State Facilities Energy Strategy Project

Hawaiʻi State Energy Office

Honolulu, Hawaiʻi
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Acronyms

ABA	Architectural Barriers Act
ADA	Americans with Disabilities Act
AIM Act	American Innovation and Manufacturing Act of 2020
APS	Advanced Power Strip
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BESS	Battery Energy Storage System
BEV	Battery Electric Vehicle
CH_4	Methane
CO_2	Carbon dioxide
DCFC	DC Fast Charger
DHW	Domestic Hot Water
DOE	U.S. Department of Energy
EBERP	Energy Burden & Emissions Reduction Program
ECM	Energy conservation measure
EECBG	Energy Efficiency and Conservation Block Grant
EPA	Environmental Protection Agency
ESCO	Energy Service Company
ESPC	Energy Savings Performance Contract
EUI	Energy use intensity
FEMP	Federal Energy Management Program
GCR	Ground cover ratio
GWP	Global Warming Potential
HD	Heavy Duty
HDR	HDR Engineering, Inc.
HFC	Hydrofluorocarbons
HOMER	Hybrid Optimization of Multiple Energy Resources
HVAC	Heating, ventilation, and air conditioning
ICE	Internal Combustion Engine
IRR	Internal Rate of Return
LCC	Life-Cycle Cost
LCCA	Life Cycle Cost Analysis
LED	Light-Emitting Diode
LGS	Large General Service
MD	Medium Duty
MEP	Mechanical, Electrical, and Plumbing
MILCON	Military Construction
N_2O	Nitrous oxide
NEMA	National Electrical Manufacturers Association
NIST	National Institute of Standards and Technology
NPV	Net Present Value
O&M	Operations and Maintenance
PV	Photovoltaic
RCx	Retro-Commissioning

ROI	Return on Investment
RTU	Rooftop Unit
SGS	Small General Service
SIR	Savings/Investment Ratio
SLD	Single-Line Diagram
TOU	Time-of-Use
TRM	Technical Reference Manual
UESC	Utility Energy Services Contract
UL	Underwriters Laboratories
Utility	Hawaiian Electric
WCM	Water conservation measure

Disclaimer

The intent of this State Facility Energy Strategy report is to provide a preliminary estimate of the potential energy, energy cost and carbon savings available at the project site. HDR Engineering, Inc. (“HDR”) has exercised all reasonable efforts, consistent with the degree of skill and care exercised by similarly situated members of the profession, performing similar services at the same time and in the same locale as the Project, to confirm the accuracy of the analysis inputs, including verifying that actual details correspond to the building as currently designed. While the preliminary findings in this report have been reviewed for technical accuracy and are believed to be reasonably accurate, the actual results may vary. As a result, HDR is not liable if estimated energy or financial savings are not realized. All savings and cost estimates in the report are for informational purposes and are not to be construed as a design document or as guarantees. There are a number of factors that may cause the actual energy use of the building to diverge from the projected energy use of the analysis model, including, without limitation, differences in building construction relative to the building modeled; differences in actual weather conditions relative to the weather modeled; variations in schedules for equipment, systems, and occupancy; inconsistencies in the application of controls and operations strategies compared to those used in the model; the level of direct loads; and changes in connected loads and electricity and gas rates.

Hawai‘i State Energy Office (HSEO) shall independently evaluate any advice or suggestions provided in this report. In no event will HDR be liable for the failure of the customer to achieve a specified amount of energy savings, the operation of the customer’s facilities, or any incidental or consequential damages of any kind in connection with this report or the installation of evaluated decarbonization and electrification measures. This document may contain information regarding third-party products and equipment; the inclusion of such information is not an endorsement by HDR.

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1 Summary of State Facility Energy Strategies and Performance Impacts

A summary of the key findings and performance impacts from the State Facilities Energy Strategy assessments is included below. Detailed results and explanations are available in the appendices of this report. The summary results presented below are organized first for the portfolio of buildings assessed, followed by summary results for each facility in each of the six categories of energy assessment.

The appendices at the back of this report provide a more comprehensive energy assessment for each facility, including details about all of the measures that have been recommended across all of the energy categories, as well as why they have been recommended. Each appendix also includes the physical details of each facility, a summary of what was assessed, the facility’s baseline energy performance and a customized set of recommendations organized into a Facility Energy Strategy.

1.1 Project Background

The Hawai‘i State Energy Office (HSEO) contracted with HDR to develop a multi-part energy strategy for improved energy efficiency, building operational performance, and utility bill savings potential for small- to medium-sized State-owned facilities (between 10,000 – 200,000 sq ft.). The State Facility Energy Strategy is based on conducting desktop assessments on a representative sample of the applicable State-owned facilities. The project is consistent with Act 239 Session Laws of Hawai‘i, 2022. The categories of energy solutions explored through the State Facility Energy Strategy project include:

- Building efficiency: Energy
- Building efficiency: Water
- Solar photovoltaic (PV) renewable energy systems and battery energy storage systems (BESS)
- Demand management and demand response
- Vehicle electrification and electric vehicle supply equipment (EVSE)
- Financial feasibility

1.2 Facilities Assessed

A multicriteria assessment was conducted to prioritize six facilities, owned by four different State agencies, out of more than 1,300 applicable facilities, spread across 26 different State agencies. The facilities assessed as part of the State Facility Energy Strategy project are all on O‘ahu.

Table 1. Facilities Assessed for the State Facility Energy Strategy Project

Facility Name	State Agency	Island
Hawai‘i Film Studio Complex: Production Office, Sound Stage 2, Crew Bathrooms, Guard Stand	Department of Business and Economic Development and Tourism (DBEDT); Hawai‘i Film Studio	O‘ahu
Hawai‘i State Library	Hawai‘i State Public Library System (HSPLS)	O‘ahu
Waimano State Laboratory- Kamauleule Building	Department of Health (DOH)	O‘ahu
Hale Ola Building (3 story)	DOH	O‘ahu

Facility Name	State Agency	Island
OR&L MAIN BUILDING	Department of Accounting and General Services (DAGS)	O‘ahu
CENTRAL SERVICES DIVISION (CSD) - ADMINISTRATION OFFICE	DAGS	O‘ahu

1.3 Executive Summary of Portfolio of Assessed Facilities

A total of 55 measures were assessed across the six facilities, including 21 energy conservation measures (ECMs), 20 water conservation measures, and 14 PV/PV+BESS configurations. Results include total kWh saved, gallons of water conserved, and avoided CO_2 emissions. Sensitivity analyses were performed to evaluate the impact of key variables, including the Clean Electricity Investment Tax Credit, variations in capital costs, and changes in electricity and water prices. The full Facility Energy Strategy for each of the facilities is included as an appendix to this report. The benefit-cost ratios (BCRs) and payback periods below are solely based on the financial impacts of each improvement. For each improvement, installation costs, available rebates, replacement costs, operating and maintenance (O&M) costs, and avoided energy costs are considered. For measures that do not show a payback period, this indicates the measure will not pay back over the 20-year study period considered in the analysis.

1.3.1 Building Efficiency: Energy

The potential building energy efficiency measures are summarized below.

Table 2. State Facility Energy Strategy, Energy Conservation Measures

Measure ID	Energy Conservation Measure	Net CapEx* (2025$)	Annual Electric Savings (kWh/yr)	Annual Peak Electric Savings (kWh)	Payback Period (years)	Benefit Cost Ratio
	OR&L Main Building					
DAGS OR&L – ECM#1	1ST FLOOR WINDOW FILM REPLACEMENT (SW – 52 SQFT)	$48	1,026	0.08	0.2	44.4
DAGS OR&L – ECM#2	COMPLETE INTERIOR LED LIGHTING RETROFIT	$15,326	12,004	0.90	6.9	3.4
DAGS OR&L – ECM#3	EXTERIOR HALLWAYS LIGHTING REPLACEMENT (150W-220W)	$12,050	13,366	2.02	5.2	2.8
DAGS OR&L – ECM#4	Retro-commissioning	$5,799	9,247	N/A	N/A	N/A
	CSD Administration Office					
DAGS Central Services – ECM #1	COMPLETE INTERIOR LED LIGHTING RETROFIT	$3,969	3,104	0.20	6.9	3.4
DAGS Central Services – ECM #2	EXTERIOR LIGHTING REPLACEMENT (150W-220W)	$4,820	5,346	0.81	5.2	2.8

Measure ID	Energy Conservation Measure	Net CapEx* (2025$)	Annual Electric Savings (kWh/yr)	Annual Peak Electric Savings (kWh)	Payback Period (years)	Benefit Cost Ratio
DAGS Central Services – ECM #3	LIGHTING OCCUPANCY SENSORS (100% - 5,355 SQFT)	$6,169	2,226	0.26	N/A	0.6
DAGS Central Services – ECM #4	Retro-commissioning	$1,499	29,786	N/A	N/A	N/A
	Hale Ola Building					
DOH – Hale Ola – ECM #1	COMPLETE EXTERIOR LED LIGHTING RETROFIT (150W-220W)	$24,100	26,732	4.04	5.2	2.8
DOH – Hale Ola – ECM #2	Retro-commissioning	$11,532	22,574	N/A	N/A	N/A
	Waimano State Laboratory – Kamauleule Building					
DOH – Lab – ECM #1	COMPLETE INTERIOR LED LIGHTING RETROFIT	$32,467	22,599	3.60	7.7	3.0
DOH – Lab – ECM #2	COMPLETE EXTERIOR LED LIGHTING RETROFIT (150W-220W)	$36,150	40,098	6.06	5.2	2.8
DOH – Lab – ECM #3	Retro-commissioning	$37,679	491,070	N/A	N/A	N/A
	Hawai'i State Library					
HSL-ECM#1	INTERIOR LED LIGHTING RETROFIT – Linear fluorescent lights	$15,824	10,561	1.80	8.0	2.9
HSL-ECM#2	INTERIOR LED LIGHTING RETROFIT – U-bend fluorescent lights	$3,857	8,032	1.50	8.0	2.9
HSL-ECM#3	INSTALL OCCUPANCY SENSORS (100% - 128,000 SQFT)	$147,456	44,963	8.68	N/A	0.5
HSL-ECM#4	FAN COIL TUNE UP/REPAIRS (REPLACE MOTOR – 1/3 HP)	$34,132	1,602	0.24	N/A	0.1
HSL-ECM#5	Retro-commissioning	$35,840	49,332	N/A	N/A	N/A
	Film Studio Complex					
Film Studio – Stage 2 – ECM #1	COMPLETE INTERIOR LED LIGHTING RETROFIT	$36,170	28,320	2.00	6.9	3.4
Film Studio – Stage 2 – ECM #2	LIGHTING OCCUPANCY SENSORS (100% - 48,860 SQFT)	$56,287	20,291	2.35	5.2	2.8

Measure ID	Energy Conservation Measure	Net CapEx* (2025$)	Annual Electric Savings (kWh/yr)	Annual Peak Electric Savings (kWh)	Payback Period (years)	Benefit Cost Ratio
Film Studio – Stage 2 – ECM #3	EXTERIOR AND PARKING LOT LED LIGHTING RETROFIT (35W-149W)	$30,125	33,415	5.05	16.9	1.8
	***Inclusive of Hawai‘i State Equipment Rebates, which are assumed to be applied only during first installation.**					

1.3.2 Building Efficiency: Water

The potential building water efficiency measures are summarized below.

Table 3. State Facility Energy Strategy, Water Conservation Measures

Measure ID	Water Conservation Measures	CapEx (2025$)	Annual Water Savings (gallons)	Payback Period (years)	Benefit Cost Ratio
	OR&L Main Building				
DAGS OR&L – WCM1	Replace toilets/ water closets	$2,728	8,428	N/A	0.3
DAGS OR&L – WCM2	Replace urinals	$1,364	9,984	N/A	0.8
DAGS OR&L – WCM3	Replace lavatory faucets	$1,102	1,983	N/A	0.1
	CSD Administration Office				
DAGS Central Services – WCM1	Replace toilets/ water closets	$2,046	27,339	14.6	1.4
DAGS Central Services – WCM2	Replace urinals	$682	9,266	14.4	1.4
DAGS Central Services – WCM3	Replace lavatory faucets	$551	1,976	N/A	0.3
	Hale Ola Building				
DOH – Hale Ola – WCM1	Replace toilets/ water closets	$8,184	172,172	9.0	2.2
DOH – Hale Ola – WCM2	Replace urinals	$1,364	56,862	4.8	4.4
DOH – Hale Ola – WCM3	Replace lavatory faucets	$3,306	12,532	N/A	0.3

Measure ID	Water Conservation Measures	CapEx (2025$)	Annual Water Savings (gallons)	Payback Period (years)	Benefit Cost Ratio
	Waimano State Laboratory – Kamauleule Building				
DOH – Lab – WCM1	Replace toilets/ water closets	$8,184	99,546	16.3	1.3
DOH – Lab – WCM2	Replace urinals	$2,046	31,730	12.4	1.6
DOH – Lab – WCM3	Replace lavatory faucets	$3,306	7,046	N/A	0.2
DOH – Lab – WCM4	Replace showerheads	$296	14,053	4.3	2.3
	Hawai‘i State Library				
HSL-WCM1	Replace toilets/ water closets	$12,276	60,081	N/A	0.5
HSL-WCM2	Replace urinals	$4,092	23,166	N/A	0.6
HSL-WCM3	Replace lavatory faucets	$3,306	4,550	N/A	0.1
	Film Studio Complex				
Film Studio – Production Office – WCM1	Replace toilets/ water closets	$3,410	85,436	4.9	4.3
Film Studio – Production Office – WCM2	Replace urinals	$682	28,080	7.6	2.6
Film Studio – Production Office – WCM3	Replace lavatory faucets	$1,102	6,110	4.4	2.2
Film Studio – Production Office – WCM4	Replace showerheads	$148	6,825	17.2	1.7

1.3.3 Solar PV and Battery Energy Storage Systems

The potential solar PV and battery energy storage system measures, including the optimal configuration of PV only and PV + BESS are summarized below.

Table 4. State Facility Energy Strategy, Renewable Energy Measures

Measure ID	Solar PV and BESS Configuration	CapEx* (2025$)	Annual PV Generation (kWh/yr)	Annual BESS Throughput (kWh)	Renewable Fraction of Facility Energy Consumption (%)	Payback Period (years)	Benefit Cost Ratio
	OR&L Main Building						
DAGS OR&L – RE1	63 kW PV Only	$116,500	102,347	N/A	47.2	9.2	3.9
DAGS OR&L – RE2	63 kW PV + 31 kWh BESS	$134,904	102,347	7,740	48.3	10.9	3.2
	CSD Administration Office						
DAGS Central Services – RE1	148 kW PV Only	$267,000	377,000* (*inc. existing PV)	N/A	57.5	18.7	1.6
DAGS Central Services – RE2	148 kW PV + 51 kWh BESS	$297,000	377,000* (*inc. existing PV)	13,976	58.4	16.9	1.7
	Hale Ola Building						
DOH – Hale Ola – RE1	95 kW PV Only	$177,000	154,500	N/A	39.1	8.6	4.4
DOH – Hale Ola – RE2	95 kW PV + 52 kWh BESS	$207,000	154,500	11,211	39.6	9.3	4.0
	Waimano State Laboratory – Kamauleule Building						
DOH – Lab – RE1	66 kW PV Only	$125,000	108,000	N/A	1.8	7.7	5.1
DOH – Lab – RE2	66 kW PV + 2000 kWh BESS	$982,000	108,000	75,000	1.6	N/A	0.2
	Hawaiʻi State Library						
HSL – RE1	115 kW PV Only	$212,000	187,000	N/A	19	7.6	5.2
HSL – RE2	115 kW PV + 70 kWh BESS	$251,000	187,000	1,750	19	8.8	4.4
	Film Studio Complex – Soundstage 2						
Film Studio – RE1	190 kW PV Only	$355,000	595,150	N/A	77.8	18.9	1.6
Film Studio – RE2	190 kW PV + 110 kWh BESS	$415,000	595,150	31,370	83.7	N/A	0.5
	Film Studio Complex – Production Office						
Film Studio – RE1	68 kW PV Only	$127,000	109,700	N/A	79	18.2	1.7
Film Studio – RE2	68 kW PV + 32 kWh BESS	$146,000	109,700	9,100	83.8	N/A	0.6

1.3.4 Demand Management and Demand Response

Qualitative recommendations about whether the state-owned facility should coordinate further with Hawaiian Electric about participation in a demand response (DR) program. One of the determining factors is whether the facility's building management system (BMS) is sophisticated enough to communicate with the utility.

Table 5. Summary of Facility Readiness to Participate in Demand Response

Facility	Good candidate for DR	BMS is Capable of Participating in DR Program
OR&L Main Building	Yes	Yes
CSD Administration Office	Yes	Yes
Hale Ola Building	TBD	TBD
Waimano State Laboratory – Kamauleule Building	No	Yes
Hawai‘i State Library	TBD	TBD
Film Studio Complex	No	No

1.3.5 Vehicle Electrification

Two of the six facilities assessed for the State Facility Energy Strategy have fleet vehicles assigned, the Department of Accounting and General Services (DAGS) Central Services Division (CSD) - Administration Office and the Department of Health's Hale Ola Building. Converting these fleet vehicles to battery electric vehicles (BEVs) will require electric vehicle supply equipment, including electric vehicle chargers, to facilitate the refueling of vehicles.

1.3.5.1 CSD ADMINISTRATION OFFICE

The recommended charging strategy for the CSD Administration Office includes **10 dual-port chargers (20 ports total)** that will serve most of the fleet assigned to this facility, and **five DC Fast Chargers (DCFCs)** to serve the refuse vehicles. Refuse vehicles would need to recharge everyday using a dedicated port with a minimum power supply of 25 kW DC fast charging. To accommodate the fleet assigned to the CSD Administration Office five DCFCs are recommended. The peak electrical load required for 20 Level 2 ports and five DCFCs is approximately 200 kW.

Table 6. EV Charging Requirements, DAGS Central Services

Vehicle Type	Number of Vehicles	Charging Frequency	Max # of Vehicles Charging Per Day
Light-Duty Vehicles			
Sedan	8	Every 3 days	3
SUV	1	Every 4 days	1
Pick-Up Truck	18	Every 7 days	3
Passenger Van	9	Every 7 days	2
Medium- and Heavy-Duty Vehicles			
Utility Truck	14	Every 2 days	7
Boom Truck	1	Every 4 days	1
Flatbed Truck	1	Every 2 days	1
Stake Truck	1	Every 3 days	1
Refuse Truck	5	Every day	5

For the CSD Administration Office, the total cost of implementation to convert the fleet and install the EVSE is $3.3 million in 2025 dollar terms, including the unit costs of individual chargers and the total vehicle cost to convert current internal combustion engine vehicles (ICEVs) to EVs on a 1:1 basis, assuming all vehicles are purchased in a single year. This reflects a $1.8 million premium over a baseline scenario where vehicles are not transitioned to EVs and no chargers are installed. This result, along with the discounted payback period results shown in Table 7 below, suggest that the incrementally higher capital costs may not be offset by operating and maintenance cost savings of operating an EV fleet.

Table 7. Fleet Conversion Financial Analysis Results, DAGS Central Services

Vehicle Type	Breakeven	Useful Life	Calculated Breakeven Year
Sedan	Immediate	12	0.0
Pick-Up Truck	Exceeds useful life	12	15.5
SUV	Beyond study period	12	N/A
Passenger Van	Exceeds useful life	12	24.0

The discounted payback period analysis reveals notable variation across vehicle types, reflecting differences in capital costs, operating expenses, and energy efficiency. As shown in the table above, the sedan is immediately cost effective since the capital cost of an EV is lower than the ICEV. None of the other vehicles offer a payback under the discounted payback period analysis, primarily due to higher upfront costs and lower relative fuel efficiency. These results suggest that smaller vehicles may offer more favorable financial returns under current cost structures and energy prices, though operational needs and service capacity must also be considered in fleet planning.

1.3.5.2 HALE OLA BUILDING

The recommended charging strategy for the Hale Ola Building includes **4 dual-port chargers (8 ports total)** that will serve all of the fleet assigned to this facility. The peak electrical load required for 8 Level 2 ports is approximately 50 kW.

Table 8. Hale Ola Charging Requirements by Vehicle Type

Vehicle Type	Number of Vehicles	Charging Frequency	Max # of Vehicles Charging Per Day
Sedan	6	Every 2 days	3
SUV	6	Every 2 days	3
Pick-Up Truck	1	Every 4 days	1
Passenger Van	1	Every 3 days	1

For the Hale Ola Building, the total cost of electric vehicle implementation is $1.6 million in 2025-dollar terms, including the unit costs of individual chargers and the total vehicle cost to convert current ICEVs to EVs on a 1:1 basis, assuming all vehicles are purchased in a single year. This reflects a $1.4 million premium over a baseline scenario where vehicles are not transitioned to EVs and no chargers are installed. This result, along with the discounted payback period results shown in Table 9 below, suggest that the incrementally higher capital costs may not be offset by operating and maintenance cost savings of operating an EV fleet.

Table 9. Fleet Conversion Financial Analysis Results, Hale Ola Building

Vehicle Type	Breakeven	Useful Life	Calculated Breakeven Year
Sedan	Immediate	12	0.0
Pick-Up Truck	Exceeds useful life	12	15.5
SUV	Beyond study period	12	N/A
Passenger Van	Exceeds useful life	12	24.0

The discounted payback period analysis reveals notable variation across vehicle types, reflecting differences in capital costs, operating expenses, and energy efficiency. As shown in the table above, the sedan is immediately cost effective since the capital cost of an EV is lower than the ICEV. None of the other vehicles offer a payback under the discounted payback period analysis, primarily due to higher upfront costs and lower relative fuel efficiency. These results suggest that smaller vehicles may offer more favorable financial returns under current cost structures and energy prices, though operational needs and service capacity must also be considered in fleet planning.

1.4 Hale Ola Building

A summary of the Facility Energy Strategy for the Department of Health's Hale Ola Building facility is included below. A more comprehensive report on the energy assessment of this facility is included as Appendix A in this report.

1.4.1 Building Efficiency: Energy

Two ECMs are recommended for implementation in support of energy efficiency at the Hale Ola Building facility.

Table 10. ECM Performance Results, Hale Ola Building

Measure ID	Energy Conservation Measures	CapEx (2025$)	Annual Electric Savings (kWh/yr)	Annual Peak Electric Savings (kWh)	Annual GHG Savings (mtCO2e)
DOH – Hale Ola – ECM #1	COMPLETE EXTERIOR LED LIGHTING RETROFIT (150W-220W)	$24,100	26,732	4.04	18.2
DOH – Hale Ola – ECM #2	RETRO-COMMISSIONING	$11,532	22,574	n/a	15.3

1.4.2 Building Efficiency: Water

Three WCMs are recommended for implementation in support of water efficiency at the Hale Ola Building facility.

Table 11. Water Conservation Measure Impacts, Hale Ola Building

Measure ID	Water Conservation Measures	CapEx (2025$)	Annual Water Savings (gallons)
DOH – Hale Ola – WCM1	Replace toilets/ water closets	$8,184	172,172
DOH – Hale Ola – WCM2	Replace urinals	$1,364	56,862
DOH – Hale Ola – WCM3	Replace lavatory faucets	$3,306	12,532

1.4.3 Solar PV and Battery Energy Storage Systems

Various configurations of a base case, roof-mounted solar PV and roof-mounted solar PV paired with a battery energy storage system were modeled for energy and financial performance.

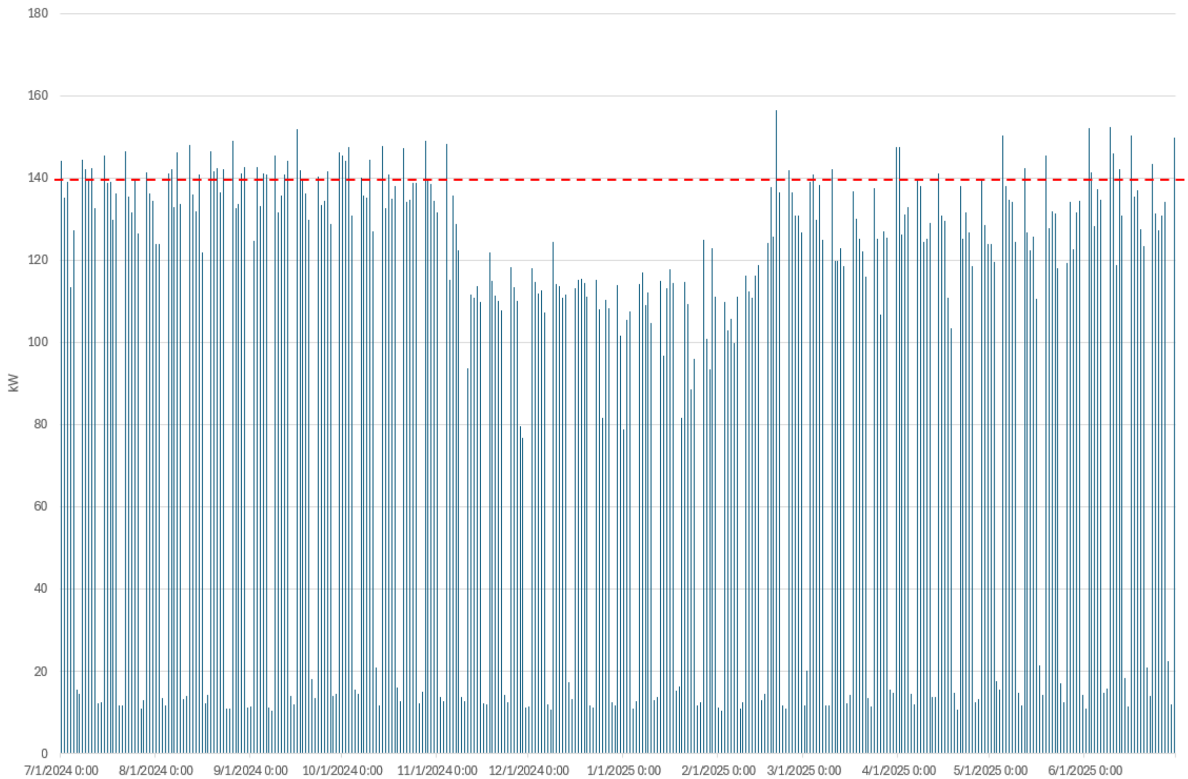
Table 12. Hale Ola Building Renewables HOMER Modeling Summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (HE Sch J - Smart Export)	369,000	N/A	N/A	N/A
95 kW PV Only	241,200	154,500	N/A	39.1
95 kW PV + 52 kWh BESS	231,800	154,500	11,211	39.6

1.4.4 Demand Management and Demand Response

The Hale Ola Building annual electrical load profile based on 15-minute interval data indicates that the facility is a potential candidate to participate in a demand response program. However, given the facility's use by the Department of Health (DOH), further coordination with DOH is necessary to determine if the facility can curtail loads without compromising the core work of the owner. It is also unclear if the current building management systems (BMS) are capable of being used for demand response so further coordination with Hawaiian Electric is recommended.

