering. All internal department servers have been virtualized and customers are highly encouraged to refresh existing physical servers into one of the virtualized CDT offerings

The kBTU energy consumption and EUI for the Gold Camp facility peaked in 2014 as a result of the computer room absorbing data processing workload from other state facilities. In 2015 and 2016 energy consumption and EUI was decreased as facility energy efficiency initiatives, combined with a cloud first policy of the State CIO, halted what had previously been a steep % increase in IT power consumption. In 2018 the department expects IT equipment load to decrease as more customer departments shift data processing workloads to the public and private cloud. Combined with further energy efficiency measures and the generation of 9% of the total energy demand for the facility onsite from solar, the source EUI for the facility is anticipated to be 1349 (a 12.9% reduction from 2014).

Energy use and EUI for the GC facility was reduced in 2016 versus 2015. IT energy use in the computer room remained constant so the savings has been attributed to the impact of energy saving initiatives in the computer room, and the building as a whole. The EUI for the CDT GC

facility as a whole is significantly higher than a standard office building due to the process use of power for data processing and network bandwidth. Due to the limitations of comparative building performance using EUI, Energy Star scoring is the chosen metric. The CDT GC facility had a 2016 Energy Star score of 97, which ranks the building as not only above average, but as a top performer for the building use type.
https://www.energystar.gov/sites/default/files/tools/Data%20Centers.pdf

As described in the above sections dollar per year spent for energy purchases is higher than in the 2003 baseline year.

Table 5: Department Wide Energy Trends

Year	Floor Area (ft^2)	Total kBTU Consumption	Department Average EUI
Baseline Year (2003)	154,250	102,452,647	664
2012	154,250	221,166,127	1434
2013	154,250	238,785,458	1548
2014	154,250	240,341,278	1558
2015	154,250	231,872,910	1503
2016	154,250	226,110,975	1466
2018 Goal	154,250	208,037,468	1349

The CDT GC facility is the primary data center for the state and as long as it continues that role and function the 20% reduction goal in relation the 2003 baseline will not be possible. Due to efficiency projects completed and economies of scale, the GC data center has the lowest PUE of any state computing facility. If data processing statewide had not consolidated primarily in a single location a significant amount of energy would be wasted on cooling and power distribution losses at inefficient data centers with higher PUE ratios. The increased use of the on premise private cloud and public cloud offerings, along with infrastructure efficiency projects will continue to reduce kBTU consumption and average source EUI over the next 10 years. Advances in energy storage, fuel cells, and the expansion of onsite solar generation may enable the department to reduce source EUI to levels equivalent to 2003.

Table 6: Energy Reductions Achieved

Purchased Energy Compared to Baseline	Number of Buildings	Floor Area (ft^2)	Current Year Energy Use	Percent of Total Energy
20% Reduction Achieved				
Less than 20% Reduction	1	154,250	226,110,975	100%
Unspecified Baseline (if any)				
Totals				100%
Department-Wide Reduction				

The CDT GC facility was originally constructed in 1999 to be both energy efficient (for its time) and a reliable mission critical data center. Over the years CDT has identified the completion of

energy efficiency initiatives as a priority both for the betterment of the environment and for the reduction in costs for energy purchases. Fixed operational costs directly impact the rates CDT charges to customers, and reducing these rates has been a departmental priority. The energy projects completed since the baseline year of 2003 include:

2007- Complete retro commissioning of the building including an upgrade of the EMCS/BMS, HVAC VAV calibrations and economizer settings, and lowered unoccupied occupancy schedules for the mechanical system. Total energy savings 2,842,234 kBTU/year

2011- New Computer room air conditioners (CRAH) with EC fans. Water Side economizer, chiller rebuild with VFD's, and office lighting replacement. Implemented Vigilent for real time algorithmic control of CRAH units. Total savings 7,176,280 kBTU/year.

2013- Replacement of three Uninterruptable Power Systems (UPS) and Phase 1 of computer room cold aisle containment. Savings 2,593,880 kBTU/year

2014- Replacement of last primary UPS, Phase II of containment, and return air chimneys. Savings 4,959,772 kBTU per year.