Figure 1. Hale Ola Building Annual Electricity Load Profile from 15-minute Interval Data, July 2024 - June 2025



1.4.5 Vehicle Electrification

The Hale Ola Building has 14 fleet vehicles assigned. The assigned fleet is predominantly light-duty passenger vehicles made up of sedans and SUVs. The facility will need to provide electric vehicle supply equipment to keep the vehicles charged if the vehicle fleet were to be fully electrified.

Table 13. Hale Ola Charging Requirements per Vehicle Type

Vehicle Type	Number of Vehicles	Charging Frequency	Max # of Vehicles Charging Per Day
Sedan	6	Every 2 days	3
SUV	6	Every 2 days	3
Pick-Up Truck	1	Every 4 days	1
Passenger Van	1	Every 3 days	1

1.4.6 Financial Feasibility

Table 14 below contains a summary of prioritized efficiency measures ranked by benefit cost ratio in descending order. The solar PV alternative offers the highest benefit cost ratio, though the water efficiency measure to replace urinals has the combined highest benefit cost ratio and shortest payback period.

Table 14. Prioritized Efficiency Strategies – Hale Ola Building

Measure ID	Measure Name	Payback Period (years)	Benefit Cost Ratio
DOH – Hale Ola – WCM2	Replace urinals	4.8	4.4
DOH – Hale Ola – RE1	PV Only	8.6	4.4
DOH – Hale Ola – RE2	PV+BESS	9.3	4.0

Measure ID	Measure Name	Payback Period (years)	Benefit Cost Ratio
DOH – Hale Ola – ECM #1	COMPLETE EXTERIOR LED LIGHTING RETROFIT (150W-220W)	5.2	2.8
DOH – Hale Ola – WCM1	Replace toilets/ water closets	9.0	2.2
DOH – Hale Ola – WCM3	Replace lavatory faucets	N/A	0.3

1.5 Central Services Division Administration Office

A summary of the Facility Energy Strategy for the DAGS Central Services Division (CSD) Administration Office facility is included below. A more comprehensive report on the energy assessment of this facility is included as Appendix B in this report.

1.5.1 Building Efficiency: Energy

Four ECMs are recommended for implementation in support of energy efficiency at the CSD Administration Office facility.

Table 15. ECM Performance Results, CSD Administration Office

Measure ID	Energy Conservation Measure	CapEx (2025$)	Annual Electric Savings (kWh/yr)	Annual Peak Electric Savings (kW)	Annual GHG Savings (mtCO2e/ kWh)
DAGS Central Services – ECM #1	COMPLETE INTERIOR LED LIGHTING RETROFIT	$3,969	3,104	0.20	2.11
DAGS Central Services – ECM #2	EXTERIOR LIGHTING REPLACEMENT (150W-220W)	$4,820	5,346	0.81	3.64
DAGS Central Services – ECM #3	LIGHTING OCCUPANCY SENSORS (100% - 5,355 SQFT)	$6,169	2,226	0.26	1.51
DAGS Central Services – ECM #4	RETRO-COMMISSIONING	$1,499	29,786	n/a	20.25

1.5.2 Building Efficiency: Water

Three WCMs are recommended for implementation in support of water efficiency at the CSD Administration Office facility.

Table 16. WCM Performance Results, CSD Administration Office

Measure ID	Water Conservation Measure	Water Conservation Measures Assumptions	
		CapEx (2025$)	Annual Water Savings (gallons)
DAGS Central Services – WCM1	Replace toilets/ water closets	$2,046	27,339
DAGS Central Services – WCM2	Replace urinals	$682	9,266
DAGS Central Services – WCM3	Replace lavatory faucets	$551	1,976

1.5.3 Solar PV and Battery Energy Storage Systems

Various configurations of a base case, roof-mounted solar PV and roof-mounted solar PV paired with a battery energy storage system were modeled for energy and financial performance.

Table 17. Solar PV and BESS Energy Modeling Summary, CSD Administration Office

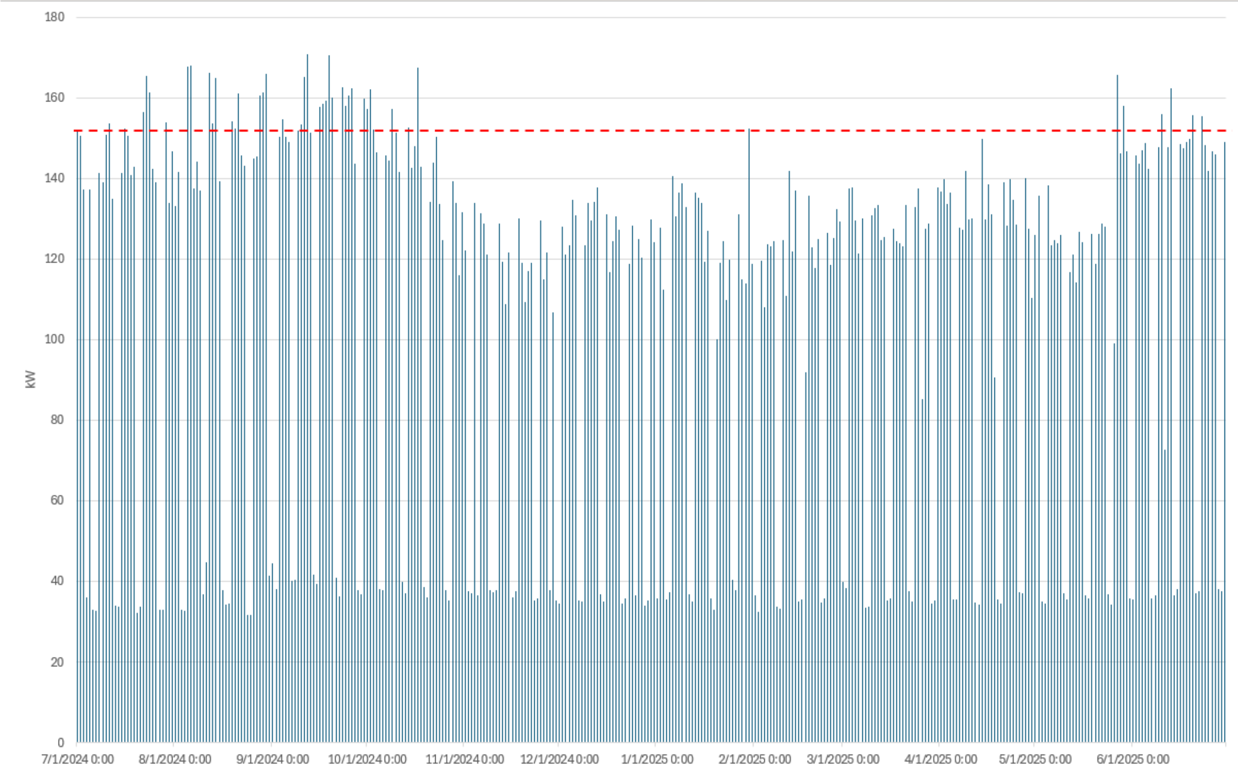
System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (HE Sch J - Smart Export)*	339,000	160,000	N/A	32
148 kW PV Only	280,900	377,000	N/A	57.5
148 kW PV + 51 kWh BESS	268,500	377,000	13,976	58.4

*Base Case Includes Existing 100 kW PV System

1.5.4 Demand Management and Demand Response

The CSD Administration Office facility's annual electrical load profile based on 15-minute interval data indicates that the facility is a potential candidate to participate in a demand response program and further coordination with Hawaiian Electric is recommended.

Figure 2. Annual Electricity Demand Profile from 15-minute Interval Data, CSD Administration Office



1.5.5 Vehicle Electrification

The CSD Administration Office has 55 fleet vehicles assigned to it. The facility will need to provide electric vehicle supply equipment to keep the vehicles charged if the vehicle fleet were to be fully electrified.

Table 18. Charging Requirements by Vehicle Type, CSD Administration Office

Vehicle Type	Number of Vehicles	Charging Frequency	Max # of Vehicles Charging Per Day
Light-Duty Vehicles			
Sedan	8	Every 3 days	3
SUV	1	Every 4 days	1
Pick-Up Truck	18	Every 7 days	3
Passenger Van	9	Every 7 days	2
Medium and Heavy-Duty Vehicles			
Utility Truck	14	Every 2 days	7
Boom Truck	1	Every 4 days	1
Flatbed Truck	1	Every 2 days	1
Stake Truck	1	Every 3 days	1
Refuse Truck	5	Every day	5

1.5.6 Financial Feasibility

Table 19 below contains a summary of prioritized efficiency measures ranked by benefit cost ratio in descending order. The complete interior LED lighting retrofit offers the highest benefit cost ratio of 3.4 among the alternatives for CSD Administration Office building, though the energy efficiency measure to replace exterior lighting has the shortest payback period at 5.2 years.

Table 19. Financial Analysis of Prioritized Energy Efficiency Strategies – CSD Administration Office

Measure ID	Measure Name	Payback Period (years)	Benefit Cost Ratio
DAGS Central Services – ECM #1	COMPLETE INTERIOR LED LIGHTING RETROFIT	6.9	3.4
DAGS Central Services – ECM #2	EXTERIOR LIGHTING REPLACEMENT (150W-220W)	5.2	2.8
DAGS Central Services – RE2	PV+BESS	16.9	1.7
DAGS Central Services – RE1	PV Only	18.7	1.6
DAGS Central Services – WCM2	Replace urinals	14.4	1.4
DAGS Central Services – WCM1	Replace toilets/ water closets	14.6	1.4
DAGS Central Services – ECM #3	LIGHTING OCCUPANCY SENSORS (100% - 5,355 SQFT)	N/A	0.6
DAGS Central Services – WCM3	Replace lavatory faucets	N/A	0.3

1.6 Waimano State Laboratory – Kamauleule Building

A summary of the Facility Energy Strategy for the Department of Health's Waimano State Laboratory – Kamauleule Building is included below. A more comprehensive report on the energy assessment of this facility is included as Appendix C in this report.

1.6.1 Building Efficiency: Energy

Three ECMs are recommended for implementation in support of energy efficiency at the Waimano State Laboratory – Kamauleule Building.

Table 20. ECM Performance Results, Waimano State Laboratory – Kamauleule Building

Measure ID	Energy Conservation Measure	CapEx (2025$)	Annual Electric Savings (kWh/yr)	Annual Peak Electric Savings (kW)	Annual GHG Savings (mtCO2e/yr)
DOH – Lab – ECM #1	COMPLETE INTERIOR LED LIGHTING RETROFIT	$32,467	22,599	3.60	15.4
DOH – Lab – ECM #2	COMPLETE EXTERIOR LED LIGHTING RETROFIT (150W-220W)	$36,150	40,098	6.06	27.3
DOH – Lab – ECM #3	RETRO-COMMISSIONING	$37,679	491,070	n/a	333.9

1.6.2 Building Efficiency: Water

Four WCMs are recommended for implementation in support of water efficiency at the Waimano State Laboratory – Kamauleule Building.

Table 21. Water Conservation Measure Impacts, Waimano State Laboratory – Kamauleule Building

Measure ID	Water Conservation Measure	Water Conservation Measures Assumptions	
		CapEx (2025$)	Annual Water Savings (gallons)
DOH – Lab – WCM1	Replace toilets/ water closets	$8,184	99,546
DOH – Lab – WCM2	Replace urinals	$2,046	31,730
DOH – Lab – WCM3	Replace lavatory faucets	$3,306	7,046
DOH – Lab – WCM4	Replace showerheads	$296	14,053

1.6.3 Solar PV and Battery Energy Storage

Various configurations of a base case, roof-mounted solar PV and roof-mounted solar PV paired with a battery energy storage system were modeled for energy and financial performance.

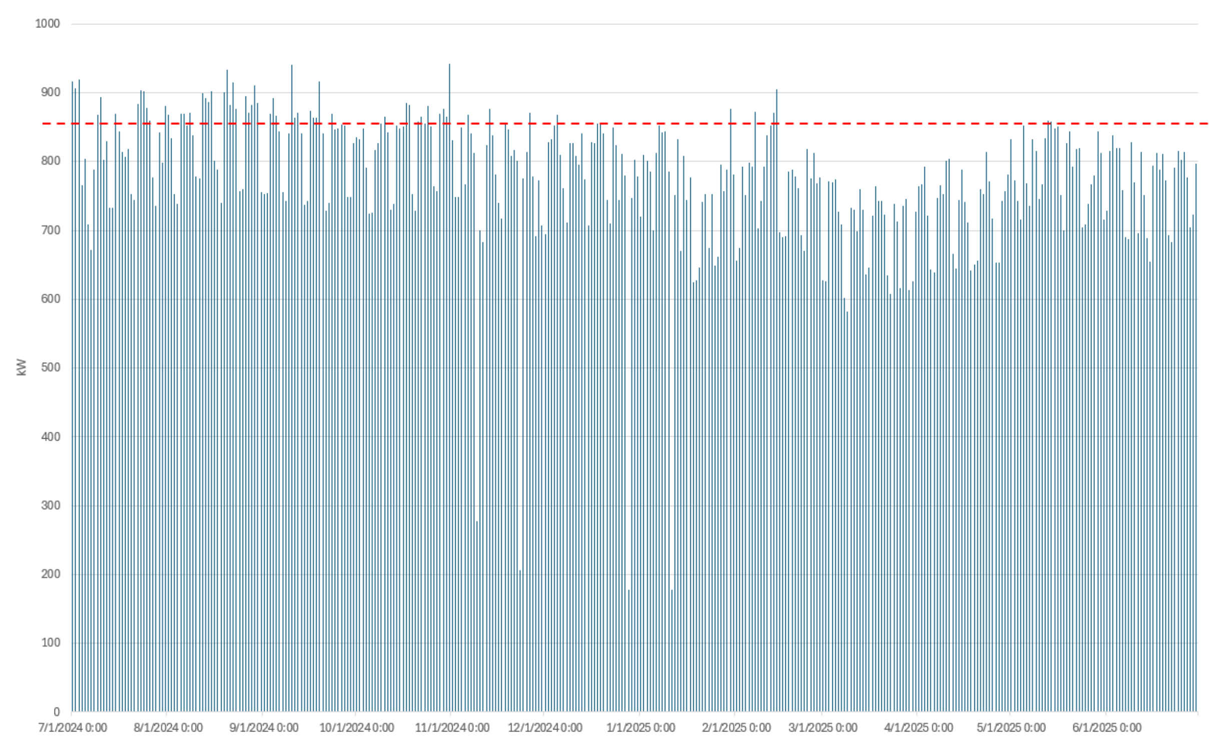
Table 22. Waimano State Laboratory – Kamauleule Building Renewables HOMER Modeling Summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (HE Sch P - Smart Export)	6,017,000	N/A	N/A	N/A
66 kW PV Only	5,910,000	108,000	N/A	1.8
66 kW PV + 2000 kWh BESS	5,923,000	108,000	75,000	1.6

1.6.4 Demand Management and Demand Response

The Waimano State Laboratory – Kamauleule Building annual electrical load profile based on 15-minute interval data indicates that the facility is a potential candidate to participate in a demand response program. However, due to the mission critical nature of the public health work that happens in the facility, there are many loads that cannot be curtailed without impacting the core work of the Department of Health. Further coordination with Hawaiian Electric is recommended.

Figure 3. Annual Electricity Demand Profile from 15-minute Interval Data, Waimano State Laboratory – Kamauleule Building



1.6.5 Vehicle Electrification

The Waimano State Laboratory – Kamauleule Building does not have fleet vehicles assigned to it. The facility has approximately 230 existing parking stalls northeast of the building. If 46 parking stalls (20 percent) were converted to Level 2 EV chargers, then approximately 330 kW of electrical capacity would be required.

1.6.6 Financial Feasibility

Table 23 below contains a summary of prioritized efficiency measures ranked by benefit cost ratio in descending order. The solar PV only configuration offers the highest benefit cost ratio of 5.1 among the alternatives for the Waimano State Laboratory – Kamauleule Building, though the energy efficiency measure to replace exterior lighting has the shortest payback period at 5.2 years.

Table 23. Prioritized Energy Efficiency Strategies – Waimano State Laboratory – Kamauleule Building

Measure ID	Measure Name	Payback Period (years)	Benefit Cost Ratio
DOH – Lab – RE1	PV Only	7.7	5.1
DOH – Lab – ECM #1	COMPLETE INTERIOR LED LIGHTING RETROFIT	7.7	3.0
DOH – Lab – ECM #2	COMPLETE EXTERIOR LED LIGHTING RETROFIT (150W-220W)	5.2	2.8
DOH – Lab – WCM4	Replace showerheads	4.3	2.3
DOH – Lab – WCM2	Replace urinals	12.4	1.6
DOH – Lab – WCM1	Replace toilets/ water closets	16.3	1.3
DOH – Lab – RE2	PV+BESS	N/A	0.2
DOH – Lab – WCM3	Replace lavatory faucets	N/A	0.2

1.7 Hawaiʻi State Library

A summary of the Facility Energy Strategy for the Hawai'i State Library facility is included below. A more comprehensive report on the energy assessment of this facility is included as Appendix D in this report.

1.7.1 Building Efficiency: Energy

Five ECMs are recommended for implementation in support of energy efficiency at the Hawai'i State Library facility.

Table 24. ECM Performance Results, Hawaiʻi State Library

Measure ID	Energy Conservation Measure	CapEx (2025$)	Annual Electric Savings (kWh/yr)	Annual Peak Electric Savings (kW)	Annual GHG Savings (mtCO2e/ yr)
HSL-ECM#1	INTERIOR LED LIGHTING RETROFIT - Linear fluorescent lights	$15,824	10,561	1.80	7.2
HSL-ECM#2	INTERIOR LED LIGHTING RETROFIT - U-bend fluorescent lights	$3,857	8,032	1.50	5.5
HSL-ECM#3	INSTALL OCCUPANCY SENSORS (100% - 128,000 SQFT)	$147,456	44,963	8.68	30.6
HSL-ECM#4	FAN COIL TUNE UP/REPAIRS (REPLACE MOTOR - 1/3 HP)	$34,132	1,602	0.24	1.1
HSL-ECM#5	RETRO-COMMISSIONING	$35,840	49,332	n/a	33.5

1.7.2 Building Efficiency: Water

Three water conservation measures (WCMs) are recommended for implementation in support of water efficiency at the Hawai'i State Library facility.

Table 25. Water Conservation Measures Performance Results, Hawaiʻi State Library

Measure ID	Water Conservation Measure	Water Conservation Measures Assumptions	
		CapEx (2025$)	Annual Water Savings (gallons)
HSL-WCM1	Replace toilets/ water closets	$12,276	60,081
HSL-WCM2	Replace urinals	$4,092	23,166
HSL-WCM3	Replace lavatory faucets	$3,306	4,550

1.7.3 Solar PV and Battery Energy Storage

The Hawaiʻi State Library building has a unique shaped roof with both sloped and flat sections. The building has some shading concerns from rooftop obstructions and surrounding trees. The north and northwest facing roof areas were not considered for solar to due shading and potential for decreased energy production.

Various configurations of a base case, roof-mounted solar PV and roof-mounted solar PV paired with a battery energy storage system were modeled for energy and financial performance. The estimated solar capacity for the structure is 115 kW DC between the flat and sloped roof sections.

Table 26. Hawaiʻi State Library Renewables HOMER Modeling Summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (HE Sch J - Smart Export)	981,000	N/A	N/A	N/A
115 kW PV Only	797,100	187,000	N/A	19
115 kW PV + 70 kWh BESS	797,000	187,000	1,750	19

1.7.4 Demand Management and Demand Response

Hawaiian Electric was not able to provide 15-minute interval data for the Hawaiʻi State Library so no quantitative analysis was done. It is not clear that the facility's BMS is capable of controlling loads in a way that would allow participation in a demand response program. We encourage HSL to have further discussions with Hawaiian Electric about the potential for participating in one of their demand response programs.

1.7.5 Vehicle Electrification

The Hawaiʻi State Library does not have any fleet vehicles assigned to it. The facility has 22 existing parking stalls northwest of the library at the Hawaiʻi State Archives building, near the Iolani Palace. If four parking stalls (20%) were converted to EV, then approximately 30 kW of electrical capacity would be required.

1.7.6 Financial Feasibility

Table 27 below contains a summary of prioritized efficiency measures ranked by benefit cost ratio in descending order. The interior LED retrofit offers the highest benefit cost ratio of 9.0 among the alternatives for the Hawaiʻi State Library building, as well as the shortest payback period at 3.2 years.

Table 27. Prioritized Energy Efficiency Strategies, Hawai‘i State Library

Measure ID	Measure Name	Payback Period (years)	Benefit Cost Ratio
HSL- ECM#2	INTERIOR LED LIGHTING RETROFIT - U-bend fluorescent lights	3.2	9.0
HSL – RE1	PV Only	7.6	5.2
HSL – RE2	PV+BESS	8.8	4.4
HSL- ECM#1	INTERIOR LED LIGHTING RETROFIT - Linear fluorescent lights	8.0	2.9
HSL- WCM2	Replace urinals	N/A	0.6
HSL- ECM#3	INSTALL OCCUPANCY SENSORS (100% - 128,000 SQFT)	N/A	0.5
HSL- WCM1	Replace toilets/ water closets	N/A	0.5
HSL- ECM#4	FAN COIL TUNE UP/REPAIRS (REPLACE MOTOR - 1/3 HP)	N/A	0.1
HSL- WCM3	Replace lavatory faucets	N/A	0.1

1.8 OR&L Main Building

A summary of the Facility Energy Strategy for the OR&L Main Building facility is included below. A more comprehensive report on the energy assessment of this facility is included as Appendix E in this report.

1.8.1 Building Efficiency: Energy

Four ECMs are recommended for implementation in support of energy efficiency at the OR&L Main Building facility.

Table 28. ECM Performance Results, OR&L Main Building

Measure ID	Energy Conservation Measures	CapEx (2025$)	Annual Electric Savings (kWh/yr)	Annual Peak Electric Savings (kWh)	Annual GHG Savings (mtCO2e)
DAGS OR&L – ECM#1	1ST FLOOR WINDOW FILM REPLACEMENT (SW - 52 SQFT)	$48	1,026	0.08	0.7
DAGS OR&L – ECM#2	COMPLETE INTERIOR LED LIGHTING RETROFIT	$15,326	12,004	0.90	8.2
DAGS OR&L – ECM#3	EXTERIOR HALLWAYS LIGHTING REPLACEMENT (150W-220W)	$12,050	13,366	2.02	9.1
DAGS OR&L – ECM#4	RETRO-COMMISSIONING	$5,799	9,247	n/a	6.3

1.8.2 Building Efficiency: Water

Three WCMs are recommended for implementation in support of water efficiency at the OR&L Main Building facility.

Table 29. Water Conservation Measure Performance Impacts, OR&L Main Building

Measure ID	Water Conservation Measures	CapEx (2025$)	Annual Water Savings (gallons)
DAGS OR&L – WCM1	Replace toilets/ water closets	$2,728	8,428
DAGS OR&L – WCM2	Replace urinals	$1,364	9,984
DAGS OR&L – WCM3	Replace lavatory faucets	$1,102	1,983

1.8.3 Solar PV and Battery Energy Storage

Various configurations of a base case, roof-mounted solar PV and roof-mounted solar PV paired with a battery energy storage system were modeled for energy and financial performance. The estimated total capacity of the roof is 65 kW DC.

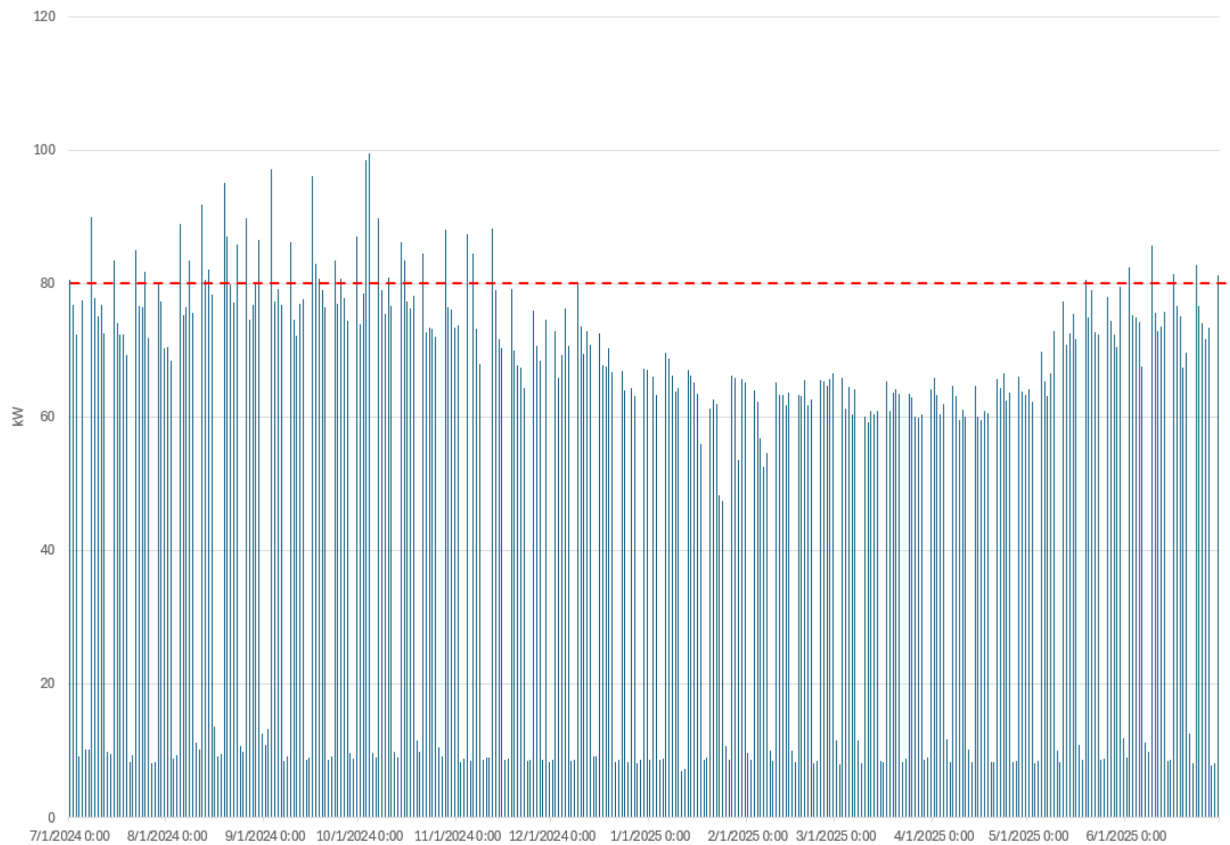
Table 30. OR&L Main Building Renewables HOMER Modeling Summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (HE Sch J - Smart Export)	185,200	N/A	N/A	N/A
62.5 kW PV	114,442	102,347	N/A	47.2
62.5 kW PV + 31 kWh BESS	107,800	102,347	7,740	48.3

1.8.4 Demand Management and Demand Response

The OR&L Main Building annual electrical load profile based on 15-minute interval data indicates that the facility is a potential candidate to participate in a demand response program. Based on information gathered for this assessment, it seems likely but needs to be confirmed that the current BMS is capable of being used for demand response. Further coordination with Hawaiian Electric is recommended.

Figure 4. Annual Electricity Demand Profile from 15-minute Interval Data, OR&L Main Building



1.8.5 Vehicle Electrification

There are no fleet vehicles assigned to the OR&L Main Building. The OR&L Main Building has 28 existing parking stalls near the building. If 6 parking stalls (20 percent) were converted to Level 2 EV chargers, then approximately 43 kW of electrical capacity would be required.

1.8.6 Financial Feasibility

Table 31 below contains a summary of prioritized efficiency measures ranked by benefit cost ratio in descending order. The first floor window film replacement (ECM #1) offers the highest benefit cost ratio of 44.4 among the alternatives for the OR&L Main Building, as well as the shortest payback period at 0.2 years, indicating an extremely advantageous payback for this measure.

Table 31. Prioritized Energy Efficiency Strategies – OR&L Main Building

Measure ID	Measure Name	Payback Period (years)	Benefit Cost Ratio
DAGS OR&L – ECM#1	1ST FLOOR WINDOW FILM REPLACEMENT (SW - 52 SQFT)	N/A	44.4
DAGS OR&L – RE1	PV Only	9.2	3.9
DAGS OR&L – ECM#2	COMPLETE INTERIOR LED LIGHTING RETROFIT	6.9	3.4

Measure ID	Measure Name	Payback Period (years)	Benefit Cost Ratio
DAGS OR&L – RE2	PV+BESS	10.9	3.2
DAGS OR&L – ECM#3	EXTERIOR HALLWAYS LIGHTING REPLACEMENT (150W-220W)	5.2	2.8
DAGS OR&L – WCM2	Replace urinals	N/A	0.8
DAGS OR&L – WCM1	Replace toilets/ water closets	N/A	0.3
DAGS OR&L – WCM3	Replace lavatory faucets	N/A	0.1

1.9 Hawai‘i Film Studio Complex: Production Office, Sound Stage 2, Crew Bathrooms, and Guard Stand

A summary of the Facility Energy Strategy for the Hawai‘i Film Studio Complex is included below. A more comprehensive report on the energy assessment of this facility is included as Appendix F in this report.

A substantial impact on this study is that the Hawai‘i Film Studio Complex was mostly unoccupied and not used for film production during the 12-month study period from July 2024 through June 2025. This study period was chosen for consistency with the other facilities assessed for the State Facility Energy Strategy project. The recommended ECMs are all still applicable under any occupancy scenario, but the facility's energy performance and the modeled impacts of the recommended measures are only representative of the facility being minimally occupied for film production throughout the year

1.9.1 Building Efficiency: Energy

Three ECMs are recommended for implementation in support of energy efficiency at the Hawai‘i Film Studio Complex.

Table 32. ECM Performance Results, Hawai‘i Film Studio Complex

Measure ID	Energy Conservation Measure	CapEx (2025$)	Annual Electric Savings (kWh/yr)	Annual Peak Electric Savings (kW)	Annual GHG Savings (mtCO2e/ kWh)
Film Studio – Stage 2 – ECM #1	COMPLETE INTERIOR LED LIGHTING RETROFIT	$50,393	28,319	2	19.3
Film Studio – Stage 2 – ECM #2	EXTERIOR LIGHTING REPLACEMENT (150W-220W)	$31,250	33,415	5.1	22.7
Film Studio – Stage 2 – ECM #3	LIGHTING OCCUPANCY SENSORS (100% - 26,000 SQFT)	$59,218	33,415	2.3	13.8

1.9.2 Building Efficiency: Water

Three WCMs are recommended for implementation in support of water efficiency at the Hawai‘i Film Studio Complex.

Table 33. Water Conservation Measure Performance Results, Hawai‘i Film Studio Complex

Measure ID	Water Conservation Measures	CapEx (2025$)	Annual Water Savings (gallons)
Film Studio – Production Office – WCM1	Replace toilets/ water closets	$3,410	85,436
Film Studio – Production Office – WCM2	Replace urinals	$682	28,080
Film Studio – Production Office – WCM3	Replace showerheads	$148	6,825

1.9.3 Solar PV and Battery Energy Storage

Various configurations of a base case, roof-mounted solar PV and roof-mounted solar PV paired with a battery energy storage system were modeled for energy and financial performance. The estimated total capacity of the roof is 190 kW DC for Sound Stage 2 and 68 kW DC for the Production Office.

Table 34. Hawai‘i Film Studio Complex: Sound Stage 2 Renewables HOMER Modeling Summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (HE Sch J - Smart Export)	166,000	N/A	N/A	N/A
190 kW PV Only	84,000	595,150	N/A	77.8
190 kW PV + 110 kWh BESS	56,200	595,150	31,370	83.7

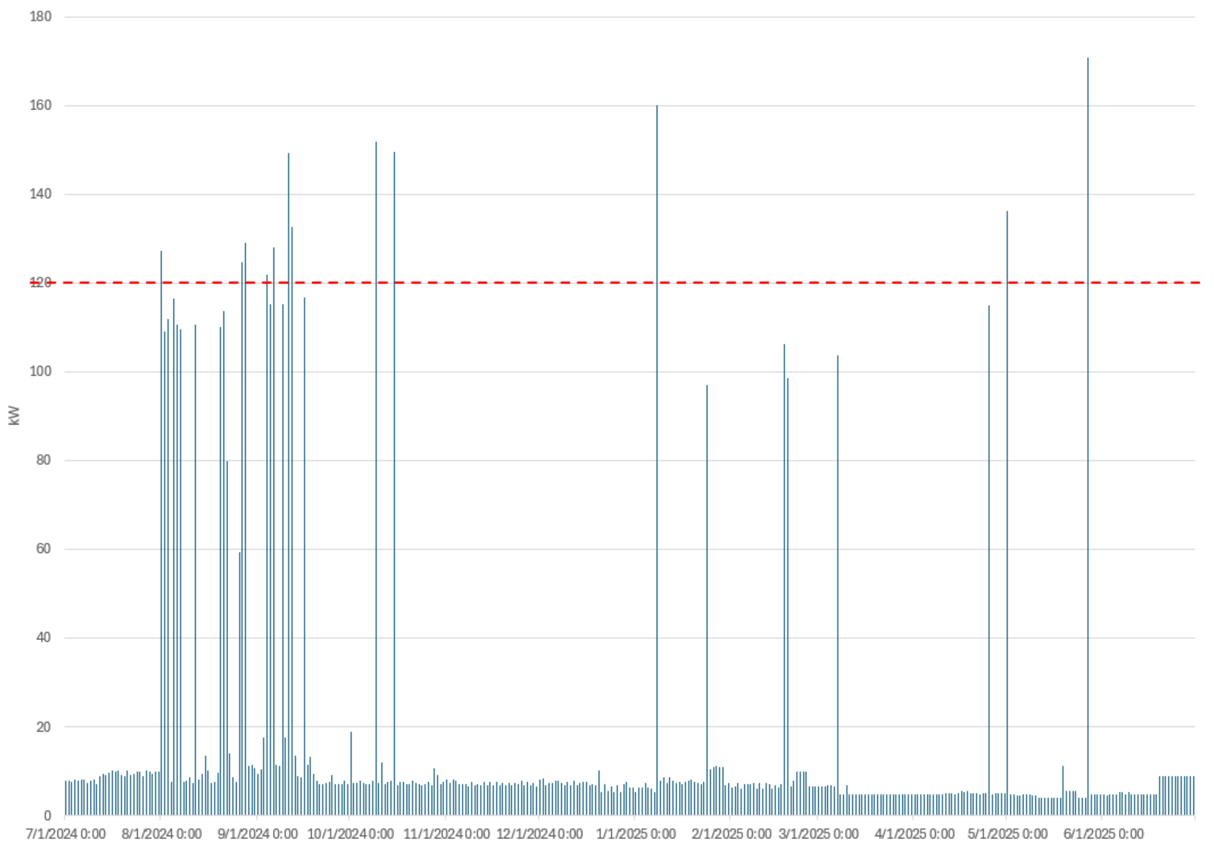
Table 35. Hawai‘i Film Studio Complex: Production Office Renewables HOMER Modeling Summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (HE Sch J - Smart Export)	56,000	N/A	N/A	N/A
68 kW PV Only	29,000	109,700	N/A	79
68 kW PV + 32 kWh BESS	20,800	109,700	9,100	83.8

1.9.4 Demand Management and Demand Response

The Hawai‘i Film Studio Complex annual electrical load profile based on 15-minute interval data indicates that the facility is a potential candidate to participate in a demand response program. However, although the facility is expected to experience substantial spikes in electrical demand when there is active film production, the loads that can be curtailed for demand management are likely limited to the electrical loads from the base building equipment, which are more limited. The Hawaiʻi Film Studio complex is a unique usage case but does experience peak loads that could potentially be managed to reduce the Hawaiʻi Film Studio's monthly energy costs. Further coordination with Hawaiian Electric around demand management is strongly encouraged.

Figure 5. Annual Electricity Load Profile from 15-minute Interval Data, Hawaiʻi Film Studio Complex



1.9.5 Vehicle Electrification

There are no fleet vehicles assigned to the Hawaiʻi Film Studio Complex. The Film Studio Complex has approximately 150 existing parking stalls throughout the facility, with a large parking area located north of the Production Office. If 30 parking stalls (20 percent) were converted to Level 2 EV chargers, then approximately 216 kW of electrical capacity would be required.

1.9.6 Financial Feasibility

Table 36 below contains a summary of prioritized efficiency measures ranked by benefit cost ratio in descending order. The replace toilets measure (WCM #1) offers the highest benefit cost ratio of 4.3 among the alternatives for the Production Office, while the alternative with the shortest payback was the replace lavatory faucets alternative. At the Stage 2 facility, the complete interior LED lighting retrofit (ECM #1) is the highest return, based on a benefit cost ratio of 3.4.

Table 36. Prioritized Energy Efficiency Strategies – Film Studio

Measure ID	Measure Name	Payback Period (years)	Benefit Cost Ratio
	Production Office		
Film Studio – Production Office – WCM1	Replace toilets/ water closets	4.9	4.3
Film Studio – Production Office – WCM2	Replace urinals	7.6	2.6
Film Studio – Production Office – WCM3	Replace lavatory faucets	4.4	2.2
Film Studio – Production Office – WCM4	Replace showerheads	17.2	1.7
Film Studio – RE1	PV Only	18.9	1.6
Film Studio – RE2	PV+BESS	N/A	0.5
	Stage 2		
Film Studio – Stage 2 – ECM #1	COMPLETE INTERIOR LED LIGHTING RETROFIT	6.9	3.4
Film Studio – Stage 2 – ECM #2	LIGHTING OCCUPANCY SENSORS (100% - 48,860 SQFT)	5.2	2.8
Film Studio – Stage 2 – ECM #3	EXTERIOR AND PARKING LOT LED LIGHTING RETROFIT (35W-149W)	16.9	1.8
Film Studio – RE1	PV Only	18.2	1.7
Film Studio – RE2	PV+BESS	N/A	0.6

2 Introduction

2.1 Project Background

The Hawai‘i State Energy Office (HSEO) contracted with HDR to develop a multi-part energy strategy for improved energy efficiency, building operational performance, and utility bill savings potential for small- to medium-sized State-owned facilities. The State Facility Energy Strategy is based on a representative sample of applicable facilities and considers current technologies, incentives, tariff and grid options, energy costs, financing approaches, and specific capabilities of small and medium State agencies, which may not have the capacity to leverage Energy Savings Performance Contracts (ESPC). Small- to medium-sized facilities are defined as those between 10,000 and 200,000 gross square feet (sf).

The State Facility Energy Strategy project is consistent with Act 239 Session Laws of Hawai‘i 2022, which requires and establishes deadlines for state facilities over 10,000 sq. ft. to implement cost-effective energy efficiency measures beginning July 1, 2023, where feasible and cost-effective. The categories of energy solutions explored through the State Facility Energy Strategy project include:

- Building efficiency: Energy
- Building efficiency: Water
- Solar photovoltaic (PV) renewable energy systems and battery energy storage system (BESS)
- Demand management and demand response
- Vehicle electrification and electric vehicle supply equipment (EVSE)
- Financial Feasibility

Hawai‘i has ambitious energy efficiency goals established in the Energy Efficiency Portfolio Standard (EEPS) under Hawai‘i Revised Statutes (HRS) section 269-96 with a target goal of achieving 6,000 gigawatt-hours (GWh) of electricity savings by 2045. Hawai‘i’s state buildings are large consumers of electricity, consuming over 670 million kilowatt-hours of electricity in 2024. This project is consistent with HRS section 196-72, which requires the Chief Energy Officer to formulate, analyze, recommend, and take actions to cost-effectively and equitably achieve the State’s energy goals in addition to providing technical assistance to state agencies to assess and implement projects and programs related to energy conservation and efficiency. In addition, this project also supports Act 239 Session Laws of Hawai‘i, 2022, which requires and establishes deadlines for state facilities over 10,000 square feet to implement cost-effective energy efficiency measures beginning July 1, 2023, where feasible and cost-effective. Additional Hawai‘i state statutes are also aimed at energy conservation and efficiency in public facilities, including HRS section 196-30[1], which requires public buildings to be energy benchmarked and retro-commissioned no less often than every 5 years.

2.2 Project Goals

HSEO defined the following goals for the State Facility Energy Strategy project:

- HSEO meeting its statutory authority under State of Hawai‘i, Act 239 of 2022

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[1] Hawaii Revised Statutes § 196-30 (2024) - Public buildings; benchmarks; retro-commissioning guidelines; energy savings performance contracts. :: 2024 Hawaii Revised Statutes :: U.S. Codes and Statutes :: U.S. Law :: Justia

- HSEO helping other State agencies to meet their statutory requirements relating to energy and resource efficiency and to reduce State facility energy use and cost
- Identifying energy savings potential to enable agencies to make informed energy investment decisions

2.3 Report Structure

This report is structured so that the main body of the report provides the overall findings and a summary of the individual facilities that were assessed. Detailed assessments of each facility are included as appendices to the report.

The appendices at the back of this report provide a more comprehensive energy assessment for each facility, including details about all the measures that have been recommended across all of the energy categories, as well as why they have been recommended. Each appendix also includes the physical details of each facility, a summary of what was assessed, the facility’s baseline energy performance and a customized set of recommendations organized into a Facility Energy Strategy.

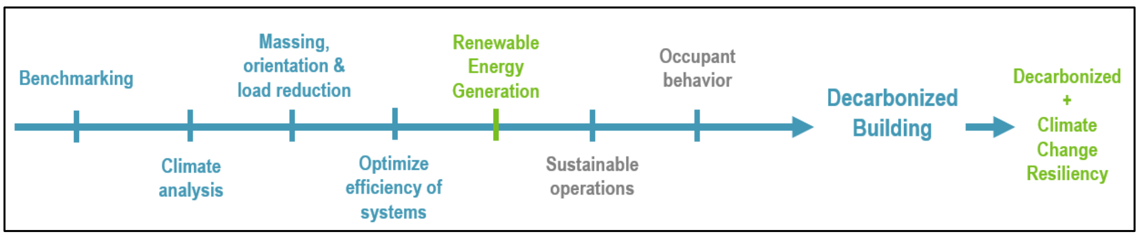
3 Analytical Methodology

This report assesses energy efficiency and utility cost saving deployment options for each facility based on current technologies, incentives, tax credits, tariff and grid options, energy costs, water costs, financing approaches, and specific capabilities of each facility. Strategy options include solar/battery energy storage projects, demand management and demand response, water savings and electric vehicle supply equipment that will facilitate electric fleet vehicle charging.

3.1 Building Efficiency: Energy

Reducing energy usage and cost in a building and ultimately reducing carbon emissions needs to follow a strict pathway to truly optimize the capacity and sizing of building HVAC equipment and build renewable energy systems.

Figure 6. Process for High Performance Buildings

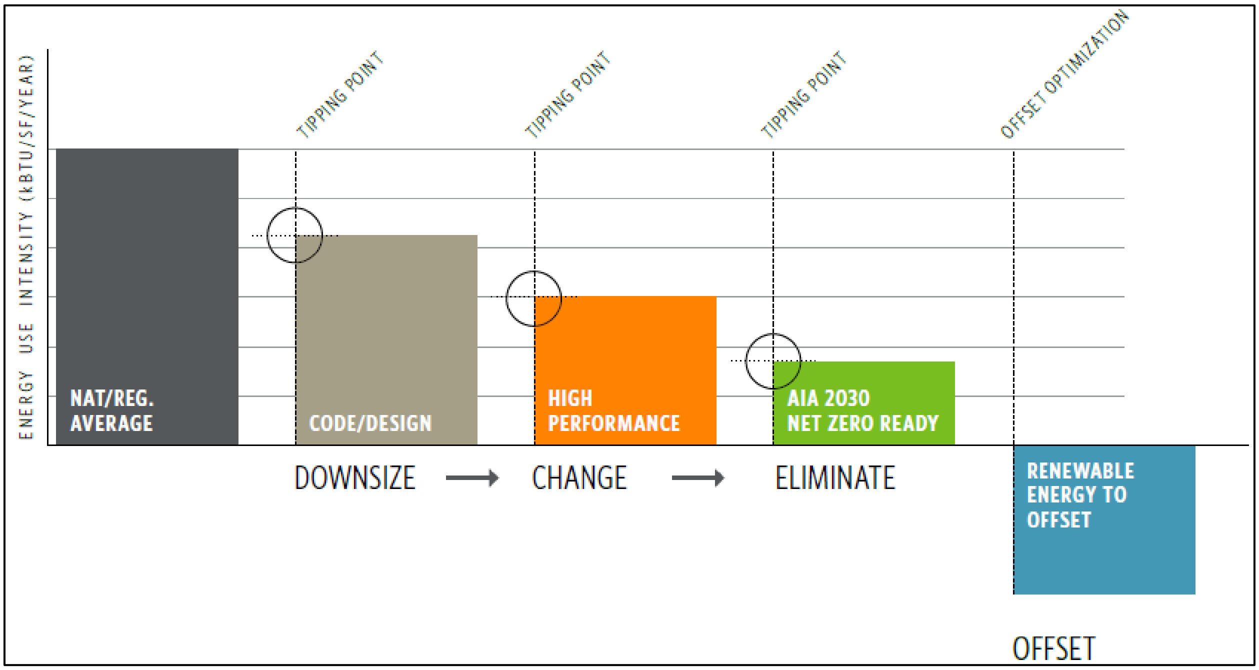


The more granular steps identified in the previous graphic are detailed as follows:

- **Be Climate Specific –** Understand project-specific climate conditions and opportunities and identify potential design measures appropriate for the project type and local climate.
- **Minimize Building Loads –** Improve the building envelope, reduce lighting power densities and usage, incorporate suitable daylighting techniques, reduce equipment power densities and usage, and reduce water consumption flow rates.
- **Improve System Efficiency –** Improve HVAC system design, increase motor efficiencies, utilize solar heating technologies, incorporate energy recovery technologies, utilize applicable controls strategies, increase plant efficiency, review utility rate options, and evaluate heating and cooling options.
- **Maximize Renewable Generation –** Provide suitable rooftop renewable energy generation and incorporate energy storage techniques. Many facilities also have potential for siting ground-mounted solar PV or canopy-mounted solar PV over parking areas. Assessments beyond rooftop solar are outside the scope of this study but further analysis of solar PV potential is encouraged.
- **Optimize Operations and Maintenance –** Establish continuous commissioning, measurement, and verification practices; incorporate robust training programs; and educate and inform occupant behavior.

By following this focused pathway to decarbonization, a phenomenon called "tipping points" presents itself, in that optimization to a building's internal loads (envelope, lighting, plug/process, etc.) results in lower heat gains/losses and thus a "tipping point" is developed. When this occurs, the larger HVAC equipment previously needed to serve the building loads can be replaced with smaller and more appropriately sized equipment, resulting in annual operational savings from both energy usage and O&M. Continuing along that pathway, through more efficient MEP systems that consume less energy, the overall annual energy profile of the building would be lower, resulting in smaller and more cost-effective renewable energy systems to meet the on-site percentile offsets desired for the project's carbon emission and resiliency goals.

Figure 7. Decarbonization & Energy Efficiency Tipping Points



The facility energy efficiency data and results provided in this report are based on information provided by the building operators via HSEO, design and operational building information documents issued in response to a detailed request for information, photographs and interviews with representatives of the state agency responsible for the building, including facilities personnel. Physical site surveys and onsite evaluations were not conducted as part of this study. The audit approach is based on a desktop version of an enhanced ASHRAE Level 1 Audit, as defined in the Procedures for Commercial Building Energy Audits (ANSI/ASHRAE/ACCA Standard 211-2018).

Modeling of energy performance impacts is based on the methods, formulas and default assumptions for estimating energy consumption and peak demand impacts of energy conservation measures (ECMs) defined in the Hawai‘i Technical Reference Manual, Program Year 2024 v1.2[2], provided as a public benefit by Hawai‘i Energy. Energy conservation measures are modeled as standalone measures, and do not account for any interactive effects, such as when a reduction in equipment run time reduces the potential energy saving impacts of installing a high efficiency motor in a supply air fan.

Energy consumption and cost data are based on Hawaiian Electric bill data from a 12-month period of July 2024 through June 2025, as provided by the state agency responsible for each facility. In most cases, one actual utility bill was provided for each facility, which included 12 months of historical total facility energy consumption and cost data, rather than 12 actual utility bills with granular information, such as peak demand and detailed cost information. All analysis of greenhouse gas emissions is limited to Scope 2 emissions from purchased electricity, in this case all from Hawaiian Electric. The carbon emission factor of Hawaiian Electric’s electric grid is taken from US EPA’s E-Grid database,[3] using data from 2023 that was published on June 12, 2025 for the HIOA subregion, which covers all O‘ahu.

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[2] https://hawaiienergy.com/about/information-reports/

[3] https://www.epa.gov/egrid/summary-data

Cost estimating is based on installation costs, including equipment, labor, and contractor overhead and profit. All cost data are sourced from RS Means,[4] version 8.7 for commercial new construction for 2025 Q3, assuming union labor at national average rates. Hawaiʻi-specific labor rate data were not available.

The audit approach follows the requirements for an ASHRAE Level 1 Audit defined in the Procedures for Commercial Building Energy Audits (ANSI/ASHRAE/ACCA Standard 211-2018), including:

- Conduct a Preliminary Energy Analysis (PEA)[5]
    - Review Historical Utility Data
    - Review Rate Structure
    - Calculate the Energy Use Intensity (EUI)
    - Calculate the Energy Cost Index (ECI)
- Perform Facility Site Survey
    - Review as-built drawings
    - Review of previous audit reports
    - Review operations and maintenance problems and needs
    - Review major energy using systems, processes, and equipment
    - Review BAS sequence of operations, control set points, and sequences
    - Interviews with building owners, operations staff, and occupants
- Identify Energy Conservation Measures (ECMs)
    - Identify low-cost and no-cost ECMs
    - Identify but don't quantify potential Capital Intensive ECMs
- Generating an Energy Audit Report
- Review ECMs with Owner Representative

All conclusions and recommendations in this report have been determined with reasonable professional care, and judgments are based solely upon the data available at the time of report preparation. Since this is an enhanced ASHRAE Level 1 energy audit, all EEM energy savings and implementation costs are very rough order of magnitude estimates. For all capital cost measures, further investigation of implementation scope and costs is required to determine the project specific costs and return on investment (ROI).

3.2 Building Efficiency: Water

Reducing water use and cost at State-owned facilities will have the multiple benefits of directly conserving Hawaiʻi's most precious resource, potable water, lowering operating costs for State agencies and reducing the amount of energy required to pump the water from its source to its sink. State-owned facilities have water conservation opportunities for both indoor and exterior water use. Water conservation results and performance data for each facility are based on 12 months of facility level water usage and cost, information provided by the building operators via HSEO, design and operational building information documents issued in response to a detailed request for information, photographs and interviews with representatives of the state agency responsible for the building, including facilities personnel. Indoor water use reductions are quantified and

[4] https://www.rsmeansonline.com/ManageAccount/QuickStart

[5] Typically, an ASHRAE energy audit would include energy benchmarking through EnergyStar Portfolio Manager. Facility energy benchmarking is being conducted under a separate contract and is not currently available for use so is excluded from this project.

exterior water use reductions are addressed qualitatively. Physical site surveys and onsite evaluations were not conducted as part of this study.