LED lighting replacement for the entire building, replacement of the existing make up air handlers for the computer room with more efficient units featuring VFD's, and the installation of a new EMCS/BMS for enhanced control of the building mechanical systems. The goal and strategy for future energy projects will focus on the replacement of existing equipment with units that are both more efficient and designed to work in the temperature ranges predicated by climate models in the next 20 years. For existing and new equipment the convergence of electrical and mechanical data from unified EMCS systems will enable better system control through the use of real time data to make intelligent optimizations based on demand. These projects have been identified on the 5 year infrastructure plan

When analyzing the energy savings in Table 7 versus the energy trends in Table 5 consideration must be given to the impact of AB 2408 signed in February of 2010. The CDT GC facility received an influx of new data processing workload and equipment as other state departments reduced their IT energy by 33% by July of 2012. The kBTU savings through completed energy initiatives stemmed what would have been an even larger increase in 2012 and 2013. In 2014 energy use plateaued and in 2015 and 2016 the energy savings achieved in Table 7 began to trend with the reported energy consumption in Table 5.

Year Funded	Energy Saved (kBTU/yr)	Floor Area Retrofit (ft^2)	Percent of Department Floor Area
2007	2,842,234	154,250	100%
2011	7,176,280	154,250	100%
2013	2,593,880	154,250	100%
2014	4,959,772	154,250	100%

As part of achieving LEED Gold certification in 2015, the CDT GC facility underwent an ASHRAE level II survey in 2014 for 100% of the building floor area.

Table 7: Energy Surveys

Year	Total Department Floor Area (ft^2)	Energy Surveys Under Way (ft^2)		Percent of Department Floor Area (ft^2)	
		Level 1	Level 2	Level 1	Level 2
2012					
2013					
2014	154,250		154,250		100%
2015					
2016					

Demand Response

Executive Order B-18-12 directed all state Departments are to participate in available demand response programs and to obtain financial incentives for reducing peak electrical loads when called upon, to the maximum extent cost-effective.

Gold Camp facility is a 24/7 mission critical operation and to avoid risk will not participate in a demand response program at this time. The department is aware of SMUD's PowerDirect Automated Demand Response program, but participation would compromise CDT's computing services to its customers. CDT does have the ability to mirror and replicate mainframe, private cloud, and other data processing services to the Vacaville data center, however there are significant software licensing costs, risks, and customer coordination issues that reserve this option for true disasters rather than for meeting local utility demand response goals.

Table 8: Demand Response

Demand Response Participation	Number of Buildings/Sites	Estimated Available Energy Reduction (kW)
Number of Buildings Participating in 2016	0	0
Number of Buildings That Will Participate in 2017	0	0
All Department Buildings (Totals)	0	0
All Department Buildings (Percent)	0 %	0 %

Renewable Energy

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% grid based energy use reduction by 2018.

CDT plans to have 1 mW of installed solar capacity at the Gold Camp facility in 2018. Given the single state owned building in the department's portfolio, renewable energy will be installed at 100 percent of the buildings in the specified time frame. CDT is actively working with DGS to implement a solar PPA in 2018. CDT is in the planning process of installing parking lot solar panels under a solar PPA.

Table 9: On-Site Renewable Energy

Status	Number of Sites	Capacity (kW)	Estimated Annual Power Generation (kWh)
Renewables In Operation or Construction	N/A	N/A	N/A
Renewables Proposed	1	1000	2,008,315
Renewable Totals	1	1000	2,008,315
Department Wide Totals	1	1000	2,008,315
Department Wide Renewable Percent	1	35%	9.5%

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.

When built, the CDT Gold Camp facility included energy monitoring systems from Automated Logic (power) and Alerton (HVAC). These original EMCS systems gave facility and engineering staff insight into how and where power and natural gas were being used, and enabled set point changes to be made which increased reliability, availability, and energy savings for the building.

In 2007 these EMCS platforms provided the foundation for the successful retro-commissioning of the building by DGS and the department. During this project, the Alerton system was upgraded to the latest version which enabled advanced trending, chiller monitoring, optimized HVAC economizer operation, and the lowering of set points based on occupancy of the space.

From 2010 to 2014 the department implemented new server based EMCS systems for precise computer room air conditioning control and electrical system monitoring. These EMCS systems directly led to energy saving initiatives, utility incentives and the replacement of existing equipment with more efficient models. The ability to identify power use at the branch circuit level has enabled the analysis and justification for projects by determining return on investment (ROI).