Water usage and cost data are sourced from utility bills from the Board of Water Supply for the 12-month period of July 2024 – June 2025. Indoor water fixture flush and flow rates are obtained from as-built design drawings where possible, discussed with facilities personnel and, if necessary, estimated based on the vintage of the plumbing system. Similarly, fixture counts are obtained from as-built design drawings or interviews with facilities personnel, wherever possible, and estimated based on building size and layout, if necessary.

Water use reductions are calculated using the LEED WEp2 v4_Indoor Water Use Reduction Calculator, version 03.0.[6] Each facility's existing indoor water fixtures are used as the baseline, rather than the LEED indoor water use baseline default values provided by the calculator. The facility indoor water use reductions are based on comparing the baseline indoor water usage against the predicted indoor water usage with high efficiency fixtures. Facilities personnel provided the occupancy of each facility in response to a request for information.

Opportunities for exterior water conservation are explored qualitatively. Equipment specifications, operational schedules, and exterior-only water use consumption data were not available, preventing quantitative modeling of performance impacts. It is important to note that exterior water applications typically account for a higher percentage of total facility water consumption than indoor water fixtures so deeper analysis of exterior water conservation opportunities is strongly encouraged.

3.3 Solar Photovoltaic and Battery Energy Storage Systems

3.3.1 Solar Photovoltaic Renewable Energy Systems

Facility roof characteristics such as parapet height, roof replacement year, material, slope, and shading characteristics were reviewed for potential rooftop solar array configuration and to estimate the renewable energy generation capacity at the facility. The QCells Q.Tron XL-G2 620-645W bifacial module was utilized for design assumptions when considering potential rooftop solar capacity at each facility. The actual capacity for rooftop solar may vary based on the equipment chosen during system design and further analysis of the rooftop.

The condition and age of a facility's roof should be factored into the decision of when to install rooftop solar PV. For example, if a roof is less than 5-10 years old and in generally good condition, a rooftop solar PV system can likely be implemented immediately, as both systems will have a similar timeline for replacement. Conversely, roofs that were installed more than 5-10 years ago may need to be replaced before the solar PV system reaches the end of its useful life and may not be ideal candidates for immediate installation from a cost standpoint. If a roof is nearing replacement or currently in need of repair, that is considered an appropriate time to coordinate implementation of a future PV system for that facility. Roofs typically have a lifespan of 15 to 30 years, depending on the type of roofing system and the climate the roof is exposed to. PV systems have a typical lifespan of approximately 25 years, but may be impacted if the system is decommissioned or relocated due to roof repair or replacement. It should be noted that some PV modules have longer lifespans, with warranties extending up to 30 years, depending on the module manufacturer.

[6] usgbc.org/credits/new-construction-core-and-shell-data-centers-new-construction-warehouse-and-distribution?view=resources&return=/credits/New Construction/v4/Water efficiency

This solar module assumed a 2.1 kW DC capacity for every 100 square feet of usable rooftop space, and a DC:AC ratio of 1.25 was considered. Available roof area indicates portions of the roof that are within reasonable solar azimuth angles and are free of obstructions and shading. To determine the conservative rooftop capacity, the following equation was utilized:

Available Roof Area — Module Capacity Per Given Area — Capacity Limiting Factor

$$\boldsymbol{Total\ Capacity}\ (kW) = \left(L\ (ft) \times W\ (ft)\right) \times \left(\frac{2.1\ kW}{100\ sqft}\right) \times (.75)$$

When considering restrictions such as local fire requirements for solar array pathway setbacks, roof area coverage, shading, and module damage, a 0.75 capacity limiting factor was applied to each capacity estimation. This total capacity and client-provided base building energy load data was processed through the HOMER modeling software. The HOMER analysis produces an optimized solar array size that can best serve the building. This array size takes the current load data and utility tariff into consideration and may be equal to or less than the total available solar capacity. This determined DC capacity will differ from the AC capacity seen by the interconnecting entity for the system due to conversion efficiency losses.

PV system models utilized estimations for the solar azimuth angle. In the case where PV layouts consisted of multiple orientations, the total system capacity was split and modeled with azimuth angles corresponding to the module orientation. The total recommended capacity is reflected as a sum of all the system orientations, although it is recommended to utilize azimuth angles ranging from +90° or -90° from due south. For most buildings, the optimal system size will lie within this range of azimuth angles as systems with angles outside this range tend to have lower annual production and thus a lower return on investment. Production of potential PV systems should be evaluated further during the design phase of the system.

All HOMER model runs utilized Hawaiian Electric Schedule J – General Service Demand except for the Waimano State Laboratory – Kamauleule Building, which utilized Hawaiian Electric Schedule P – Large Power Service for annual utility cost estimation. All utility tariffs utilized the Hawaiian Electric Smart Export program to determine bill credits from exporting renewables back to the grid. Renewable fraction estimates for each system are calculated as the ratio of the total energy provided from renewable sources to the total load on an annual basis.

An estimated annual 15-minute load profile for use in the HOMER model was generated for each facility based on a year's worth of 15-minute energy consumption interval data for that facility, if available, otherwise from a proxy facility's data. Monthly and annual energy consumption as well as energy cost was pulled from recent utility bills provided by each facility.

Multiple metrics are utilized to indicate the cost performance of PV and PV + BESS systems. CAPEX is the amount of upfront capital required for equipment and system installation. Net present cost is the total cost of the system, including CAPEX, O&M costs, annual utility costs. For the systems studies in this report, a lower net present cost represents a system that reduces the total energy costs of the building over the study period. The base case system for each building considers only energy purchased from the utility, unless otherwise noted.

3.3.2 Battery Energy Storage Systems

Due to the location of the reviewed facilities, small-scale BESS was coupled with solar equipment or EV charging infrastructure. The model assumed that lithium-ion BESS would be the battery type utilized at each site. The BESS equipment, coupled with the solar array was sized through the HOMER modeling software and is primarily dependent on the existing building load profile and potential solar capacity. The acoustic and aesthetic pollutants associated with standalone BESS near commercial or residential zones may impact the equipment size and location.

3.4 Demand Management and Demand Response

For state-owned facilities, energy demand management and demand response strategies are powerful tools to reduce utility costs, generate revenue, and improve operational efficiency, while also supporting grid reliability. By strategically managing peak energy consumption through load shifting, energy-efficient technologies, and smart scheduling, state-owned facility operators can avoid costly demand charges and take advantage of lower off-peak rates. This not only leads to direct financial savings but also supports broader sustainability and climate goals mandated by State policies. Moreover, demand response programs, including Hawaiian Electric's, typically directly pay customers for curtailing loads during a demand response event, providing an additional source of revenue for the facility, albeit modest.

Demand response programs offer additional value by enabling State owned facilities to support grid reliability while earning financial incentives. During periods of high grid stress, facilities can temporarily reduce or shift energy use in coordination with utility signals, helping to prevent outages and reduce reliance on fossil-fuel peaker plants. Participation in these programs can generate revenue or rebates, which can be reinvested into further energy upgrades or community services. Moreover, integrating demand response with building automation systems allows State agencies to make data-driven decisions that align with fiscal responsibility, energy resilience and environmental stewardship.

As of the time this report is published, the only demand response program from Hawaiian Electric that commercial customers, including State owned facilities, can consider is the Fast DR program. Figure 8 below includes details about the program, which also requires a building management or energy management system that is sophisticated enough to be capable of controlling the operation of individual loads and sufficient loads that can be safely curtailed without compromising essential facility functionality.

Figure 8. Hawaiian Electric Commercial Demand Response Program Comparison

Fast Demand Response Basics

Description	Oahu	Maui
Availability	7 a.m. to 9 p.m. weekdays, excluding holidays	24/7
Event Duration	Up to 1 hour	Up to 1 or 4 hours
Annual Limit	40 or 80 hours	40 hours

Typical load reducing measures:

- Turn off or adjust non-essential equipment
- Reduce HVAC usage
- Modify thermostat settings
- Shut off water fountains, heaters, or pumps
- Shut off excess elevators or escalators (as permitted)
- Note: Transferring load to emergency generators is prohibited on Oahu but allowed on Maui.

Assessing facility-level opportunities for energy demand management through participation in a demand response program involves analyzing the overall facility load profile, as well as the load profiles of specific systems, or even individual pieces of equipment in a facility. Given that demand management seeks to identify specific loads that can be shifted or curtailed during peak demand events, the operator needs to understand the facility's overall potential to participate in a demand response program, in terms of how frequently throughout the year the facility experiences high spikes in demand that would warrant participation in a demand response event. Another qualifying element is whether the facility's controls system, or building management system, is capable of receiving a signal from the utility and powering down specific loads. Once the operator establishes that the facility has the potential to participate in a demand response program, the specific loads within the facility that can be curtailed during a demand response event need to be identified.

Data available to the State Facility Energy Strategy project was limited to 12 months of 15-minute interval, whole facility energy usage data, which was provided on request by Hawaiian Electric for all the buildings except for the Hawaiʻi State Library. The whole facility-level energy usage data allowed for an initial screening of the annual load profile. This annual load profile is used to identify the frequency of peak loads recorded at the facility that could be high enough to trigger a demand response event, providing an indicator of the suitability of the facility to participate in a demand response program. System- and equipment-level load profiles were not available, limiting the ability to conduct a more comprehensive quantitative analysis of demand response potential. Further coordination with Hawaiian Electric about the potential for State owned facilities to participate in demand management through a demand response program is strongly encouraged.

3.5 Fleet Vehicle Electrification

The fleet electrification analysis provides insight into the potential total daily energy required to operate electric fleet vehicles, as well as recommendation of an overall charging strategy. The charging strategy includes the number of chargers and ports needed and power level required to recharge vehicles at Hale Ola and the Administration Office.

3.5.1 Methodology and Assumptions

The EV charging modeling effort was based on operating data provided by HSEO as well as the battery and charging specifications of equivalent battery electric vehicles (BEVs). Average and maximum daily miles driven and hours in service were considered in the modeling, derived from annual mileage data for the existing fleet. In cases where mileage data was unavailable, the operational use case was estimated based on the available mileage data for vehicles of the same type and class. Vehicle mileage was provided in two different forms depending on the vehicle:

1. Odometer readings (lifetime mileage) and vehicle age for some vehicles
2. Monthly data for the month of March 2025 for other vehicles

For vehicles with lifetime mileage provided, the average daily mileage was calculated by dividing lifetime mileage by vehicle age to determine the average annual mileage. This was derived by dividing annual mileage by 12 to calculate the average monthly mileage and then dividing monthly mileage by an assumed 20 working days per month. For vehicles where monthly mileage was only provided for the month of March 2025 rather than the whole year, an average of the monthly mileage was divided by an assumed 20 working days per month to calculate the average daily mileage. Further, in cases where a maximum daily mileage could not be calculated, it is conservatively assumed to be twice the average daily mileage.

The total energy consumption of the BEV fleet is based on the maximum daily miles driven and hours of service to forecast overall site energy consumption and fleet size impacts. If the daily amount of energy required exceeds the available energy for a vehicle, then the cases for an increase in fleet size or mid-day fast charging are considered. These additional cases facilitate protecting the vehicles' health while avoiding interruptions to normal operations.

A spreadsheet-based modeling tool was used to determine the level of demand each EV equivalent would place on its battery, based on the inputs and assumptions described above. Best practices to maintain operational and battery resilience were incorporated into this analysis, which assumes that an EV should not use more than 80% of its OEM-stated battery capacity, representing a minimum state of charge (SOC) of 10% (to avoid reaching zero charge) and a maximum SOC of 90% (to reduce battery degradation over time).

3.5.2 Fleet Vehicle Analysis

The foundation of this Fleet Electrification Plan begins with system-level planning. An analysis of HSEO light-, medium- and heavy-duty vehicles assigned to the Hale Ola Building and the CSD Administration Office was performed to estimate the energy consumption and charger requirements to support a future battery electric vehicle (BEV) fleet. This analysis included a review of vehicle mileage to determine daily energy and power requirements, as well as development of an overall charging strategy for each location.

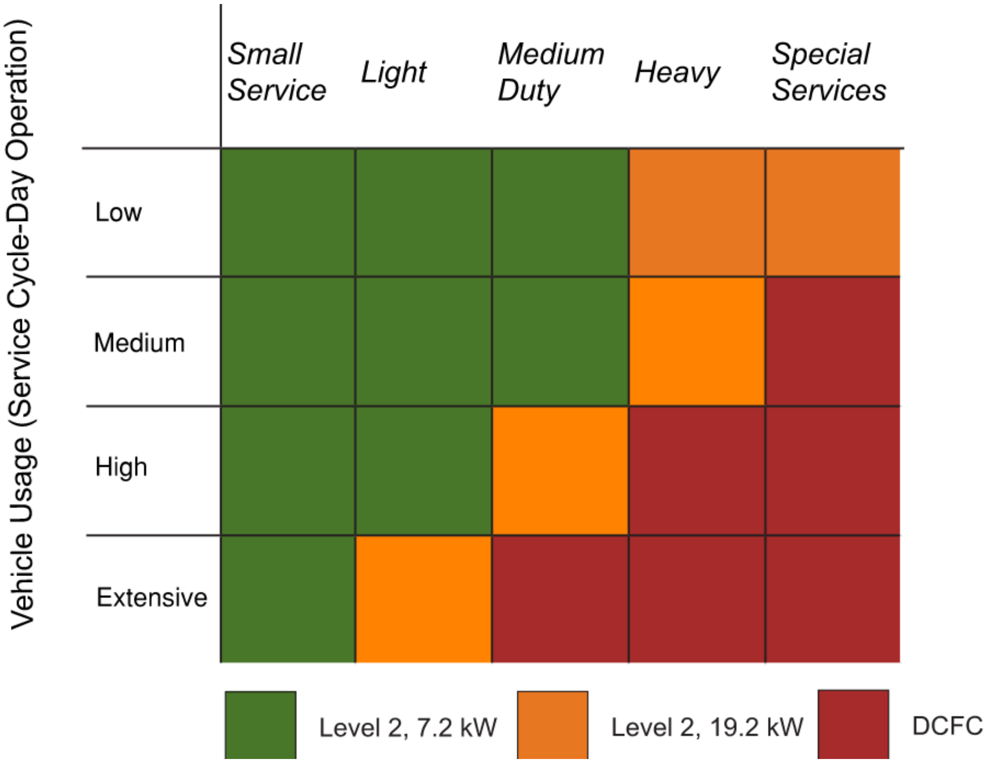
HSEO and agency stakeholder staff provided data on the quantity, age, usage and mileage of each fleet vehicle for those facilities that had fleet vehicles.

3.5.3 Future Fleet Electrification

All facilities considering fleet electrification are recommended to initially consult the self-assessment matrix detailed in Figure 9, considering the vehicle usage, service cycle for a daily operation, and vehicle duty size. Vehicle usage refers to the percent use of a fuel tank for an internal combustion engine (ICE) vehicle that will later be replaced with the battery electric vehicle (BEV). This vehicle usage should be considered for one service cycle, also known as the period of use between charging events (or refueling) for the vehicle. Due to current lack of viable replacement alternative fuel vehicles for MD, HD, and special use vehicles, all scenarios resulting in an orange or red tile are typically considered to remain hydrocarbon fueled until a viable replacement is available.

The decision matrix detailed in Figure 9 provides a starting point to determine which fleet vehicles could be easily considered for electrification based on EV charging demand. Additional analysis can help determine optimized charger deployment and charging strategy to reduce capital and operational expenses.

Figure 9. Electric Vehicle Charger Demand based on Vehicle Duty Size and Usage



3.5.4 Public EV Charging Analysis

In addition to data-driven decision making for vehicles domiciled at Hale Ola and the CSD Administration Office, a charger location evaluation was conducted for four additional sites: Hawaiʻi State Library, Waimano State Laboratory – Kamauleule Building, OR&L Main Building, and the Hawaiʻi Film Studio. This additional evaluation seeks to identify optimal locations at state-owned buildings for future EV charging infrastructure.

Operations and flow characteristics were considered when identifying possible public electric vehicle charger locations. Various parking stalls were identified as potential locations for public or employee charging areas at the four locations that do not have fleet vehicles.

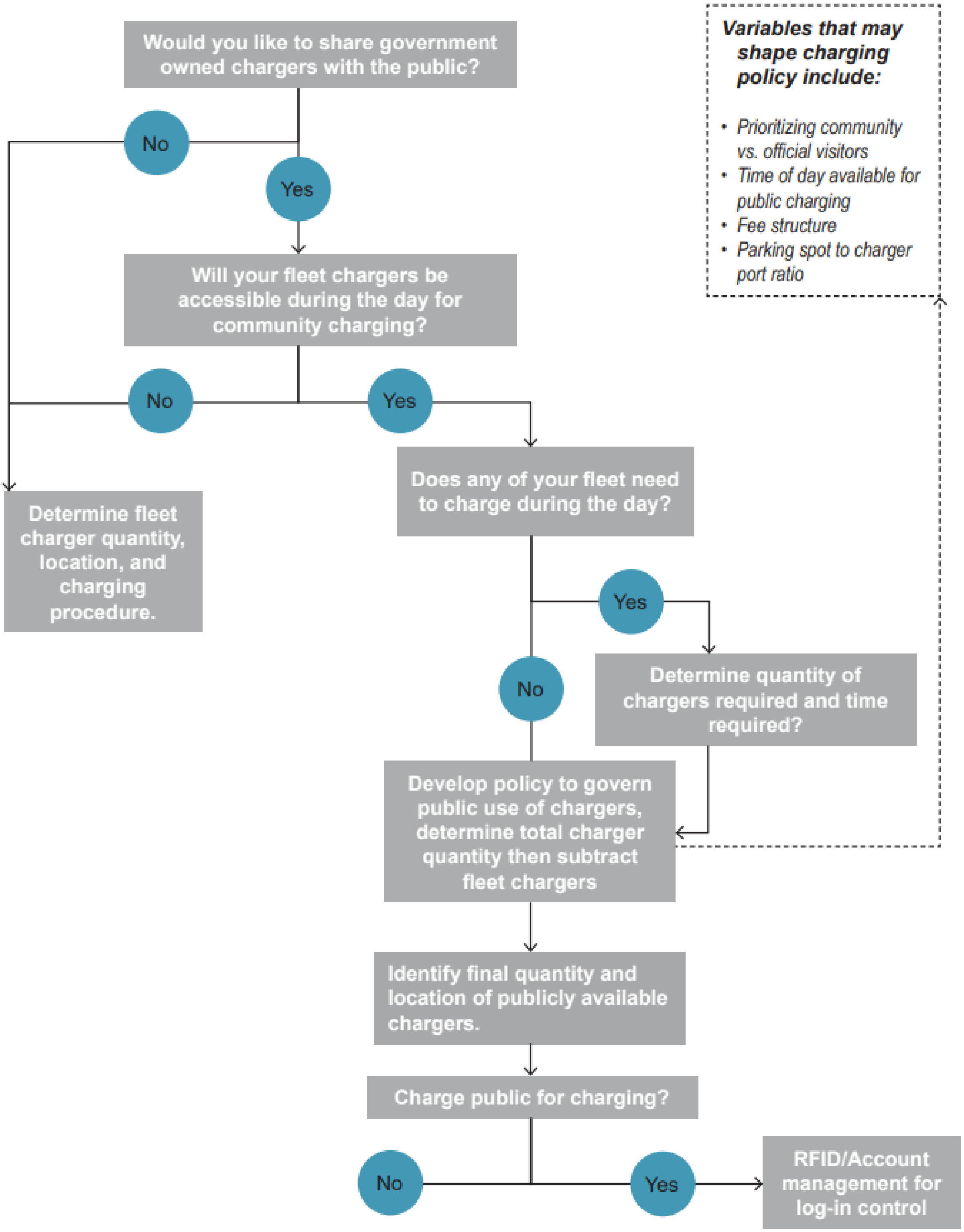
Hawaiʻi Revised Statute (HRS) 297-71 states "(a) places of public accommodation with at least one hundred parking spaces available for use by the general public shall have at least one parking space equipped with an electric vehicle charging system located anywhere in the parking structure or lot…" and "(b) Effective January 1, 2022, each new electric vehicle charging system installed or placed in service pursuant to this section shall be at least a level 2 charging station that is network-capable."

Similar rules to HRS 297-71 are in place in other states, though many states still do not have these rules in place. Washington and California both recommend or require 20 percent of parking stalls to be designed for EV capability, though this does not mean the chargers are installed immediately.

For the purpose of this project, 20 percent of stalls near the building are planned for future level 2 EV charging. This value is a placeholder to begin conversations with the agency, stakeholders, and the utility as to how much additional energy may be needed. Each site in this study includes a figure with these placeholder EV parking spaces, though the EV charging quantity, type, and location should be finalized prior to starting any design.

EV chargers are typically compatible with a wide range of vehicles, including most commercially available consumer vehicles. When considering public charging, several factors need to be weighed (Figure 10) the most important being whether non-fleet charging will affect fleet logistics. Public-facing chargers can distinguish between government fleet users and public users with the help of a charge management system.

Figure 10. Public Electric Vehicle Charging Considerations Flow Chart



3.5.5 Existing Electrical Infrastructure

Electrical utility infrastructure was not evaluated as part of this project, but in most cases, the existing buildings are not designed to accommodate the increased electrical loads for EV charging or building electrification. Additional electrical infrastructure is typically required.

3.6 Financial Feasibility

A financial feasibility assessment was conducted to evaluate the cost-effectiveness of proposed energy and water conservation measures, as well as photovoltaic (PV) and battery energy storage system (BESS) options. The analysis generated several key metrics, including benefit-cost ratio and discounted payback period, which were used to prioritize each measure.

An escalation rate of 3% obtained from the TRM 2024 was used to escalate future costs from 2025$ to year-of-expenditure (YOE) dollars. A discount rate of 6% was applied to all future cash flows and follows the guidance provided in the Hawaiʻi 2024 Technical Reference Manual (TRM 2024). Discounting values back to present day allows for comparison of cash flows in different years on an apples-to-apples basis.

The discounted payback period is calculated by summing the present value of annual savings until they equal the initial investment, using a discount rate to account for the time value of money. Discounted payback is the length of time required to recover the initial investment. The shorter the payback period, the better the investment. The benefit-cost ratio is determined by dividing the present value of all benefits (for example, energy or water savings) by the present value of all costs over the analysis period. This compares the dollars spent on installing the measure against the expected cost savings of that measure. A ratio greater than 1 indicates the project is economically viable.

The analysis considered a study period of 20 years. PV and BESS have expected useful lives closer to 30 years, and the ECM and WCM projects considered were replaced in later years of the study period. As a result, some of the benefits and costs associated with these measures were not captured within the initial 20-year study period. To explicitly account for these benefits, the present value of those cash flows were added to the final year of the study period.

The analysis excluded any salvage value at the end of the study period; thus, representing a conservative estimate of the value of some measures, such as solar panels and batteries. The analysis excluded the potential impact of loans or grants on the value of different measures. All improvements were assumed to be funded with cash.

A total of 56 discrete measures were analyzed quantitatively: 22 energy conservation measures, 20 water conservation measures, and 14 PV/PV+BESS configurations. Additionally, the EVs considered in Section 3.5 were also evaluated using the discounted payback period methodology for various vehicle types.

3.6.1 General Assumptions

Energy and water savings estimates were based on the modeling described in sections 3.1 and 3.2 for each conservation measure. Cost inputs for conservation measures were obtained from RSMeans, while PV and BESS costs were sourced from HOMER modeling. The study applied a 20-year analysis period, using a 6% discount rate and 3% inflation rate, consistent with the Hawaiʻi Technical Reference Manual (2024). The analysis accounted for capital costs, incremental maintenance costs for PV/BESS, energy sales and energy cost savings from implementing PV/BESS, and projected energy and water cost savings. To account for the value of improvements remaining after the end of the 20-year study period, the present value of future cash flows from 20 years until the end of the replacement's useful life were included in the analysis in the final year of the study period.

Emissions reductions were quantified using EPA's eGrid emission factors for Hawai‘i (2023). General assumptions used in the analysis are contained in Table 37, and the full list of projects by project type analyzed quantitatively is shown in each corresponding subsection below.

Table 37. General Assumptions

General Assumptions	Unit	Value	Source
Base Year	year	2025	Assumption
Year 1 of Analysis	year	2026	Assumption
Study Period Length	years	20	Assumption
Study Period End	year	2045	Calculated value
Discount Rate	percent	6%	Hawai‘i Technical Reference Manual 2024
Inflation Rate	percent	3%	Hawai‘i Technical Reference Manual 2024
Electricity cost escalation	percent	3%	EIA 2025 Annual Energy Outlook
Construction Year	year	2026	Assumption
DC:AC Ratio	ratio	1.25	HOMER Assumption
Solar Degradation Rate	percent	-0.5%	HDR Assumption
BESS RTE Degradation Rate	percent	-0.1%	HDR Assumption
CO2 Emission Rate	lb per MWh	1,650	eGrid 2023 data; fossil fuel generation for Hawai‘i
Cost Sensitivity Factor - Low	factor	0.70	HDR Assumption
Cost Sensitivity Factor - Mid	factor	1.00	HDR Assumption
Cost Sensitivity Factor - High	factor	1.30	HDR Assumption
Facilities Square Footage			
Hawai‘i State Library	sq ft	128,000	HSEO building data
Hale Ola Building		41,186	
Waimano State Lab		134,570	
CSD Administration Office		5,355	
OR&L Building		20,711	
Film Studio Complex		37,724	

3.6.2 Building Energy Efficiency Measures Financial Assumptions

Avoided energy costs (electricity consumption) and avoided capacity costs (peak demand) were calculated using values from the Hawai‘i TRM Avoided Energy and Capacity Cost forecasts. The annual electricity savings in kWh, and annual peak kW savings was applied to the $/kWh and $/kW rates published in the TRM to estimate the cost savings possible from implementing the energy conservation measures. Incremental O&M costs were considered to be negligible for the energy conservation measures and therefore, were not explicitly calculated in the analysis. However, it was assumed that there would be full replacement of the measures over the study period based on the service life of proposed improvements. The cost of future replacement was included in the analysis and escalated to account for inflation.

Building energy efficiency measures include the Hawai‘i State Equipment Rebate provided on a dollar per unit cost for the initial capital expenditure on the equipment. Subsequent replacement cycles do not include the rebate since it is not known whether the benefit will be available in perpetuity. As a result, the analysis reflects a conservative estimate of capital costs for ECMs.

Table 38. Projects included in the Financial Feasibility Analysis - ECM

Facility	ECM Improvement Description	ECM Improvement ID
Hawai'i State Library	INTERIOR LED LIGHTING RETROFIT - Linear fluorescent lights	HSL - ECM #1
	INTERIOR LED LIGHTING RETROFIT - U-bend fluorescent lights	HSL - ECM #2
	INSTALL OCCUPANCY SENSORS (100% - 128,000 SQFT)	HSL - ECM #3
	FAN COIL TUNE UP/REPAIRS (REPLACE MOTOR - 1/3 HP)	HSL - ECM #4
Hale Ola Building	COMPLETE EXTERIOR LED LIGHTING RETROFIT (150W-220W)	DOH - Hale Ola - ECM #1
Waimano State Lab	COMPLETE INTERIOR LED LIGHTING RETROFIT	DOH - Lab - ECM #1
	COMPLETE EXTERIOR LED LIGHTING RETROFIT (150W-220W)	DOH - Lab - ECM #2
CSD Administration Office	COMPLETE INTERIOR LED LIGHTING RETROFIT	DAGS Central Services - ECM #1
	EXTERIOR LIGHTING REPLACEMENT (150W-220W)	DAGS Central Services - ECM #2
	LIGHTING OCCUPANCY SENSORS (100% - 5,355 SQFT)	DAGS Central Services - ECM #3
OR&L Main Building	1ST FLOOR WINDOW FILM REPLACEMENT (SW - 52 SQFT)	DAGS OR&L - ECM #1
	COMPLETE INTERIOR LED LIGHTING RETROFIT	DAGS OR&L - ECM #2
	EXTERIOR HALLWAYS LIGHTING REPLACEMENT (150W-220W)	DAGS OR&L - ECM #3
Film Studio Complex	COMPLETE INTERIOR LED LIGHTING RETROFIT	Film Studio – Stage 2 – ECM #1
	LIGHTING OCCUPANCY SENSORS (100% - 48,860 SQFT)	Film Studio – Stage 2 – ECM #2
	EXTERIOR AND PARKING LOT LED LIGHTING RETROFIT (35W-149W)	Film Studio – Stage 2 – ECM #3

Table 39. Energy Conservation Measure Assumptions

Measure ID	Electricity Conservation Measure	Electricity Conservation Measures Assumptions		
		Net CapEx* (2025$)	Annual Electric Savings (kWh/yr)	Annual Peak Electric Savings (kWh)
	OR&L Main Building			
DAGS OR&L – ECM#1	1ST FLOOR WINDOW FILM REPLACEMENT (SW – 52 SQFT)	$48	1,026	0.08
DAGS OR&L – ECM#2	COMPLETE INTERIOR LED LIGHTING RETROFIT	$15,326	12,004	0.90
DAGS OR&L – ECM#3	EXTERIOR HALLWAYS LIGHTING REPLACEMENT (150W-220W)	$12,050	13,366	2.02
	CSD Administration Office			

Measure ID	Electricity Conservation Measure	Electricity Conservation Measures Assumptions		
		Net CapEx* (2025$)	Annual Electric Savings (kWh/yr)	Annual Peak Electric Savings (kWh)
DAGS Central Services – ECM #1	COMPLETE INTERIOR LED LIGHTING RETROFIT	$3,969	3,104	0.20
DAGS Central Services – ECM #2	EXTERIOR LIGHTING REPLACEMENT (150W-220W)	$4,820	5,346	0.81
DAGS Central Services – ECM #3	LIGHTING OCCUPANCY SENSORS (100% - 5,355 SQFT)	$6,169	2,226	0.26
	Hale Ola Building			
DOH – Hale Ola – ECM #1	COMPLETE EXTERIOR LED LIGHTING RETROFIT (150W-220W)	$24,100	26,732	4.04
	Waimano State Laboratory – Kamauleule Building			
DOH – Lab – ECM #1	COMPLETE INTERIOR LED LIGHTING RETROFIT	$32,467	22,599	3.60
DOH – Lab – ECM #2	COMPLETE EXTERIOR LED LIGHTING RETROFIT (150W-220W)	$36,150	40,098	6.06
	Hawaiʻi State Library			
HSL-ECM#1	INTERIOR LED LIGHTING RETROFIT – Linear fluorescent lights	$15,824	10,561	1.80
HSL-ECM#2	INTERIOR LED LIGHTING RETROFIT – U-bend fluorescent lights	$3,857	8,032	1.50
HSL-ECM#3	INSTALL OCCUPANCY SENSORS (100% - 128,000 SQFT)	$147,456	44,963	8.68
HSL-ECM#4	FAN COIL TUNE UP/REPAIRS (REPLACE MOTOR – 1/3 HP)	$34,132	1,602	0.24
	Film Studio Complex			
Film Studio – Stage 2 – ECM #1	COMPLETE INTERIOR LED LIGHTING RETROFIT	$36,170	28,320	2.00
Film Studio – Stage 2 – ECM #2	LIGHTING OCCUPANCY SENSORS (100% - 48,860 SQFT)	$56,287	20,291	2.35
Film Studio – Stage 2 – ECM #3	EXTERIOR AND PARKING LOT LED LIGHTING RETROFIT (35W-149W)	$30,125	33,415	5.05
	***Inclusive of Hawaiʻi State Equipment Rebates, which are assumed to be applied only during first installation.**			

Table 40. Electricity Rates Assumptions

Electricity Rates Assumptions	Unit	Value	Source
Electricity Capacity Cost, Year 1	$/kW	$299	Hawai‘i Technical Reference Manual 2024 - 2025$/kW rate
Electricity Usage Cost, Year 1	$/kWh	$0.21	Hawai‘i Technical Reference Manual 2024 - 2025$/kWh value for avoided cost.
Electricity Export Rates, Year 1			
OR&L Main Building	$/kWh	$0.1351	Weighted average export rates based on Hawaiian Electric Smart Energy Export rates for O‘ahu. Values weighted by generation hours from HOMER time series for 1 year of generation.
CSD Administration Office		$0.1378	
Hale Ola Building		$0.1352	
Waimano State Lab		$0.1350	
Hawai‘i State Library		$0.1350	
Film Studio - Stage 2		$0.1382	
Film Studio - Production Office		$0.1394	

3.6.3 Building Water Efficiency Financial Assumptions

Water cost savings were quantified based on actual utility billing data analogously to the energy cost savings described above. Water consumption savings values for each proposed project and by site can be found in section 3.2. Annual water savings in gallons per year were applied to the average cost per gallon calculated from the utility bills provided for each facility. The cost of water was escalated over time to account for inflation but no adjustments were made to account for scarcity. Incremental O&M costs were considered to be negligible for the water conservation measures relative to current maintenance costs and therefore, were not included. Since some measures have useful lives shorter than the study period, replacements of certain measures were included in the analysis. The cost of future replacement was escalated to account for inflation.

Building water efficiency measures do not include any rebates or incentives.

Table 41. Projects included in the Financial Feasibility Analysis - WCM

Facility	WCM Improvement Description	WCM Improvement ID
Hale Ola Building	Replace toilets/ water closets	DOH - Hale Ola -WCM 1
	Replace urinals	DOH - Hale Ola -WCM 2
	Replace lavatory faucets	DOH - Hale Ola -WCM 3
Waimano State Lab	Replace toilets/ water closets	DOH - Lab -WCM 1
	Replace urinals	DOH - Lab -WCM 2
	Replace lavatory faucets	DOH - Lab -WCM 3
	Replace showerheads	DOH - Lab -WCM 4
Hawai‘i State Library	Replace toilets/ water closets	HSL -WCM 1
	Replace urinals	HSL -WCM 2
	Replace lavatory faucets	HSL -WCM 3
CSD Administration Office	Replace toilets/ water closets	DAGS Central Services -WCM 1
	Replace urinals	DAGS Central Services -WCM 2
	Replace lavatory faucets	DAGS Central Services -WCM 3
	Replace toilets/ water closets	DAGS OR&L -WCM 1

Facility	WCM Improvement Description	WCM Improvement ID
OR&L Main Building	Replace urinals	DAGS OR&L -WCM 2
	Replace lavatory faucets	DAGS OR&L -WCM 3
Film Studio Complex	Replace toilets/ water closets	Film Studio - Production Office -WCM 1
	Replace urinals	Film Studio - Production Office -WCM 2
	Replace lavatory faucets	Film Studio - Production Office -WCM 3
	Replace showerheads	Film Studio - Production Office -WCM 4

Table 42. Water Conservation Measure Assumptions

Measure ID	Water Conservation Measure	Water Conservation Measures Assumptions	
		CapEx (2025$)	Annual Water Savings (gallons)
	OR&L Main Building		
DAGS OR&L – WCM1	Replace toilets/ water closets	$2,728	8,428
DAGS OR&L – WCM2	Replace urinals	$1,364	9,984
DAGS OR&L – WCM3	Replace lavatory faucets	$1,102	1,983
	CSD – Administration Office		
DAGS Central Services – WCM1	Replace toilets/ water closets	$2,046	27,339
DAGS Central Services – WCM2	Replace urinals	$682	9,266
DAGS Central Services – WCM3	Replace lavatory faucets	$551	1,976
	Hale Ola Building		
DOH – Hale Ola – WCM1	Replace toilets/ water closets	$8,184	172,172
DOH – Hale Ola – WCM2	Replace urinals	$1,364	56,862
DOH – Hale Ola – WCM3	Replace lavatory faucets	$3,306	12,532
	Waimano State Lab – Kamauleule Building		
DOH – Lab – WCM1	Replace toilets/ water closets	$8,184	99,546
DOH – Lab – WCM2	Replace urinals	$2,046	31,730
DOH – Lab – WCM3	Replace lavatory faucets	$3,306	7,046
DOH – Lab – WCM4	Replace showerheads	$296	14,053
	Hawai'i State Library		
HSL- WCM1	Replace toilets/ water closets	$12,276	60,081
HSL- WCM2	Replace urinals	$4,092	23,166
HSL- WCM3	Replace lavatory faucets	$3,306	4,550
	Film Studio Complex		
Film Studio – Production Office – WCM1	Replace toilets/ water closets	$3,410	85,436
Film Studio – Production Office – WCM2	Replace urinals	$682	28,080
Film Studio – Production Office – WCM3	Replace lavatory faucets	$1,102	6,110
Film Studio – Production Office – WCM4	Replace showerheads	$148	6,825

Table 43. Water Rates Assumptions

Year 1 Cost of Water	Unit	Value	Source
OR&L Main Building	$/kgal	$0.0065	HSEO building utility bills - 2024 annual average calculated in HDR analysis
CSD - Administration Office		$0.0065	
Hale Ola Building		$0.0065	
Waimano State Lab – Kamauleule Building		$0.0065	
Hawai‘i State Library		$0.0065	
Film Studio - Stage 2		$0.0065	
Film Studio - Production Office		$0.0065	

3.6.4 PV and BESS Financial Assumptions

PV generation and battery storage benefits were valued using the TRM values in $/kWh described above, and Hawaiian Electric's Smart Renewable Energy Export Rates. Hourly generation profiles for each PV or PV+BESS configuration were used to compute weighted average export rates applicable to each facility. The total value attributable to PV/BESS alternatives was assumed to come from two components: building energy cost savings, and export revenue. The energy cost savings were calculated as annual building energy consumption (in kWh) in the PV/BESS scenario less energy consumption in the Base (no action) scenario. The kWh savings were then applied to the TRM avoided cost per kWh. Then, annual generation from the PV, or combined PV+BESS configuration was applied to weighted average export rate. Peak kW savings were not included in the PV/BESS analysis. As a result, the cost savings available from operating PV/PV+BESS at the facilities reflect a conservative estimate.

PV and BESS operating assumptions included solar degradation rate at 0.5% per year and battery round-trip efficiency decline of 0.1% per year, assuming one charge/discharge cycle per day. Operating costs for PV and BESS systems were incorporated using National Laboratory of the Rockies (NLR) Annual Technology Baseline. 2022-dollar costs expressed in $/kW were escalated to 2025-dollar terms and scaled to planned system capacities for each building configuration.

The capital expenditure estimates for PV Only and PV+BESS alternatives did not include the impact of the existing Investment Tax Credit or Clean Electricity Investment Tax Credit. Due to the accelerated phaseout of these tax credits through the passage of the One Big Beautiful Bill Act for solar PV (though not BESS), they were excluded from the analysis. Thus, the capital cost estimates reflect conservative values of the total cost.

Table 44. Projects included in the Financial Feasibility Analysis - PV/BESS

Facility	PV/BESS Improvement Description
Hale Ola Building	PV Only
	PV+BESS
Waimano State Lab – Kamauleule Building	PV Only
	PV+BESS
Hawai‘i State Library	PV Only
	PV+BESS
CSD – Administration Office	PV Only
	PV+BESS
OR&L Main Building	PV Only
	PV+BESS

Facility	PV/BESS Improvement Description
Film Studio - Stage 2	PV Only
	PV+BESS
Film Studio – Production Office	PV Only
	PV+BESS

Table 45. PV+BESS Cost Assumptions

Facility	PV+BESS Cost Assumptions			
	CapEx, PV Only (2025$)[1]	CapEx, PV+BESS (2025$)[1]	O&M Costs, PV Only (2025$/yr)[2]	O&M Costs, PV+BESS (2025$/yr)[3]
OR&L Main Building	$116,500	$134,904	$1,190	$2,030
CSD – Administration Office	$267,000	$297,000	$2,818	$4,200
Hale Ola Building	$177,000	$207,000	$1,809	$3,218
Waimano State Lab – Kamauleule Building	$125,000	$982,000	$1,257	$20,646
Hawai‘i State Library	$212,000	$251,000	$2,190	$4,087
Film Studio - Stage 2	$355,000	$415,000	$3,617	$6,599
Film Studio - Production Office	$127,000	$146,000	$1,295	$2,162
Sources:				
[1] HOMER, 2025$				
[2] 2024 Annual Technology Baseline, Commercial PV Fixed O&M Costs escalated to 2025$, applied to kW-yr to estimate annual maintenance costs				
[3] 2024 Annual Technology Baseline, Commercial and Residential BESS Fixed O&M Costs escalated to 2025$, applied to kW-yr to estimate annual maintenance costs.				

Table 46. PV+BESS Energy Consumption Assumptions

Facility	PV+BESS Energy Consumption Assumptions		
	Annual Energy Consumption, Base (kWh/yr)[4]	Annual Energy Consumption, PV Only (kWh/yr)[4]	Annual Energy Consumption, PV+BESS (kWh/yr)[4]
OR&L Main Building	185,200	114,442	114,442
CSD – Administration Office	339,000	280,900	268,500
Hale Ola Building	369,000	241,200	231,800
Waimano State Lab – Kamauleule Building	6,017,000	5,910,000	5,923,000
Hawai‘i State Library	981,000	797,100	797,000
Film Studio - Stage 2	166,000	84,000	56,200
Film Studio - Production Office	56,000	29,000	20,800
Sources:			
[4] HSEO Data used as input for HOMER model			

Table 47. PV+BESS Generation and Battery Throughput Assumptions

Facility	PV+BESS Generation and Battery Throughput Assumptions		
	Year 1 PV Export Generation, PV Only (kWh/yr)[5]	Year 1 PV Export Generation, PV+BESS (kWh/yr)[5]	Year 1 Battery Throughput (kWh/yr)[5]
OR&L Main Building	31,525	23,278	7,742
CSD – Administration Office	174,148	158,634	13,976
Hale Ola Building	26,661	15,038	11,211
Waimano State Lab – Kamauleule Building	159	0	75,000
Hawai‘i State Library	2,696	1,929	1,750
Film Studio - Stage 2	213,801	179,930	31,370
Film Studio - Production Office	82,362	72,400	9,100
Sources:			
[5] HOMER Outputs			

As noted above, a total of 56 measures were assessed: 21 energy conservation measures, 20 water conservation measures, and 14 PV/PV+BESS configurations. Results include total kWh saved, gallons of water conserved, and avoided CO_2 emissions, where applicable. Sensitivity analyses were performed to evaluate the impact of key variables, including the Clean Electricity Investment Tax Credit, variations in capital costs, and changes in electricity and water prices.

3.6.5 EVSE Financial Analysis Assumptions

Electric vehicles considered for transition were primarily evaluated individually using a discounted payback period approach to determine whether operating cost savings over the useful life of the cycle could offset the cost of EVs.

The cost of chargers is noted here for completeness but is not included in the discounted payback analysis for individual vehicles. The analysis assumed that all chargers discussed in section 3.5 above are installed, and the entire fleet is transitioned over the 20-year study period. The fleet transition is evaluated assuming that all vehicles and chargers are purchased in Year 1. This compares the total cost of implementation against the potential cost savings possible from switching to EVs.

Capital costs for each vehicle type were sourced from publicly available procurement data and manufacturer specifications, based on the assumption that procurement for EVs would follow current practice that used vehicles are purchased from other government agencies after approximately 5 years of fleet use. Capital costs were primarily sourced from General Services Administration sales data. In the case that comparable EVs were not available for 5-year-old models, empirical depreciation rates were applied to new EV purchase prices to estimate the comparable cost of a used 5-year-old vehicle.

Operating and maintenance (O&M) costs were derived from Argonne National Laboratory (ANL) research on total cost of ownership for vehicles. Vehicle energy efficiency metrics, including miles per gallon (MPG) and miles per kilowatt-hour (mi/kWh), were obtained from ANL data and HDR analysis.[7]

[7] https://www.anl.gov/esia/economic-analysis-of-vehicle-technologies

Electricity rates were sourced from the 2024 TRM, in alignment with the energy efficiency measures discussed above. EVs were anticipated to have maintenance cost savings relative to comparable ICEVs based on research from the Argonne National Laboratory, which varied based on the vehicle size. The discount varied from 10% to 25% and was applied to ICEV maintenance cost rates in $/mi to estimate EV maintenance costs per mile.

Table 48. EVSE Financial Analysis Assumptions

General Inputs	Unit	Value	Source
Inflation Rate	%	3%	Hawai‘i Technical Reference Manual 2024
Discount Rate	%	6%	Hawai‘i Technical Reference Manual 2024
Base Year	year	2025	Assumption
Year 1 Gasoline Cost	$/gal	$3.92	US Energy Information Administration Monthly Gas Price
Year 1 Diesel Cost	$/gal	$4.33	
Year 1 Electricity Cost (Commercial)	$/kWh	$0.21	Hawai‘i Technical Reference Manual 2024
Charging Efficiency	%	95%	HDR assumption based on similar projects
EV Depreciation (5 year)	%	55%	https://www.recurrentauto.com/research/used-electric-vehicle-buying-report

4 Agency and Facility Identification

The State Facility Energy Strategy is based on facility-specific assessments of six facilities, which are intended to serve as a representative sample of all small- to medium-sized State-owned facilities. As shown in Table 49 below, HSEO estimated that there are over 1,300 small- to medium-sized State-owned facilities, spread across 26 different State agencies.

Table 49. State Agencies and Quantity of Buildings between 10,000 – 200,000 SF

Department/Agency		# of Facilities
AG	Attorney General	3
AGR	Agriculture	12
B&F	Budget & Finance	2
DAGS	Accounting and General Services	42
DBEDT	Business, Economic Dev. & Tourism	13
DCCA	Commerce & Consumer Affairs	1
DHHL	Hawaiian Home Lands	4
DHRD	Human Resources Development	1
DHS	Human Services	30
DLIR	Labor & Industrial Relations	2
DLNR	Land & Natural Resources	8
DOD	Defense	21
DOE	Education	638
DOE - PCS	Charter Schools	26
DOH	Health	15
DOT Airports	Airports	63
DOT Harbors	Harbors	21
DOT Hwys	Highways	3
HHFDC (DBEDT)	Housing Finance & Development Corp.	3
HHSC	Health Systems Corp.	35
HPHA (DHS)	Public Housing Authority	54
HSPLS (HSL)	State Public Library System	31
JUD	Judiciary	12

Department/Agency		# of Facilities
OHA	Office of Hawaiian Affairs	3
PSD	Public Safety	19
UH	University of Hawaiʻi	257
Total		**1,319**

The process of identifying the six primary facilities, along with six alternate options to be assessed for the State Facilities Energy Strategy project, involved a multi-criteria analysis (MCA). The MCA provides an apples-to-apples method for comparing facilities with consistent evaluation criteria, system for awarding points, and weighting factors. Individual facilities are evaluated based on data and documentation provided by the State agency that owns that facility. The intention of using a representative sampling method is that the recommendations from the selected facilities could be applied to many small- to medium-sized State-owned facilities and scaled throughout the portfolio.

4.1 Approach

4.1.1 Request for Information

To establish the evaluation criteria and develop a facility scoring methodology, HDR requested facility-specific data from HSEO. HDR issued a Request for Information (RFI) to HSEO on April 21, 2025, to transfer facility-specific data about the small- to medium-sized facilities owned by the State of Hawaiʻi that are covered by this Project. The RFI sought information across a range of categories, including:

- Background Information: address, island/location, agency that the facility serves, size/floor area, age/vintage, building usage, and number of stories;
- Energy Performance Data: annual energy consumption, types of energy consumed, whether the facility participates in energy performance contracting;
- Operational Information: planned capital projects, whether facility is located on sensitive land; and
- Fleet-Related Data: vehicle type/quantity assigned to facility, vehicle mileage and fuel use.

HSEO's response to the RFI represented the primary data that was made available to HDR for the identification and recommendation of facilities for further assessment. This data provided the basis for identifying the evaluation criteria and developing the scoring methodology.

4.1.2 Priority List of Facilities

At the initial Project kickoff on April 9, 2025, HSEO shared the results of a recently conducted preliminary survey of State agencies and facilities. The survey was issued by HSEO to State agencies and provided an opportunity for the agencies to have input into the Project. The survey asked State agencies to propose which of their facilities they would like to have included in the evaluation, nominate any specific facilities for inclusion, identify which State agencies are most interested or willing to participate in the Project, and highlight any agency priorities for selecting a representative sample.

HSEO compiled the results of the preliminary survey of State agencies and facilities into a spreadsheet that serves as a Priority List of Facilities for consideration. The Priority List of Facilities identified 19 unique facilities for consideration, belonging to four different State agencies:

- Hawaiʻi Department of Business, Economic Development and Tourism Film Office (DBEDT)
- Hawaiʻi State Public Library System (HSPLS)
- Hawaiʻi State Department of Health (DOH)
- Hawaiʻi Department of Accounting and General Services (DAGS)

While the Prioritized List of Facilities includes facilities spread across four islands, the majority of the facilities identified in the Prioritized List of Facilities are located on Oʻahu:

- Oʻahu (13 facilities)
- Maui (4)
- Hawaiʻi (1)
- Kauaʻi (1)

The 19 priority facilities identified are listed in Table 50 below:

Table 50. Priority Facilities for Consideration

Facility Name	State Agency	Island
Hawaiʻi Film Studio: Production Office	DBEDT Film Office	Oʻahu
Hawaiʻi Film Studio: Sound Stage 2, Crew Bathrooms, Guard Stand	DBEDT Film Office	Oʻahu
Hawaiʻi Film Studio: Bungalows, Sound Stage 1, misc. buildings	DBEDT Film Office	Oʻahu
Hawaiʻi Film Studio: Construction Mill (aka Tech Building)	DBEDT Film Office	Oʻahu
Kaimuki Library	HSPLS	Oʻahu
Hawaiʻi State Library	HSPLS	Oʻahu
Waimano State Laboratory- Kamauleule Building	DOH	Oʻahu
Hale Ola Building (3 story)	DOH	Oʻahu
Kitchen/Dining Bldg @ Hale Ola Site	DOH	Oʻahu
Uluakupu Building	DOH	Oʻahu
AUTOMOTIVE MGMT DIV. - VINEYARD STREET PARKING	DAGS	Oʻahu
OR&L MAIN BUILDING	DAGS	Oʻahu
CENTRAL SERVICES DIV. - ADMINISTRATION OFFICE	DAGS	Oʻahu
WAILUKU STATE OFFICE BUILDING #1	DAGS	Maui
WAILUKU STATE OFFICE BUILDING #2	DAGS	Maui

Facility Name	State Agency	Island
MAINTENANCE FACILITY OFFICE	DAGS	Maui
MAUI DISTRICT OFFICE ADMINISTRATION BLDG	DAGS	Maui
HILO STATE OFFICE BUILDING	DAGS	Hawai‘i Island
LĪHU‘E STATE OFFICE BUILDING	DAGS	Kaua‘i

4.2 Selection Criteria and Weighting

4.2.1 Selection Criteria

Based on facility responses to the RFI, HSEO’s Prioritized List of Facilities, and discussions with HSEO, HDR identified six selection criteria for identifying the small- to medium-sized, State-owned facilities for this Project. Criteria were determined based on the desired Project goals of realizing operational energy cost savings and developing a representative sample, such that the findings could be applied throughout the State’s portfolio of facilities.

To develop a representative sample, the initial step was to screen for only small- to medium-sized buildings that are not currently participating in energy performance contracting. This initial step established the portfolio of State-owned facilities from which the representative sample is taken from. HDR then used the information available in the responses to the RFI and follow-up discussions with HSEO to identify a handful of factors that differentiate the facilities in the portfolio from one another, including which State agency the facility belongs to, the presence of fleet vehicles, and the age of the facility. Based on direction from HSEO, HDR focused on buildings located on O‘ahu.

To further define a representative sample, additional screening was done to identify factors that are likely to drive energy performance improvement. For example, the biggest energy efficiency savings typically come from facilities that currently have high energy usage, and buildings without energy usage data were screened out of the scoring methodology. Recommendations are most likely to be implemented if there are already capital improvements planned at the facility. Energy cost savings from onsite renewable energy systems depend on the facility’s propensity for solar, which is its solar PV generation potential. Likewise, the State will only realize energy cost savings by installing EVSE if there are fleet vehicles assigned to the facilities where EVSE is proposed. The following are the six evaluation criteria that resulted from this process:

1. State Agency Uniqueness
2. Energy Usage Intensity (EUI)
3. Age of Facility
4. Planned Capital Improvements (y/n)
5. Assigned Fleet Vehicles (y/n)
6. Propensity for Solar

4.2.2 Scoring Methodology

HDR developed a scoring methodology organized around the above criteria to narrow the list of candidate facilities to a short list of seven recommended facilities for deeper assessment, along with six alternate options.