The two main challenges CDT faces when updating EMCS systems is that GC is a mission critical facility that can never be completely taken down for maintenance/modifications, and IT security system restrictions on system functionality.

Any changes in EMCS/BMS control systems must be done in a systematic manner on redundant equipment as to not affect the building operations. As such, major upgrades are typically only completed when replacing systems of equipment (example: replacing all of the computer room PDU's enabled SiteScan to be installed for precise cabinet power consumption monitoring).

EMCS/BMS system functionality such as offsite monitoring, mobile device notifications, and wireless transmission are not currently used due to the need to have secure systems that are hardened against hacking and unauthorized access. Per our internal IT security policy, the Department cannot allow external vendor access to EMCS/BMS. Additionally, the Department allowed a DGS appointed ESCO to analyze 3 months of data in our EMCS/BMS system and had no recommended changes to the system.

Monitoring based commissioning and EMCS/BMS systems are currently in place at the CDT GC facility as required by MM 15-04. CDT has 3 separate integrated EMCS/BMS systems that provide the required MBCx services. In addition the department is currently undergoing a pilot to test a new ALC mechanical monitoring system that may eventually reduce the total number of EMCS/BMS systems to 2.

The CDT GC facility has a modern EMCS/BMS system that enables monitoring based commissioning (MBCx). Due to the identified challenges and the need to further achieve energy efficiency goals, the department is currently implementing a more advanced system. The new EMCS will initially monitor and control the make-up air units and humidity control for the computer room. It will eventually be expanded to the all of the mechanical systems and power systems for the building. On average, the new system will feature 3 times the number of sensors and control points, and will enable new and innovative control schemes to be implemented.

Table 10: Planned MBCx Projects

Building	Location	Floor Area (ft^2)	EMCS Exists? (MBCx Capable, MBCx Difficult, No EMCS)	MBCx Projected To Start	Projected Cost ($)
Gold Camp	Rancho Cordova	42,000	MBCx exists, enhancement and modernization	2017	$40,000
Totals		42,000			$40,000

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

The Department of Technology is participating in DGS RFP for solar power purchase agreement (PPA). In addition, CDT was working with an Energy Savings Company (ESCO) to reduce energy

use and GHG emissions. However, after evaluating the ESCO contract, the return on investment (ROI) on proposed projects were not practical. The Department actively pursue utility's incentive programs when practical and has periodic meetings with SMUD representative to discuss future incentive programs. CDT will consider financing of projects targeted on the 5-year infrastructure plan.

DEPARTMENT STAKEHOLDERS

Zero Net Energy (ZNE)	
Facility and Administrative Services Branch	Mark Standley, Facility and Administrative Service Branch Manager Ian Noumov, Senior Information Systems Analyst Sarah Do, Sustainability Coordinator

Reduce Grid-Based Energy Purchased by 20% by 2018	
Facility and Administrative Services Branch	Mark Standley, Facility and Administrative Service Branch Manager Ian Noumov, Senior Information Systems Analyst Freddie Sells, Facility Services & Physical Security Analyst Sarah Do, Sustainability Coordinator

Demand Response	
Facility and Administrative Services Branch	Mark Standley, Facility and Administrative Service Branch Manager Ian Noumov, Senior Information Systems Analyst Freddie Sells, Facility Services & Physical Security Analyst Sarah Do, Sustainability Coordinator

Renewable Energy	
Facility and Administrative Services Branch	Mark Standley, Facility and Administrative Service Branch Manager Ian Noumov, Senior Information Systems Analyst Freddie Sells, Facility Services & Physical Security Analyst Sarah Do, Sustainability Coordinator

Monitoring Based Commissioning (MBCx)	
Facility and Administrative Services Branch	Mark Standley, Facility and Administrative Service Branch Manager Ian Noumov, Senior Information Systems Analyst Freddie Sells, Facility Services & Physical Security Analyst Sarah Do, Sustainability Coordinator

Financing	
Facility and Administrative Services Branch	Mark Standley, Facility and Administrative Service Branch Manager Ian Noumov, Senior Information Systems Analyst Sarah Do, Sustainability Coordinator