There are seven key steps in the scoring methodology.

1. Identify scoring criteria
2. Assign a relative weighting factor to each of the six criteria
3. Establish quintile bins for each of the criteria
4. Assign a 1-5 score to each of the quintile bins
5. Calculate a 1-5 score for each criteria for each building
6. Multiply the criteria score by the criteria weighting to get a weighted average
7. Rank and prioritize facilities based on weighted average

4.2.3 Weighting Factor

Each of the six criteria may be more or less impactful to the selection process than other criteria. To weigh the impact relative to the other criteria, a percentile value was assigned to each criterion to demonstrate that criterion's value. The cumulative value of all the criteria was 100%, and each criterion comprised a portion of that total. Figure 1011 shows the weighting factors used in this evaluation for each criterion, which were developed in collaboration with HSEO. The facility's energy usage was considered the most important factor and contributed 35% of the facility's total score, while age of the facility was considered less determinative and only contributed 10% of the facility's total score.

Figure 11. Criteria Weighting Factors from Facility Scoring Matrix

10%	10%	35%	20%	10%	15%
Age of Facility	Upcoming Capital Improvements	Energy Usage Intensity	Propensity for Solar	Presence of Fleet Vehicles on Site	Agency Uniqueness

4.2.4 Quintile Bins

In order to assign a numeric score for the facility's performance based on each of the criteria, the range of performance values was assessed and sorted into five separate bins for each criterion. For most variables, the bins were sorted as low performance to high performance, with the bins corresponding to 20% performance bands. Facilities that perform in the 0-19th percentile were sorted into one bin, facilities that perform in the 20-39th percentile were sorted into a second bin and so on. For binary variables, where there is a yes or no answer, only two quintiles were used, and the others were excluded.

4.2.5 Assign Score to Quintile Bins

Once the quintile bins were established, a 1-5 score is assigned to each bin, with "1" representing the lowest score and "5" representing the highest score.

4.2.6 Calculate a Score for Each Criteria for Each Facility

After the quintile bins were established and scores assigned to each bin for each criterion, each facility was individually analyzed to determine the facility-specific score for each criterion.

Figure 12 shows the Scoring Matrix, including the score for each criterion for each facility by applying the scores for each of the quintile[8].

Figure 12. Facility Scoring Matrix Score Calculations

Current Year	2025

Facility	Building (if Applicable)	Notes	Results							Score					
										10%	10%	35%	20%	10%	15%
			Age of Facility (Years)	Upcoming Capital Improvements (Y/N)	Energy Usage Intensity (kWh/sqft)	Propensity for Solar (sqft)	Presence of Fleet Vehicles on Site (Y/N)	Island Uniqueness (%)	Agency Uniqueness (%)	Age of Facility	Upcoming Capital Improvements	Energy Usage Intensity	Propensity for Solar	Presence of Fleet Vehicles on Site	Agency Uniqueness
Hawai'i Film Studio	Combined: Stage 2, Crew Bathroom, Mechanical Gate, Parking Lot Lights, Guard House, Production Office		31	No	6.7	11963.0	No	67%	17%	2	1	3	5	1	5
Hawai'i Film Studio	Bungalows, Stage 1, Misc Buildings		7	No	4.7	10313.0	No	67%	17%	1	1	2	5	1	5
Hawai'i Film Studio	Construction Mill (Tech Building)		19	No	4.1	3375.0	No	67%	17%	1	1	2	2	1	5
Kaimuki Library	2 Story w/ Mezzanine		61	Yes	3.7	5175.0	No	67%	11%	4	5	2	4	1	3
Hawaii State Library	3 Story w/ Basement		98	Yes	8.2	5325.0	No	67%	11%	5	5	4	4	1	5
Waimano State Laboratory - Kamauleule Buidling	3 Story		32	Yes	44.7	4650.0	No	67%	22%	2	5	5	3	1	4
Hale Ola Building (3 Story)	3 Story w/ Basement		104	No	8.8	5475.0	Yes	67%	22%	5	1	4	5	5	4
Kitchen/Dining Bldg @ Hale Ola Site	Single Story		104	No	8.1	4575.0	Yes	67%	22%	5	1	3	3	5	2
Uluakupu Building	1.5 Stories		75	No	10.3	2400.0	Yes	67%	22%	4	1	5	1	5	1
AUTOMOTIVE MGMT DIV. - VINEYARD STREET PARKING				Yes	0.0	2925.0	Yes	67%	50%	0	5	1	2	5	3
OR&L MAIN BUILDING	2 Stories; Historic Name: Oahu Railway & Land Company Terminal Property		95	Yes	9.6	2985.0	No	67%	50%	5	5	4	2	1	3
CENTRAL SERVICES DIV. - ADMINISTRATION OFFICE	2 Adjacent Buildings. One with 1 floor and the other with 2 floors. Shared space with DOE.		48	No	86.5	6825.0	Yes	67%	50%	3	1	5	5	5	3
WAILUKU STATE OFFICE BUILDING #1		Year built not confirmed, listed as 1970s	50	No	2.2	900.0	No	22%	50%	0	0	0	0	0	0
WAILUKU STATE OFFICE BUILDING #2			94	Yes	1.8	0.0	Yes	22%	50%	0	0	0	0	0	0
MAINTENANCE FACILITY OFFICE			31	Yes	0.0	2625.0	Yes	22%	50%	0	0	0	0	0	0
MAUI DISTRICT OFFICE ADMINISTRATION BLDG			31	Yes	0.0	0.0	Yes	22%	50%	0	0	0	0	0	0
HILO STATE OFFICE BUILDING			57	Yes	0.0	0.0	Yes	6%	50%	0	0	0	0	0	0
LIHUE STATE OFFICE BUILDING			22	Yes	0.0	3975.0	Yes	6%	50%	0	0	0	0	0	0

[8] In the absence of available data, buildings have generally been assigned a score of 0 or 1 for a given criterion to reflect missing data or if the facility was screened out altogether. The one exception is Department of Health (DOH) buildings for the presence of fleet vehicles criteria. Since DOH does have fleet vehicles, there is the possibility for fleet vehicles to be located at the sites identified. As such, these have been assigned a "Maybe", instead of a clear "Yes" or "No".

4.2.7 Calculate a Weighted Average Score

Once the facility-specific score for each criterion was determined, the relative weighting factor from Step 1 was applied. This was done by multiplying the facility-specific score for each criterion by that criterion’s weighting factor. The weighted scores for all criteria were then summed to get a facility-specific weighted score for each facility.

4.2.8 Rank and Prioritize Facilities

Finally, once a facility-specific weighted average score was calculated for each facility, the facilities were ranked and prioritized. The six facilities with the highest scores were presented to HSEO, along with the next six highest scoring facilities, which were presented as alternative facility options for final consideration.

4.3 Facilities Selected for Assessment

Based on the results of the priority scoring, discussions between HSEO and the state agencies, and coordination between HSEO and HDR, six facilities were selected for further assessment as part of the State Facilities Energy Strategy Project, as shown in Table 51. The six facilities were selected because they represent a diverse mix of agencies and building types and were evaluated to provide the best opportunities for finding energy cost saving measures that can be scaled for deployment across the portfolio of small- to medium-sized state-owned facilities.

Table 51. Facilities selected for further assessment as part of the State Facilities Energy Strategy project

Rank	Facility	Agency	Island	Building Type	Weighted Average
1	Hale Ola Building (3 Story)	DOH	O‘ahu	3 Story w/ Basement	4.10
2	Central Services Division – Administration Office	DAGS	O‘ahu	2 Adjacent Buildings. One with 1 floor and the other with 2 floors. Shared space with DOE.	4.10
3	Hawai‘i State Library	HSPLS	O‘ahu	3 Story w/ Basement	4.05
4	Waimano State Laboratory - Kamauleule Building	DOH	O‘ahu	3 Story	3.75
5	OR&L Main Building	DAGS	O‘ahu	2 Stories; Historic Name: O‘ahu Railway & Land Company Terminal Property	3.35
6	Hawai‘i Film Studio Complex	DBEDT (Film Office)	O‘ahu	Combined: Stage 2, Crew Bathroom, Mechanical Gate, Parking Lot Lights, Guard House, Production Office	3.20

5 Conclusion

The State Facility Energy Strategy identified energy cost and energy usage savings opportunities across the sample of small- to medium-sized State-owned facilities assessed. Energy cost saving solutions explored through the State Facility Energy Strategy project include:

- Building efficiency: Energy
- Building efficiency: Water
- Solar photovoltaic (PV) renewable energy systems and battery energy storage system (BESS)
- Demand management and demand response
- Vehicle electrification and electric vehicle supply equipment (EVSE)
- Financial Feasibility

While the recommendations across these categories are specific to each facility assessed for the State Facility Energy Strategy, the recommendations are intended to be applicable to a wide range of small- to medium-sized State-owned facilities and representative of the scale of energy saving opportunities throughout the portfolio. The scale of the State's portfolio of small- to medium-sized facilities is immense and there are a substantial amount of energy saving measures recommended throughout this State Facility Energy Strategy report. Each State agency will have its own budgeting and project planning process that will have to be navigated for the recommended projects to be implemented. We highly recommend prioritizing which potential energy saving measures to implement as soon as possible and begin planning immediately.

By implementing the energy saving measures recommended in the State Facility Energy Strategy report, HSEO and the State agencies that own small- to medium-sized facilities can realize energy cost and energy usage savings, helping to save taxpayer funding, conserve resources, stabilize the local electricity grid, improve the local green economy and provide stewardship and take responsible action for the natural environment.

A

Appendix A – Hawai‘i Film Studio Complex: Production Office, Sound Stage 2, Crew Bathrooms, Guard Stand, Front Gate

A. Hawai‘i Film Studio: Production Office, Sound Stage 2, Crew Restrooms, Guard Stand, Front Gate

A.1 Facility Description

The Department of Business, Economic Development and Tourism’s (DBEDT) Hawai‘i Film Studio complex includes a series of structures, including the Production Office, Sound Stage 2, Crew Restroom Facility, Guard Stand, and an electronic security gate that are included in this assessment. The complex also includes other structures, all of which are excluded from this assessment, including Sound Stage 1 and the Construction Mill. The various structures included in this assessment were built between 1994 (Sound Stage 2) and 2006 (Production Office), with minor modifications in the intervening years.

The Hawai‘i Film Studio complex has an irregular occupancy schedule, with a highly variable energy load profile based on whether it is being actively used for television and film production. When the complex is in active production, energy usage can be intensive and sustained. However, when the facility is not being actively used for film production, there are minimal loads and limited opportunities for energy conservation.

DBEDT | Hawai‘i Film Studio | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	510 18th Avenue, Honolulu, O‘ahu	**Heating Primary Fuel**	n/a
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	1	**Heating Generation**	n/a
Building Type	Office and Film Production	**Cooling Generation**	Air cooled chiller
Year Built	2006 (Production Office) 1994 Sound Stage 2, etc.	**Domestic Hot Water Generation**	Electric Storage-type Water Heater
Floor Area (ft2)	26,000	**Heating / Cooling / Vent Distribution**	Fan coil units
Stories	1	**Electric Rate Structure**	Hawaiian Electric General Commercial Schedule
Window Type	Production Office: Single-pane, vinyl framed Sound Stage: no windows		
Wall Type	Production Office: wood framed with stucco, composite roof Sound Stage: precast concrete and steel structure. Fiberglass blanket walls for sound control; (2) elephant swing doors	**Natural Gas Rate Structure**	N/A

DBEDT | Hawaiʻi Film Studio | Building Characteristics			
Lighting System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Mostly fluorescent; film production lighting	**Weekday Operating Hours**	40+ (when occupied)
Exterior Lighting Systems	HPS HID pole mounted	**Weekday Opening Time**	Monday – Friday: 5am – 1pm (when occupied)
		Weekend Operating Hours	Varies pending occupancy
		Weekend Opening Time	Varies pending occupancy

Figure 13. Photos of Hawaiʻi Film Studio Production Office, Sound Stage 2 and Related Structures

A.2 Energy-using Systems Assessed

The Hawaiʻi Film Studio: Production Office, Sound Stage 2, Crew Bathrooms, Guard Stand and Front Gate (collectively referred to here as the Hawaiʻi Film Studio complex) facility was remotely assessed for operational energy performance improvement opportunities. The assessment used design and as-built drawings, previous reports and facility assessments, and utility bills, along with written facility narratives and interviews conducted with facilities management personnel to investigate the energy-using systems and equipment in the facility. Specific energy-using systems investigated as part of this assessment include:

- Building envelope
- HVAC
- Domestic hot water
- Lighting – interior / exterior
- Plug loads
- Water fixtures

A.3 Energy Performance Analysis

The facility's operational energy consumption in units of kilowatt hours was obtained from utility bill summaries provided by Hawaiian Electric, the electric utility. The facility does not use any other energy types as a primary energy source. Utility bill summaries were analyzed for the 12-month period from July 2024 through June 2025.

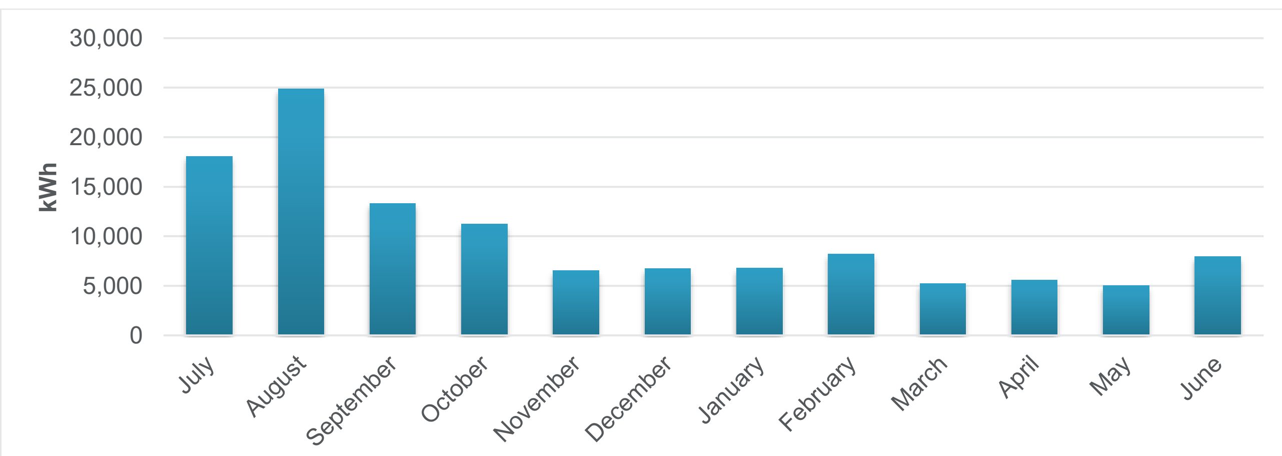
A substantial impact on this study is that the Hawaiʻi Film Studio Complex was mostly unoccupied and not used for film production during the 12-month study period from July 2024 through June 2025. This study period was chosen for consistency with the other facilities assessed for the State Facility Energy Strategy project. The recommended ECMs are all still applicable under any occupancy scenario, but the facility's energy performance and the modeled impacts of the recommended measures are only representative of the facility being minimally occupied for film production throughout the year.

One method for measuring a facility's energy efficiency is to determine its energy use intensity (EUI), which is the energy consumption per gross square foot. Two types of EUI are typically determined for a facility. The first is the site EUI, which is defined as the energy use at the site divided by the building's gross square footage. The second is the source EUI, which is defined as the energy used by the various energy plants to provide energy to the site. This value is always higher than the site EUI because it accounts for inefficiencies and losses in generation and distribution. For the State Facilities Energy Strategy, US EPA's national site-to-source energy conversion factor of 2.80[9] is used to calculate source energy. Because EUI looks at total consumption of all types of energy used in a facility, the unit of measurement for energy is typically expressed in kilo British thermal units (kBtu), which allows for an apples-to-apples comparison of different energy types in a common unit. Moreover, because EUI is a measure of intensity, there is a defined time period of 1 calendar year and efficiency is calculated by dividing the total energy usage by the floor area of the building. The units for EUI are typically expressed as kBtu/sf/yr.

A.3.1 Energy Consumption and Energy Use Intensity

During the year of July 2024 through June 2025, the Hawaiʻi Film Studio complex consumed 119,677 kWh of site energy, which cost $72,868 during the year. This equates to a site Energy Use Intensity (EUI) of 6.4 kBtu/sf/yr and source EUI of 17.9 kBtu/sf/yr. Total greenhouse gas emissions for the year are estimated to be 81.4 metric tons CO2e, equivalent to a greenhouse gas emissions intensity of 1.3 kgCO2e/sf/yr.

Figure 14. Hawaiʻi Film Studio Complex Monthly Site Energy Usage, July 2024 - June 2025



9 https://portfoliomanager.energystar.gov/pdf/reference/Source%20Energy.pdf?_gl=1*3nkuy*_ga*NTI0NjA3MDA0LjE3NTI1OTAzMzI.*_ga_S0KJTVVLQ6*czE3NjI0NzM2MDEkbzU5JGcxJHQxNzYyNDczNjYwJGoxJGwwJGgw

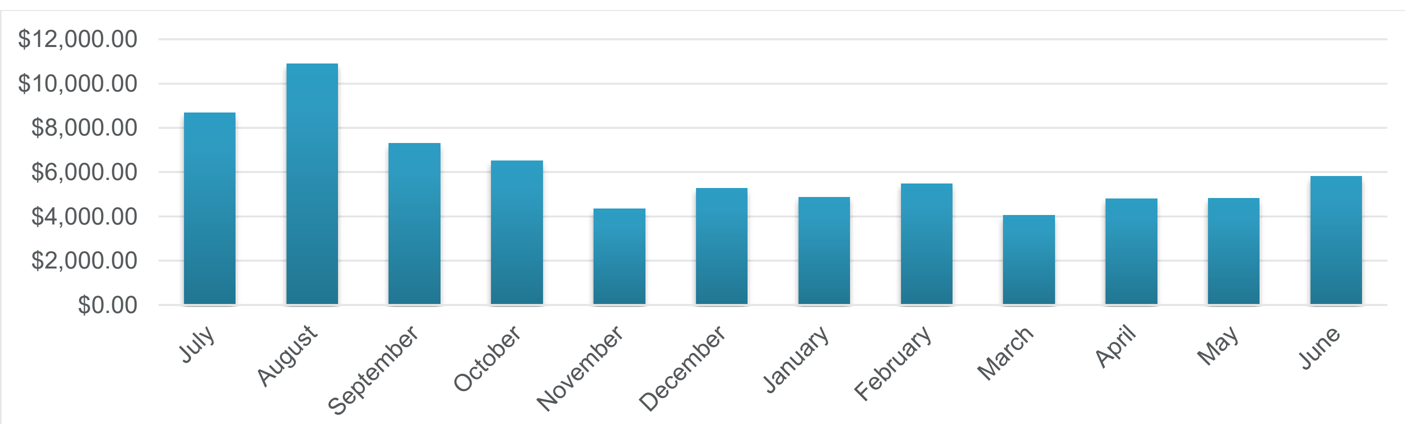
Table 52. Energy Consumption and Energy Use Intensity Summary, Hawai'i Film Studio Complex

Metric	Current Year (7/24 – 6/25)
Source EUI (kBTU/sf)	17.9
Site EUI (kBTU/sf)	6.4
Source Energy Use (kBtu)	335,096
Site Energy Use (kBtu)	119,677
Energy Cost ($)	$72,868
Energy Cost Index, ECI ($/sf-yr)	$1.14
Total Location-based Greenhouse Gas (GHG) Emissions[10] (Metric tonsCO2e/yr)	81.4
Total Location-based GHG Emissions Intensity (kgCO2e/sf/yr)	1.3

A.3.2 Energy Cost

The Hawai'i Film Studio complex spent $72,868 on electricity during the year, which yields an Energy Cost Index (ECI) of $1.14/sf/yr. A summary of the monthly energy costs is in Figure 15 below. The actual costs are inclusive of the cost per unit of energy, as well as all fees, tariffs, and other charges.

Figure 15. Hawai'i Film Studio Complex Monthly Energy Costs, July 2024 - June 2025



[10] Emission factors derived from US EPA E-grid for the HIOA (Hawai'i – O'ahu) region: https://www.epa.gov/egrid

A.4 Facility Energy Strategy

A.4.1 Building Efficiency: Energy

The Hawai‘i Film Studio complex is identified as a facility that has the potential for high energy use when occupied, with significant potential for energy cost savings. A desktop assessment revealed a set of potential energy conservation measures (ECMs). Only those opportunities viewed to be the most feasible based on analysis, experience and interviews with onsite personnel are included in the sections below.

The potential projects encompassing both low-cost/no-cost and capital investment projects are categorized by type. Low-cost/no-cost opportunities involve little to no capital investment and typically require changes to setpoints or methods of operation to obtain energy savings.

Capital investment measures are defined as energy conservation, energy efficiency, or time-of use management projects with a capital cost of greater than $3,000 in first-cost implementation costs or are non-BAS (Building Automation System) controls optimization, where BAS optimization typically is included in the low-cost/no-cost measures section. These measures can significantly reduce energy consumption and costs but also require more significant first cost investments.

Potential opportunities or concepts that require further development or investigations by owner/contractor are presented at the end under “Non-Quantified Measures”.

A.4.1.1 QUANTIFIED ENERGY CONSERVATION MEASURES

Calculations for the quantifiable ECMs are based on a combination of algorithms from the Hawai‘i State-approved technical resource manual (TRM). A TRM is a resource used to help plan and evaluate energy efficiency programs. TRMs outline how much energy can be expected to be saved for certain measures, either through deemed savings values or engineering algorithms. TRMs also contain source documentation, specified assumptions, and other metrics associated with energy efficiency measures.

Three ECMs were identified during the assessment that can be quantified for the energy usage reduction, peak demand savings and life cycle cost implications. Table 53 below lists the ECMs, which are described below the table.

Table 53. Hawai‘i Film Studio Complex Summary of Energy Conservation Measures

Energy Conservation Measure	ECM Improvement ID	ECM Type
COMPLETE INTERIOR LED LIGHTING RETROFIT	DBEDT – Film Studio - ECM #1	Capital
EXTERIOR LIGHTING REPLACEMENT (150W-220W)	DBEDT – Film Studio - ECM #2	Capital
LIGHTING OCCUPANCY SENSORS (100% - 5,355 SQFT)	DBEDT – Film Studio - ECM #3	Capital

A.4.1.2 MEASURE DESCRIPTIONS

DBEDT – Film Studio – ECM #1: Complete Interior LED Lighting Retrofit

The Hawai'i Film Studio Complex's interior lights are all fluorescent, primarily linear T8 fluorescents mixed with CFL downlights and other types of fluorescent lighting. The Hawai'i Clean Lighting Standards (Act 225, 2023[11]) prohibits the sale of fluorescent lighting in Hawai'i, as of January 1, 2025. In order to ensure that replacement bulbs are available, DAGS will need to retrofit the lighting to be all LED. Retrofitting the lighting to be all LED will also save the facility money, while saving electricity. Per the TRM, this measure pertains to the installation of an LED luminaire or retrofit kit for general area illumination in place of a fluorescent light source. These luminaires and retrofit kits are typically recessed, suspended, or surface-mounted and intended to provide ambient lighting in office spaces, schools, retail stores, and other commercial environments. Because of the improved optical control afforded by LED luminaires and retrofit kits, LED lighting systems can typically reduce total lumen output while maintaining required illuminance on work surfaces.

Figure 16. TRM Algorithms Used to Calculate Energy and Peak Demand Savings – Light General

First Baseline Peak Demand Reduction, kW

$$\Delta kW_{1st} = \left(kW_{base,1} - kW_{EE}\right) * ISR * CF * IE_{C,D} * PF \quad (1)$$

Second Baseline Peak Demand Reduction, kW

$$\Delta kW_{2nd} = \left(kW_{base,2} - kW_{EE}\right) * ISR * CF * IE_{C,D} * PF \quad (2)$$

First Baseline Annual Energy Savings, kWh/yr

$$\Delta kWh_{1st} = \left(kW_{base,1} - kW_{EE}\right) * ISR * HOU_{year} * IE_{C,E} * PF \quad (3)$$

Second Baseline Annual Energy Savings, kWh/yr

$$\Delta kWh_{2nd} = \left(kW_{base,2} - kW_{EE}\right) * ISR * HOU_{year} * IE_{C,E} * PF \quad (4)$$

Lifetime Energy Savings, kWh (Dual Baseline, ROB)

$$\Delta kWh_{life,dual} = \Delta kWh_{1st} * EUL_{1st} + \Delta kWh_{2nd} * (EUL_{EE} - EUL_{1st}) \quad (5)$$

Lifetime Energy Savings, kWh (Dual Baseline, Early Replacement)

$$\Delta kWh_{life,dual} = \Delta kWh_{1st} * RUL + \Delta kWh_{2nd} * (EUL_{EE} - RUL) \quad (6)$$

[11] https://hawaiienergy.com/wp-content/uploads/Lighting-Ban-FAQ-1.pdf

Lifetime Energy Savings, kWh (Single Baseline)

$$\Delta kWh_{life,single} = \Delta kWh_{2nd} * EUL_{EE} \quad (7)$$

Remaining Useful Life

$$RUL = ROUND(1/3 * EUL_{pre-existing}) \quad (8)$$

DBEDT – Film Studio – ECM #2: Exterior LED Lighting Replacement

The facility's exterior lighting is mostly high-pressure sodium, high-intensity discharge pole mounted lighting, as well as wall packs for egress along the perimeter of the building envelope. Per the TRM, this measure pertains to the installation of an LED outdoor pole/arm- or wall-mounted luminaire or retrofit kit for parking lot, street, or general area illumination in place of a high-intensity discharge light source.

Figure 17. TRM Algorithms Used to Calculate Energy and Peak Demand Savings – Light Exterior

ALGORITHMS

Peak Demand Reduction, kW

$$\Delta kW = (kW_{base} - kW_{EE}) * ISR * CF * PF \quad (1)$$

Annual Energy Savings, kWh/yr

$$\Delta kWh = (kW_{base} - kW_{EE}) * ISR * HOU_{year} * PF \quad (2)$$

Lifetime Energy Savings, kWh

$$\Delta kWh_{life} = \Delta kWh * EUL_{EE} \quad (3)$$

DBEDT – Film Studio – ECM #3: Lighting Occupancy Sensors

Based on as-built drawings and photographs, the facility only has manual lighting controls, such as wall Adding lighting occupancy sensors throughout the facility will reduce electricity being used to power lighting for spaces that are unoccupied. Per the TRM, this measure defines the savings associated with installing a wall, fixture, or remote-mounted occupancy sensor that switches lights off after a brief delay when it does not detect occupancy.

The calculated implementation costs and energy savings in this report are based on installing 21 total remote (overhead) occupancy sensors throughout the facility, based on average coverage area of 250 square feet per sensor. A detailed lighting control audit was outside the scope of this assessment, and we recommend consulting a lighting control vendor to get a quote. Cost and savings calculations can be scaled based on the total number recommended.

The ECM from the TRM is identified as: COMMERCIAL – Light Occupancy Sensor. The algorithms used to calculate energy savings and peak demand savings are listed below.

Figure 18. TRM Algorithms Used to Calculate Energy and Peak Demand Savings: Light Occupancy Sensor

ALGORITHMS

Peak Demand Reduction, kW

$$\Delta kW = (P_{ctrl}/1000) * RTR * ISR * CF * IE_{C,D} * PF \quad (1)$$

Annual Energy Savings, kWh/yr

$$\Delta kWh = (P_{ctrl}/1000) * RTR * ISR * HRS * IE_{C,E} * PF \quad (2)$$

Lifetime Energy Savings, kWh

$$\Delta kWh_{life} = \Delta kWh * EUL_{EE} \quad (3)$$

A.4.1.3 NON-QUANTIFIED ENERGY CONSERVATION MEASURES

Additionally, four ECMs were identified during the assessment that requires further information to quantify the impacts. These measures require further investigation, either via an onsite inventory of individual pieces of equipment for condition and remaining useful life, review of the controls programming by a Controls Contractor, or further trending to verify that the occurrences happen regularly.

Table 54. Non-quantified Energy Conservation Measures, Hawai'i Film Studio Complex

Energy Conservation Measure	ECM Improvement ID
IMPLEMENT BMS/ AUTOMATED SYSTEM TO CONTROL HVAC SYSTEM	DBEDT Film Studio - ECM #NQ-1
REPLACE WINDOWS WITH DOUBLE-PANED WINDOWS	DBEDT Film Studio - ECM #NQ-2
REPLACE FCUs WITH MORE EFFICIENT UNITS	DBEDT Film Studio - ECM #NQ-3
INSTALL LOCKOUT SENSORS TO TURN OFF HVAC SYSTEM IN SOUNDSTAGE 2 WHEN EXTERIOR DOORS ARE OPEN	DBEDT Film Studio - ECM #NQ-4

DBEDT Film Studio – ECM #NQ1: IMPLEMENT BMS/ AUTOMATED SYSTEM TO CONTROL HVAC SYSTEM

There is no centralized, automated control system controlling the operation of the chiller and other HVAC equipment. Implementing a building management system or similar centralized, automated control system will allow for enhanced capability to actively manage energy and leaves control of the building's systems and equipment in the hands of the Hawai'i Film Studio staff, rather than the tenants occupying the facility.

The measure cannot be quantified because there is no TRM algorithm specific to replacing a whole facility control system and the potential for energy savings depends on how the equipment is controlled once a system is installed.

DBEDT Film Studio – ECM #NQ2: REPLACE WINDOWS WITH DOUBLE-PANED WINDOWS

The windows in the Production Office are original to the building and single paned, providing poor thermal performance. Installing double-paned windows will reduce thermal energy transfer between the exterior and the interior, reducing the need for space conditioning. The measure cannot be quantified because there is no TRM algorithm specific to replacing single-paned windows with double-paned windows.

DBEDT Film Studio – ECM #NQ3: REPLACE FCUs WITH MORE EFFICIENT UNITS

The fan coil units in the Production Office are at or near the end of their useful life and need to be replaced. Installing more energy efficient fan coil units, including FCUs that have electronically commutated motors, will reduce energy consumption in the facility and keep occupants more comfortable. Since the units at the end of their useful life, this measure is considered a capital replacement item and is not quantified as an energy conservation measure.

DBEDT Film Studio – ECM #NQ4: INSTALL LOCKOUT SENSORS TO TURN OFF HVAC SYSTEM IN SOUNDSTAGE 2 WHEN EXTERIOR DOORS ARE OPEN

Because there is no centralized building management system, there is no automated way for the operation of the building's equipment to be responsive to changing conditions. Currently, the HVAC system remains running even when the large swing doors to Sound Stage 2 are open. This wastes energy providing air conditioning that is escaping out the front door. When installing a new building management system, we recommend also installing lockout sensors on the swing doors that will disable the HVAC system when the doors are open for an extended period of time.

A.4.1.4 PERFORMANCE ANALYSIS

The energy and GHG performance impacts of each of the quantified ECMs described above are listed in Table 55 below.

Table 55. ECM Performance Results, Hawaiʻi Film Studio Complex

Measure ID	Energy Conservation Measure	CapEx (2025$)	Annual Electric Savings (kWh/yr)	Annual Peak Electric Savings (kW)	Annual GHG Savings (mtCO2e/ kWh)
Film Studio – Stage 2 – ECM #1	**COMPLETE INTERIOR LED LIGHTING RETROFIT**	$50,393	28,319	2	19.3
Film Studio – Stage 2 – ECM #3	**EXTERIOR LIGHTING REPLACEMENT (150W-220W)**	$31,250	33,415	5.1	22.7
Film Studio – Stage 2 – ECM #2	**LIGHTING OCCUPANCY SENSORS (100% - 26,000 SQFT)**	$59,218	33,415	2.3	13.8

A.4.2 Building Efficiency: Water

The desktop facility assessment of the Hawaiʻi Film Studio Complex revealed potential measures that could save water at the facility, referred to here as water conservation measures (WCMs). Water use and cost conservation at State-owned facilities will provide direct reductions in resource consumption, while also lowering operating costs for State agencies and reducing the amount of energy required to pump the water from its source to its sink.

A.4.2.1 WATER CONSERVATION MEASURES

The Hawaiʻi Film Studio Complex has water conservation opportunities for both indoor and exterior water use. Due to limitations in the available data, only measures impacting indoor water use are quantifiably assessed as part of this study.

Table 56. Hawaiʻi Film Studio Complex Summary of Water Conservation Measures

WCM Improvement Description	WCM Improvement ID
Replace toilets/ water closets	DBEDT – Film Studio - WCM #1
Replace urinals	DBEDT - Film Studio - WCM #2
Replace showerheads	DBEDT – Film Studio - WCM #3

<u>DBEDT – Film Studio – WCM #1: Replace Toilets/ Water Closets with 1.28 GPF Units</u>

The Hawaiʻi Film Studio complex still has its original indoor plumbing system and fixtures. Based on photos, interviews and as-built information provided, it is assumed that there are five toilets/ water closets installed in the facility, each with a flush rate of 3.4 gallons per flush (GPF). There have been great advances in low-cost, water saving technology since the facility's plumbing fixtures were installed, with 1.28 GPF commonly and commercially available.

DBEDT – Film Studio – WCM #2: Replace Urinals with 0.25 GPF Units

The facility has one original urinal, rated at 1.6 GPF. Many lower flush options for urinals are commonly and commercially available, including low flow, ultra-low flow and waterless urinals. While waterless urinals offer the greatest potential water savings of those options, older buildings with original plumbing systems sometimes experience operational issues with the waterless system being able to properly clear the pipes. Ultra-low flow 0.25 GPF urinals provide an optimal balance by still offering substantial water use savings but with a more functional configuration.

DBEDT – Film Studio – WCM #3: Replace Showerheads with 1.6 GPM Units

The two original lavatory showerheads have a 2.5 gallons per minute (GPM) flow rate. Newer low flow showerheads can deliver high pressure with a flow rate of only 1.6 GPM.

A.4.2.2 PERFORMANCE ANALYSIS

The expected annual water savings from implementing each of the recommended WCMs is detailed below.

Table 57. WCM Performance Results, Hawaiʻi Film Studio Complex

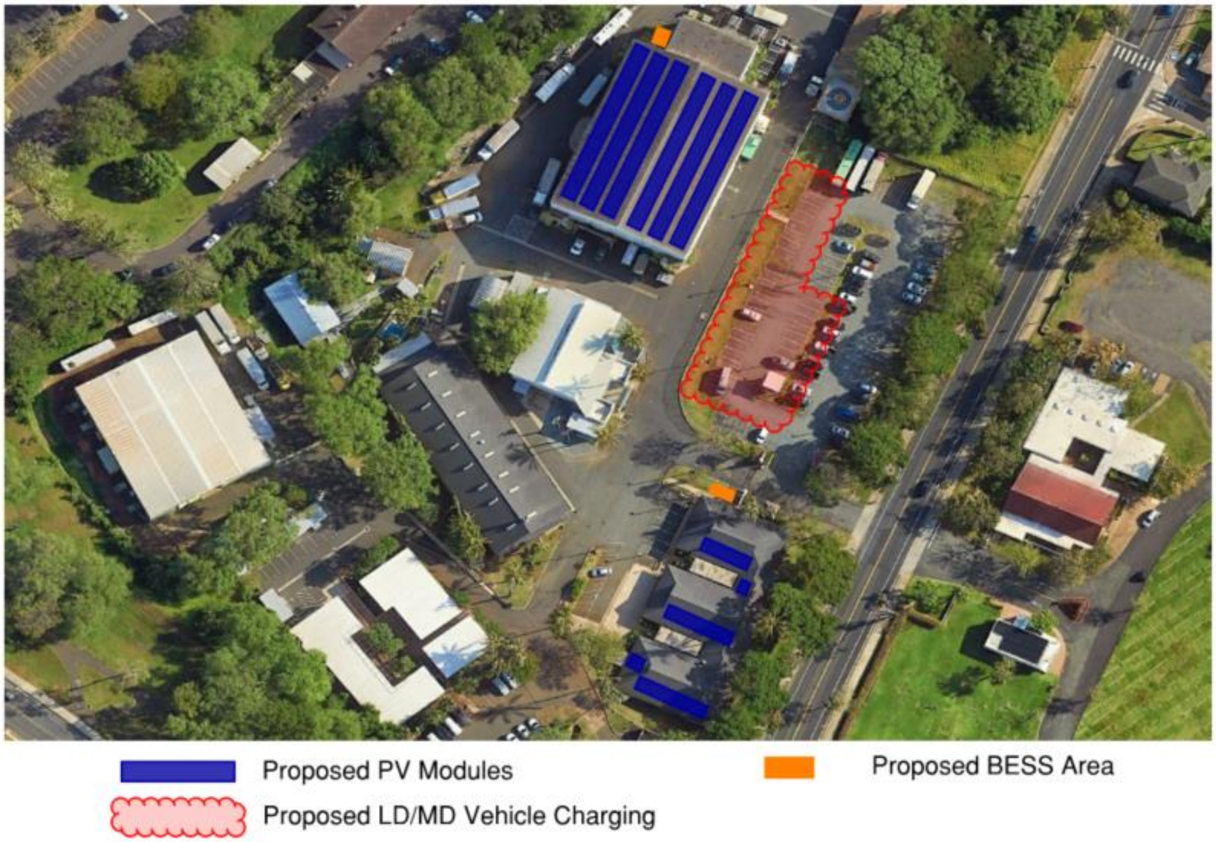
Measure ID	Water Conservation Measures	CapEx (2025$)	Annual Water Savings (gallons)
Film Studio – Production Office – WCM1	Replace toilets/ water closets	$3,410	85,436
Film Studio – Production Office – WCM2	Replace urinals	$682	28,080
Film Studio – Production Office – WCM4	Replace showerheads	$148	6,825

A.4.3 Solar PV and BESS Analysis

The Hawaiʻi Film Studio facility contains numerous buildings. This analysis focuses on the Stage 2 Building and the Production Offices. The Stage 2 building is a large building with a sloped roof with minimal existing rooftop equipment. There is minimal concern for shading at the Stage 2 Building. The estimated solar capacity for the structure is 190 kW.

The Production Office is a smaller building with a sloped roof and minimal existing rooftop equipment. There are multiple large trees near the building that could cause minor shading on the PV system. To avoid shading, and maximize energy output, roof areas with south or southwest facing azimuth angles were chosen for potential PV modules. The estimated solar capacity for the structure is 68 kW.

Figure 19. **Hawai‘i Film Studio Concept Solar and EV Layout**



The current building load data, utility rate, and estimated PV system size for Stage 2 was analyzed through the HOMER modeling software as discussed under the Solar Analysis Methodology. The annual building consumption for the past year is approximately 166,000 kWh. The estimated roof solar capacity is 190 kW DC, and the initial HOMER analysis indicates that a 190 kW DC nameplate PV system would be optimal.

HOMER model results indicate that multiple PV system configurations possess favorable payback periods, Internal Rate of Return (IRR), and renewable fractions. PV and BESS hybrid systems tend to have slightly longer payback periods but provide an increase in renewable fraction.

The base case, PV only and PV and BESS system configurations with the fastest payback periods are provided in Table 60.

The current building load data, utility rate, and estimated PV system size for the Production Office was analyzed through the HOMER modeling software as discussed under the Solar Analysis Methodology. The annual building consumption for the past year is approximately 56,000 kWh. The estimated roof solar capacity is 68 kW DC, and the initial HOMER analysis indicates that a 68 kW DC nameplate PV system would be optimal.

HOMER model results indicate that multiple PV system configurations possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems tend to have slightly longer payback periods but provide an increase in renewable fraction.

The base case, PV only and PV and BESS system configurations with the fastest payback periods are provided in Table 58 and Table 59.

Table 58. Hawai'i Film Studio Stage 2 Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (HE Sch J - Smart Export)	166,000	N/A	N/A	N/A
190 kW PV Only	84,000	595,150	N/A	77.8
190 kW PV + 110 kWh BESS	56,200	595,150	31,370	83.7

Table 59. Hawai'i Film Studio Production Office Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (HE Sch J - Smart Export)	56,000	N/A	N/A	N/A
68 kW PV Only	29,000	109,700	N/A	79
68 kW PV + 32 kWh BESS	20,800	109,700	9,100	83.8

Cost performances for the three systems at each building are provided in Table 60 and Table 61.

Table 60. Hawai'i Film Studio Stage 2 Renewables Cost Summary

System Configuration	CAPEX	Net Present Cost ($)	IRR (%)	Discounted Payback Period (yr)
Base Case (HE Sch J - Smart Export)	N/A	1,060,000	N/A	N/A
190 kW PV Only	355,000	619,000	4	18.2
190 kW PV + 110 kWh BESS	415,000	618,000	5	16.9

Table 61. Hawai'i Film Studio Production Office Renewables Cost Summary

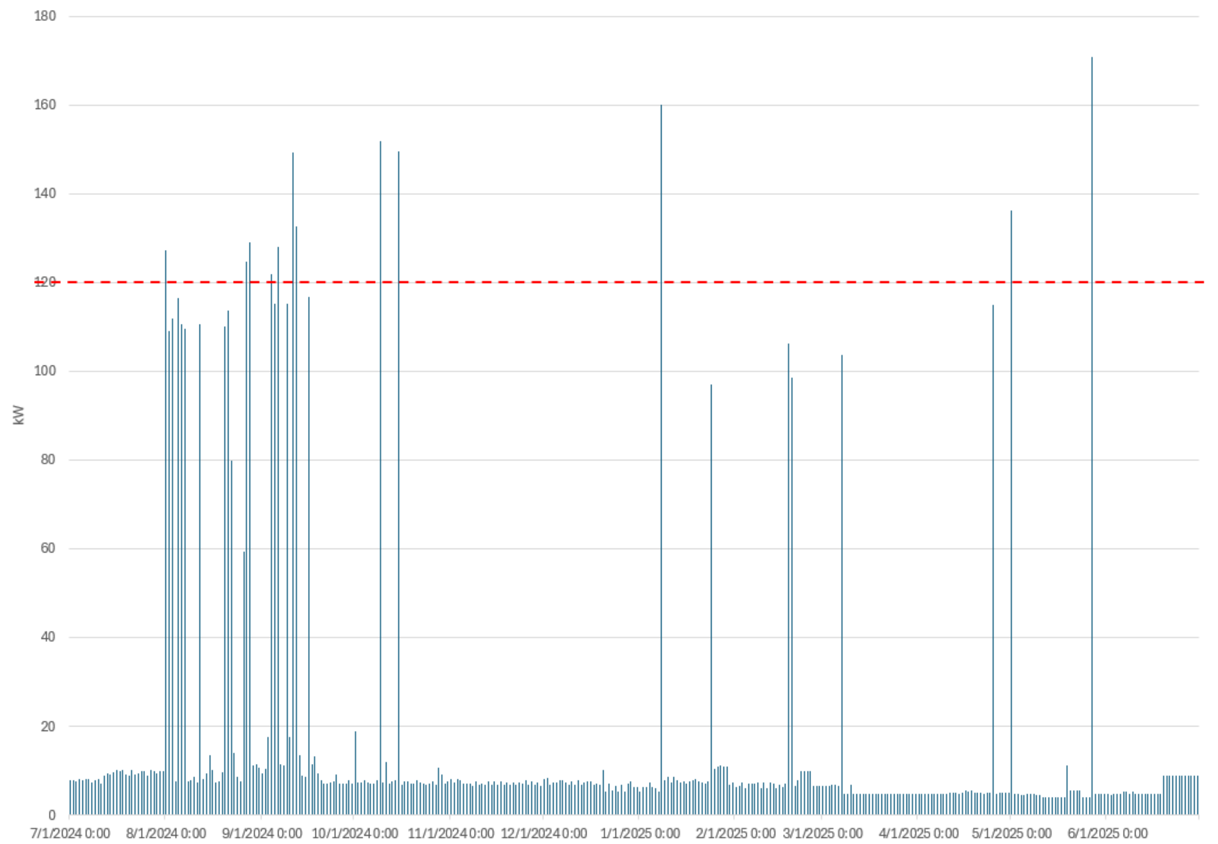
System Configuration	CAPEX	Net Present Cost ($)	IRR (%)	Discounted Payback Period (yr)
Base Case (HE Sch J - Smart Export)	N/A	285,000	N/A	N/A
68 kW PV Only	127,000	168,000	4	18.9
68 kW PV + 32 kWh BESS	146,000	182,000	5	17.2

A.4.4 Demand Management and Demand Response

15-minute interval data from the Hawaiʻi Film Studio complex's Hawaiian Electric meter covering the 12-month period from July 2024 through June 2025 was assessed. The whole facility-level energy usage data allowed for an initial screening of the annual electricity demand profile. Electricity demand is a measure of the peak electrical load in the facility at any given point in time during the year. This annual load profile is used to identify the frequency of peak loads recorded at the facility that could be high enough to trigger a demand response event, providing an indicator of the suitability of the facility to participate in a demand response program.

A substantial impact on this study is that the Hawaiʻi Film Studio Complex was mostly unoccupied and not used for film production during the 12-month study period from July 2024 through June 2025. This study period was chosen for consistency with the other facilities assessed for the State Facility Energy Strategy project. The electrical load profile is expected to be substantially different during times the complex is being actively used for film production.

Figure 20. Annual Electricity Demand Profile from 15-minute Interval Data, Hawai‘i Film Studio Complex



The Hawai‘i Film Studio complex has a base load demand of approximately 6kW, but can spike as high as 170kW during peak usage periods. While there are 12 times during the course of the year where the peak demand met or exceeded 120kW, the assessment year is not considered representative of the complex’s intended, or historical usage patterns. More importantly, although the facility is expected to experience substantial spikes in electrical demand during film production, the loads that can be curtailed for demand management are likely limited to base building electrical loads. The Hawai‘i Film Studio complex is a unique usage case but does experience peak loads that could potentially be managed to reduce the Hawai‘i Film Studio’s monthly energy costs. Further coordination with Hawaiian Electric around demand management is strongly encouraged.

A.4.5 Vehicle Electrification

There are no fleet vehicles assigned to the Hawai‘i Film Studio complex. The Film Studio complex has approximately 150 existing parking stalls throughout the facility, with a large parking area located north of the Production Office. If 30 parking stalls (20 percent) were converted to Level 2 EV chargers, then approximately 216 kW of electrical capacity would be required.

A.4.6 Financial Feasibility

Table 62 shows the discounted payback period and the benefit cost ratio of applicable ECM and PV/BESS measures for Stage 2, and applicable WCM and PV/BESS measures for the Production Office. PV options for both facilities have considerably longer payback periods: the Stage 2 facility has a payback period of 18.2

years for the PV Only option, and 16.9 years for PV+BESS; while the Production Office has a longer payback period of 18.9 years and 17.2 years for the standalone and combined PV options.

For Stage 2, Interior LED Lighting Retrofit (ECM #3) has the shortest payback period for this facility at 3.4 years, which is followed by the Exterior and Parking Lot LED Lighting Retrofit (ECM #1) option at 6.9 years. Lighting Occupancy Sensors (100% - 48,860 SQFT) have a payback period beyond the study period.

For the Production Office, all measures except for PV+BESS have a positive return. These range from BCRs of 1.6 to 4.3 for beneficial projects. The highest return project at the Production Office is the Replace Toilets option, which returns $4.30 for every $1 spent.

Table 62. Efficiency and PV/BESS Results, Film Studio - Stage 2

Measure ID	Improvement Type	Film Studio	
		Payback Period (years)	Benefit Cost Ratio
	Production Office		
Film Studio – Production Office – WCM1	Replace toilets/ water closets	4.9	4.3
Film Studio – Production Office – WCM2	Replace urinals	7.6	2.6
Film Studio – Production Office – WCM3	Replace lavatory faucets	4.4	2.2
Film Studio – Production Office – WCM4	Replace showerheads	17.2	1.7
Film Studio – RE1	PV Only	18.9	1.6
Film Studio – RE2	PV+BESS	N/A	0.5
	Stage 2		
Film Studio – Stage 2 – ECM #1	COMPLETE INTERIOR LED LIGHTING RETROFIT	6.9	3.4
Film Studio – Stage 2 – ECM #2	LIGHTING OCCUPANCY SENSORS (100% - 48,860 SQFT)	5.2	2.8
Film Studio – Stage 2 – ECM #3	EXTERIOR AND PARKING LOT LED LIGHTING RETROFIT (35W-149W)	16.9	1.8
Film Studio – RE1	PV Only	18.2	1.7
Film Studio – RE2	PV+BESS	N/A	0.6

B

Appendix B – Hawai‘i State Library

B. Hawai‘i State Library

B.1 Facility Description

The Hawai‘i State Library, which is part of the Hawai‘i State Public Library System, is a 3-story above grade structure, with a basement, comprising 107,000 square feet. The library was originally built in 1927 and underwent a renovation and major expansion in 1990. The facility is used as the main public library for the State of Hawai‘i and is visited by thousands of people per year. There is programming, as well as extensive book collections across a wide range of genres.

HSPLS | Hawai‘i State Library | Building Characteristics

Location | Envelope Basics		Heating | Cooling | Ventilation	
Location	478 S. King St., Honolulu, O‘ahu	**Heating Primary Fuel**	Electricity
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	1	**Heating Generation**	Electric resistance duct heaters
Building Type	Library	**Cooling Generation**	Water-Cooled Chillers
Year Built	1927 (1990 expansion)	**Domestic Hot Water Generation**	Electric Storage-type Water Heater
Floor Area (ft2)	107,000	**Heating / Cooling / Vent Distribution**	Constant volume fan coil units
Stories	3, plus a basement	**Electric Rate Structure**	Hawaiian Electric J- General Service - DEMAND
Window Type	Single-pane, Aluminum Frame		
Wall Type	Reinforced concrete	**Natural Gas Rate Structure**	N/A
Lighting System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Mostly fluorescent; with some LED	**Weekday Operating Hours**	38
Exterior Lighting System	None	**Weekday Opening Time**	Monday, Tuesday, Wednesday, and Friday: 9am – 4pm Thursday: 9am – 7pm
		Weekend Operating Hours	5
		Weekend Opening Time	Saturday: 11am – 4pm

Figure 21. Hawaiʻi State Library

B.2 Energy-using Systems Addressed

The Hawaiʻi State Library facility was remotely assessed for operational energy performance improvement opportunities. The assessment used design and as-built drawings, previous reports and facility assessments, and utility bills, along with written facility narratives and interviews conducted with facilities management personnel to investigate the energy-using systems and equipment in the facility. Specific energy-using systems investigated as part of this assessment include:

- Building envelope
- HVAC
- Domestic hot water
- Lighting – interior / exterior
- Plug loads
- Water fixtures

B.3 Energy Performance Analysis

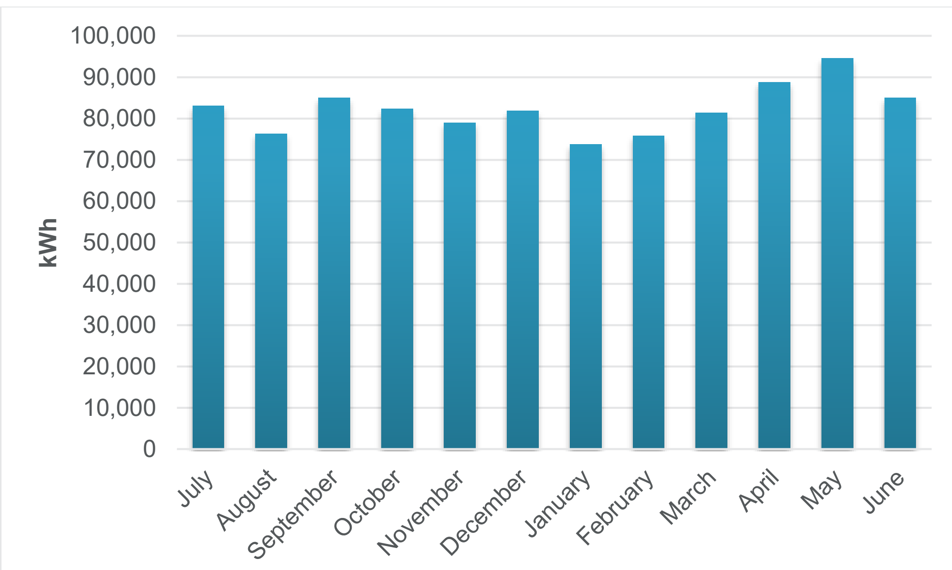
The facility's operational energy consumption in units of kilowatt hours was obtained from utility bill summaries provided by Hawaiian Electric, the electric utility. The facility does not use any other energy types as a primary energy source. Utility bill summaries were analyzed for the 12-month period from July 2024 through June 2025.

One method for measuring a facility's energy efficiency is to determine its energy use intensity (EUI), which is the energy consumption per gross square foot. Two types of EUI are typically determined for a facility. The first is the site EUI, which is defined as the energy use at the site divided by the building's gross square footage. The second is the source EUI, which is defined as the energy used by the various energy plants to provide energy to the site. This value is always higher than the site EUI because it accounts for inefficiencies and losses in generation and distribution. For the State Facilities Energy Strategy, US EPA's national site-to-source energy conversion factor of 2.80[12] is used to calculate source energy. Because EUI looks at total consumption of all types of energy used in a facility, the unit of measurement for energy is typically expressed in kilo British thermal units (kBtu), which allows for an apples-to-apples comparison of different energy types in a common unit. Moreover, because EUI is a measure of intensity, there is a defined time period of 1 calendar year and efficiency is calculated by dividing the total energy usage by the floor area of the building. The units for EUI are typically expressed as kBtu/sf/yr.

B.3.1 Energy Consumption and Energy Use Intensity

During the year of July 2024 through June 2025, the Hawai‘i State Library consumed 986,640 kWh of site energy, which cost $338,885 during the year. This equates to a site Energy Use Intensity (EUI) of 31.5 kBtu/sf/yr and source EUI of 88.1 kBtu/sf/yr. Total greenhouse gas emissions for the year are estimated to be 670.84 metric tons CO2e, equivalent to a greenhouse gas emissions intensity of 6.27 kgCO2e/sf/yr.

Figure 22. Hawai‘i State Library Monthly Energy Usage, July 2024 - June 2025



12 https://portfoliomanager.energystar.gov/pdf/reference/Source%20Energy.pdf?_gl=1*3nkuy*_ga*NTI0NjA3MDA0LjE3NTI1OTAzMzI.*_ga_S0KJTVVLQ6*czE3NjI0NzM2MDEkbzU5JGcxJHQxNzYyNDczNjYwJGoxJGwwJGgw

Table 63. Energy Consumption and Energy Use Intensity Summary

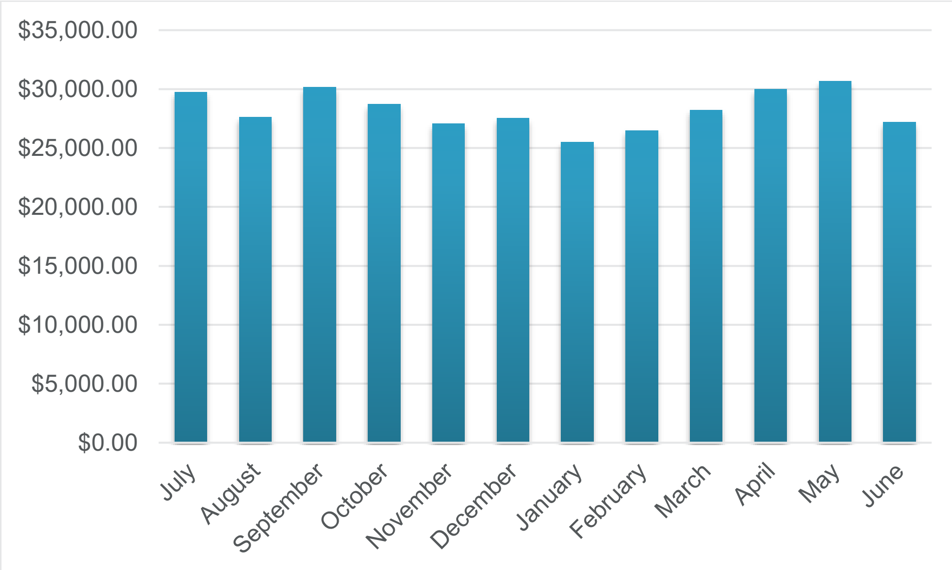
Metric	Current Year (7/24 – 6/25)
Source EUI (kBTU/sf)	88.1
Site EUI (kBTU/sf)	31.5
Source Energy Use (kBtu)	9,425,963
Site Energy Use (kBtu)	3,366,415
Energy Cost ($)	$338,885
Energy Cost Index, ECI ($/sf-yr)	$3.17
Total Location-based Greenhouse Gas (GHG) Emissions[13] (Metric tonsCO2e/yr)	670.84
Total Location-based GHG Emissions Intensity (kgCO2e/sf/yr)	6.27

B.3.2 Energy Cost

The Hawai'i State Library spent $338,885 on electricity during the year, which yields an Energy Cost Index (ECI) of $3.17/sf/yr. A summary of the monthly energy costs is in Figure 23 below. The actual costs are inclusive of the cost per unit of energy, as well as all fees, tariffs, and other charges.

[13] Emission factors derived from US EPA E-grid for the HIOA (Hawai'i – O'ahu) region: https://www.epa.gov/egrid

Figure 23. Hawai‘i State Library Monthly Energy Costs, July 2024 - June 2025



B.4 Facility Energy Strategy

B.4.1 Building Efficiency: Energy

The Hawai‘i State Library is identified as a high energy-using facility with significant potential for energy cost savings. A desktop assessment revealed a set of potential energy conservation measures (ECMs). Only those opportunities viewed to be the most feasible based on analysis, experience and interviews with onsite personnel are included in the sections below.

The potential projects encompassing both low-cost/no-cost and capital investment projects are categorized by type. Low-cost/no-cost opportunities involve little to no capital investment and typically require changes to setpoints or methods of operation to obtain energy savings.

Capital investment measures are defined as energy conservation, energy efficiency, or time-of use management projects with a capital cost of greater than $3,000 in first-cost implementation costs or are non-BAS (Building Automation System) controls optimization, where BAS optimization typically is included in the low-cost/no-cost measures section. These measures can significantly reduce energy consumption and costs but also require more significant first cost investments.

Potential opportunities or concepts that require further development or investigations by owner/contractor are presented at the end under “Non-Quantifiable Measures.”

B.4.1.1 QUANTIFIED ENERGY CONSERVATION MEASURES

Calculations for the quantifiable ECMs are based on a combination of algorithms from the Hawai‘i State-approved technical resource manual (TRM). A TRM is a resource used to help plan and evaluate energy efficiency programs. TRMs outline how much energy can be expected to be saved for certain measures, either through deemed savings values or engineering algorithms. TRMs also contain source documentation, specified assumptions, and other metrics associated with energy efficiency measures.

Five ECMs were identified during the assessment that can be quantified for the energy usage reduction, peak demand savings and life cycle cost implications. Table 64 below lists the ECMs, which are described below the table.

Table 64. Hawai‘i State Library Summary of Energy Conservation Measures

ECM Improvement Description	ECM Improvement ID	ECM Type
INTERIOR LED LIGHTING RETROFIT - Linear fluorescent lights	HSL - ECM #1	Capital
INTERIOR LED LIGHTING RETROFIT - U-bend fluorescent lights	HSL - ECM #2	Capital
INSTALL LIGHTING OCCUPANCY SENSORS (100% - 128,000 SQFT)	HSL - ECM #3	Capital
FAN COIL TUNE UP/REPAIRS (REPLACE MOTOR - 1/3 HP)	HSL- ECM #4	Capital
RETRO-COMMISSIONING	HSL– ECM #5	Capital

B.4.1.2 MEASURE DESCRIPTIONS

The following measures are recommended for implementation at the Hawai‘i State Library:

HSL – ECM #1 & ECM #2: Interior LED Lighting Retrofit – Linear and U-bend Lamps

The Hawai‘i State Library facility’s interior lights are all fluorescent, primarily linear T8 fluorescents and U-bend fluorescents, mixed with CFL downlights and other types of fluorescent lighting. The Hawai‘i Clean Lighting Standards (Act 225, 2023[14]) prohibits the sale of fluorescent lighting in Hawai‘i, as of January 1, 2025. In order to ensure that replacement bulbs are available, DAGS will need to retrofit the lighting to be all LED. Retrofitting the lighting to be all LED will also save the facility money, while saving electricity. Per the TRM, this measure pertains to the installation of an LED luminaire or retrofit kit for general area illumination in place of a fluorescent light source. These luminaires and retrofit kits are typically recessed, suspended, or surface-mounted and intended to provide ambient lighting in office spaces, schools, retail stores, and other commercial environments. Because of the improved optical control afforded by LED luminaires and retrofit kits, LED lighting systems can typically reduce total lumen output while maintaining required illuminance on work surfaces.

[14] https://hawaiienergy.com/wp-content/uploads/Lighting-Ban-FAQ-1.pdf

Figure 24. TRM Algorithms Used to Calculate Energy and Peak Demand Savings – Light General

First Baseline Peak Demand Reduction, kW

$$\Delta kW_{1st} = (kW_{base,1} - kW_{EE}) * ISR * CF * IE_{C,D} * PF \quad (1)$$

Second Baseline Peak Demand Reduction, kW

$$\Delta kW_{2nd} = (kW_{base,2} - kW_{EE}) * ISR * CF * IE_{C,D} * PF \quad (2)$$

First Baseline Annual Energy Savings, kWh/yr

$$\Delta kWh_{1st} = (kW_{base,1} - kW_{EE}) * ISR * HOU_{year} * IE_{C,E} * PF \quad (3)$$

Second Baseline Annual Energy Savings, kWh/yr

$$\Delta kWh_{2nd} = (kW_{base,2} - kW_{EE}) * ISR * HOU_{year} * IE_{C,E} * PF \quad (4)$$

Lifetime Energy Savings, kWh (Dual Baseline, ROB)

$$\Delta kWh_{life,dual} = \Delta kWh_{1st} * EUL_{1st} + \Delta kWh_{2nd} * (EUL_{EE} - EUL_{1st}) \quad (5)$$

Lifetime Energy Savings, kWh (Dual Baseline, Early Replacement)

$$\Delta kWh_{life,dual} = \Delta kWh_{1st} * RUL + \Delta kWh_{2nd} * (EUL_{EE} - RUL) \quad (6)$$

Lifetime Energy Savings, kWh (Single Baseline)

$$\Delta kWh_{life,single} = \Delta kWh_{2nd} * EUL_{EE} \quad (7)$$

Remaining Useful Life

$$RUL = ROUND(1/3 * EUL_{pre-existing}) \quad (8)$$

HSL – ECM #3: Lighting Occupancy Sensors

Based on as-built drawings and photographs, the facility only has manual lighting controls, such as wall-mounted switches. Adding lighting occupancy sensors throughout the facility will reduce electricity being used to power lighting for spaces that are unoccupied. Per the TRM, this measure defines the savings associated with installing a wall, fixture, or remote-mounted occupancy sensor that switches lights off after a brief delay when it does not detect occupancy.

The calculated implementation costs and energy savings in this report are based on installing 21 total remote (overhead) occupancy sensors throughout the facility, based on average coverage area of 250 square feet per sensor. A detailed lighting control audit was outside the scope of this assessment, and we recommend consulting a lighting control vendor to get a quote. Cost and savings calculations can be scaled based on the total number recommended.

The ECM from the TRM is identified as: COMMERCIAL – Light Occupancy Sensor. The algorithms used to calculate energy savings and peak demand savings are listed below.

Figure 25. TRM Algorithms Used to Calculate Energy and Peak Demand Savings: Light Occupancy Sensor

ALGORITHMS

Peak Demand Reduction, kW

$$\Delta kW = (P_{ctrl}/1000) * RTR * ISR * CF * IE_{C,D} * PF \quad (1)$$

Annual Energy Savings, kWh/yr

$$\Delta kWh = (P_{ctrl}/1000) * RTR * ISR * HRS * IE_{C,E} * PF \quad (2)$$

Lifetime Energy Savings, kWh

$$\Delta kWh_{life} = \Delta kWh * EUL_{EE} \quad (3)$$

HSL – ECM #4: Fan Coil Unit Tune Up / Motor Replacement

Based on previous reports about the condition of energy using equipment at the Hawai‘i State Library and responses to the RFI, many of the fan coil units may be performing sub-optimally and are in need of a general tune-up maintenance. The TRM does not include a measure of general fan coil unit maintenance but the closest proxy available in the TRM is to use electronically commutated motors in fan coil units, measure COMMERCIAL: Electronically Commutated Motors.

Figure 26. TRM Algorithms Used to Calculate Energy and Peak Demand Savings: Fan Coil Unit Electronically Commutated Motor Replacement

ALGORITHMS

Baseline Motor Input Wattage

$$W_{BL} = \frac{hp * 746}{\eta_{BL}} \quad (1)$$

Energy Efficient Motor Input Wattage

$$W_{EE} = \frac{hp * 746}{\eta_{EE}} \quad (2)$$

Peak Demand Reduction, kW

Evaporator fan motors for walk-in and reach-in cases and motors for HVAC FCU fans:

$$\Delta kW = \frac{(W_{BL} - W_{EE})}{1000} * \left(1 + \frac{1}{COP}\right) * CF \quad (3)$$

Evaporator fan motors **coupled with controls** for walk-ins:

$$\Delta kW = \frac{(W_{BL} - W_{EE})}{1000} * \left(1 + \frac{1}{COP}\right) * CF + \Delta kW_{Control} \quad (4)$$

Compressor and condenser / condensing unit fan motors:

$$\Delta kW = \frac{(W_{BL} - W_{EE})}{1000} * CF \quad (5)$$

Annual Energy Savings, kWh/yr

Evaporator fan motors for walk-in and reach-in cases and motors for HVAC FCU fans:

$$\Delta kWh = \frac{(W_{BL} - W_{EE})}{1000} * \left(1 + \frac{1}{COP}\right) * HRS \quad (6)$$

Evaporator fan motors **coupled with controls** for walk-ins:

$$\Delta kWh = \frac{(W_{BL} - W_{EE})}{1000} * \left(1 + \frac{1}{COP}\right) * HRS + \Delta kWh_{Control} \quad (7)$$

Compressor and condenser / condensing unit fan motors:

$$\Delta kWh = \frac{(W_{BL} - W_{EE})}{1000} * HRS \quad (8)$$

Lifetime Energy Savings, kWh

HVAC FCU fans, ≥1/12 hp and < 1hp

$$\Delta kWh_{life} = \Delta kWh * RUL \quad (9)$$

Evaporator fan motors **and controls** for walk-ins

$$\Delta kWh_{life} = (\Delta kWh + \Delta kWh_{Control}) * EUL \quad (10)$$

Rest of measures

$$\Delta kWh_{life} = \Delta kWh * EUL \quad (11)$$

HSL– ECM #5: Retro-commissioning

Retro-commissioning (RCx) is a systematic process that seeks to improve the performance of an existing building and how equipment and systems function together by optimizing the building controls or building management system. RCx can often resolve problems that occurred during design or construction or address those that have developed throughout the building's life. RCx uses a whole-building systems approach to identify operational improvements in a building's O&M procedures that will save energy and increase occupant comfort.

Estimated percent savings opportunities for implementing RCx on a given existing building range anywhere from 5% to 15% across the board, varying for different building typologies and build dates.

There are up to fourteen controls optimization measures that offer the highest opportunity for energy/carbon savings for non-residential facilities, and three of those have been determined to be appropriate for the Hawai‘i State Library, including:

Table 65. RCx measures that could improve energy performance at Hawai‘i State Library

Controls Measure	Measure and Description
1	Scheduling equipment: AHUs, Fans, Pumps, Electrical Heat, VAV/FPBs, Lighting
2	Align timeclocks controlling supply and exhaust fans, and terminal distribution equipment
3	Setback space temperature

B.4.1.3 NON-QUANTIFIED ENERGY CONSERVATION MEASURES

Additionally, two ECMs were identified during the assessment that requires further information to quantify the impacts. These measures require further investigation, either via an onsite inventory of individual pieces of equipment for condition and remaining useful life, review of the controls programming by a Controls Contractor, or further trending to verify that the occurrences happen regularly.

Table 66. Non-quantified Energy Conservation Measures, Hawai‘i State Library

Energy Conservation Measure	ECM Improvement ID
Replace fan coil units with new, more efficient units	HSL - ECM #NQ-1
Install facility-wide DDC controls for fan coil units and airside distribution system	HSL – ECM #NQ-2

<u>HSL – ECM #NQ1: Replace fan coil units with newer, more efficient units</u>

Many of the fan coil units that provide conditioned air throughout the facility are at or near the end of their useful life. Moreover, previous studies and reports from facilities personnel suggest that some of the fan coil units are not functioning properly, potentially causing extra energy to be consumed and/or failing to meet the comfort needs of building occupants. Repairing and eventually replacing the fan coil units is a capital improvement project and beyond the scope of this assessment but there is an opportunity to replace the existing units with a more energy efficient version, including fan coil units with electronically commutated motors.

<u>HSL – ECM #NQ2: Install facility-wide DDC controls for fan coil units and airside distribution system</u>

There is a patchwork of building controls in the State Library right now but there is no centralized control over the fan coil units and airside distribution systems. Airside distribution can have a significant impact on facility-wide energy use. Implementing direct digital controls (DDC) will enable more proactive energy management and will also provide operators with better insight into units that are not functioning properly.

B.4.1.4 PERFORMANCE ANALYSIS

The energy and GHG performance impacts of each of the quantified ECMs described above are listed in Table 67 below.

Table 67. ECM Performance Results, Hawai‘i State Library

Measure ID	Energy Conservation Measure	CapEx (2025$)	Annual Electric Savings (kWh/yr)	Annual Peak Electric Savings (kW)	Annual GHG Savings (mtCO2e/ yr)
HSL-ECM#1	INTERIOR LED LIGHTING RETROFIT - Linear fluorescent lights	$15,824	10,561	1.80	7.2
HSL-ECM#2	INTERIOR LED LIGHTING RETROFIT - U-bend fluorescent lights	$3,857	8,032	1.50	5.5
HSL-ECM#3	INSTALL OCCUPANCY SENSORS (100% - 128,000 SQFT)	$147,456	44,963	8.68	30.6
HSL-ECM#4	FAN COIL TUNE UP/REPAIRS (REPLACE MOTOR - 1/3 HP)	$34,132	1,602	0.24	1.1
HSL-ECM#5	RETRO-COMMISSIONING	$35,840	49,332	n/a	33.5

B.4.2 Building Efficiency: Water

The desktop facility assessment of the Hawai‘i State Library revealed potential measures that could save water at the facility, referred to here as water conservation measures (WCMs). Water use and cost conservation at State-owned facilities will provide direct reductions in resource consumption, while also lowering operating costs for State agencies and reducing the amount of energy required to pump the water from its source to its sink.

B.4.2.1 WATER CONSERVATION MEASURES

The Hawai‘i State Library has water conservation opportunities for both indoor and exterior water use. Due to limitations in the available data, only measures impacting indoor water use are quantifiably assessed as part of this study.

Table 68. Hawai‘i State Library Summary of Water Conservation Measures

WCM Improvement Description	WCM Improvement ID
Replace toilets/ water closets	HSL - WCM #1
Replace urinals	HSL - WCM #2
Replace lavatory faucets	HSL - WCM #3

HSL – WCM #1: Replace Toilets/ Water Closets with 1.28 GPF Units

The Hawaiʻi State Library still has its original indoor plumbing system and fixtures. Based on photos, interviews and as-built information provided, it is assumed that there are 18 toilets/ water closets installed in the facility, each with a flush rate of 3.4 gallons per flush (GPF). There have been great advances in low-cost, water saving technology since the facility's plumbing fixtures were installed, with 1.28 GPF commonly and commercially available.

HSL – WCM#2: Replace Urinals with 0.25 GPF Units

The facility has six original urinals, rated at 1.6 GPF. Many lower flush options for urinals are commonly and commercially available, including low flow, ultra-low flow and waterless urinals. While waterless urinals offer the greatest potential water savings of those options, older buildings with original plumbing systems sometimes experience operational issues with the waterless system being able to properly clear the pipes. Ultra-low flow 0.25 GPF urinals provide an optimal balance by still offering substantial water use savings but with a more functional configuration.

HSL – WCM #3: Replace Lavatory Faucets with 0.4 GPM Units

The 12 original lavatory faucets have a 0.6 gallons per minute (GPM) flow rate and are manually turned on and off. Newer low flow faucets can deliver higher pressure using only 0.4 GPM with a timed release that closes the faucet after 5-15 seconds.

B.4.2.2 PERFORMANCE ANALYSIS

The expected annual water savings from implementing each of the recommended WCMs is detailed in Table 69 below.

Table 69. WCM Performance Results, Hawaiʻi State Library

Measure ID	Water Conservation Measure	Assumptions	
		CapEx (2025$)	Annual Water Savings (gallons)
HSL-WCM1	Replace toilets/ water closets	$12,276	60,081
HSL-WCM2	Replace urinals	$4,092	23,166
HSL-WCM3	Replace lavatory faucets	$3,306	4,550

B.4.3 Solar PV and BESS Analysis

The Hawaiʻi State Library building has a unique shaped roof with both sloped and flat sections. The building has some shading concerns from rooftop obstructions and surrounding trees. The north and northwest facing roof areas were not considered for solar to due shading and potential for decreased energy production. The estimated solar capacity for the structure is 115 kW DC between the flat and sloped roof sections as shown in Figure 27.

Figure 27. **Hawaiʻi State Library Concept Solar and EV Layout**

The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software as discussed under the Solar Analysis Methodology. The annual building consumption for the past year is approximately 981,000 kWh. The initial HOMER analysis indicates that a 115 kW DC nameplate PV system would be optimal.

HOMER model results indicate that multiple PV systems possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems tend to have slightly less favorable payback periods and IRR due to the high capital cost of BESS and small amounts of excess PV generation. PV and BESS hybrid systems also tend to provide minimal increase in renewable fraction over standalone PV systems.

The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 70.

Table 70. Hawai'i State Library Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (HE Sch J - Smart Export)	981,000	N/A	N/A	N/A
115 kW PV Only	797,100	187,000	N/A	19
115 kW PV + 70 kWh BESS	797,000	187,000	1,750	19

Cost performance for the three systems is provided in Table 71.

Table 71. Hawai'i State Library Renewables Cost Summary

System Configuration	CAPEX	Net Present Cost ($)	IRR (%)	Discounted Payback Period (yr)
Base Case (HE Sch J - Smart Export)	N/A	4,680,000	N/A	N/A
115 kW PV Only	212,000	4,100,000	29	7.6
115 kW PV + 70 kWh BESS	251,000	4,120,000	25	8.8

B.4.4 Demand Management and Demand Response

Hawaiian Electric was not able to provide 15-minute interval data for the Hawai'i State Library, therefore no quantitative analysis was done. It is not clear that the facility's BMS is capable of controlling loads in a way that would allow participation in a demand response program. We encourage HSPLS to have further discussions with Hawaiian Electric about the potential for participating in one of their demand response programs.

B.4.5 Vehicle Electrification

The Hawai'i State Library does not have any fleet vehicles assigned to it. The facility has 22 existing parking stalls northwest of the library at the Hawai'i State Archives building, near the Iolani Palace. If four parking stalls (20 percent) were converted to EV, then approximately 30 kW of electrical capacity would be required.

B.4.6 Financial Feasibility

Table 72 shows the discounted payback period along with the benefit cost ratio of applicable ECM, WCM, and PV/BESS measures for HSL. Interior LED Lighting Retrofit – U-bend Fluorescent Lights (ECM #2) has the shortest payback period for this facility at 3.2 years, which is followed by the PV Only option at 7.6 years; the Interior LED Lighting Retrofit – Linear Fluorescent Lights (ECM #2) option at 8.0 year; and the PV+BESS option at 8.8 years.

Most of the measures studied have a payback period beyond the study period for HSL, which include:

- Occupancy Sensors Installation (100% - 128,000 SQFT) (ECM #3)
- Fan Coil Tune-Up/Repairs (Replace Motor - 1/3 HP) (ECM #4)

- Toilet/Water Closets Replacements
- Urinals Replacements
- Lavatory Faucets Replacements

Table 72. Efficiency and PV/BESS Results, HSL

Measure ID	Improvement Type	HSL	
		Payback Period (years)	Benefit Cost Ratio
HSL-ECM#2	INTERIOR LED LIGHTING RETROFIT - U-bend fluorescent lights	3.2	9.0
HSL – RE1	PV Only	7.6	5.2
HSL – RE2	PV+BESS	8.8	4.4
HSL-ECM#1	INTERIOR LED LIGHTING RETROFIT - Linear fluorescent lights	8.0	2.9
HSL-WCM2	Replace urinals	N/A	0.6
HSL-ECM#3	INSTALL OCCUPANCY SENSORS (100% - 128,000 SQFT)	N/A	0.5
HSL-WCM1	Replace toilets/ water closets	N/A	0.5
HSL-ECM#4	FAN COIL TUNE UP/REPAIRS (REPLACE MOTOR - 1/3 HP)	N/A	0.1
HSL-WCM3	Replace lavatory faucets	N/A	0.1

C

Appendix C – Waimano State Laboratory- Kamauleule Building

C. Waimano State Laboratory – Kamauleule Building

C.1 Facility Description

The Department of Health's Waimano State Laboratory – Kamauleule Building is a public health laboratory that conducts a wide range of scientific testing. The 134,570 square foot facility is 3 stories and was originally built in 1995. The facility includes a significant amount of energy using process equipment in a laboratory-type environment, though not all of the process load equipment is actively used.

DOH | Waimano State Laboratory – Kamauleule Building | Building Characteristics

Location | Envelope Basics		Heating | Cooling | Ventilation	
Location	2725 Waimano Home Road, Pearl City, Oʻahu	**Heating Primary Fuel**	Electricity
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	1	**Heating Generation**	Electric re-heat
Building Type	Laboratory	**Cooling Generation**	Water cooled chillers
Year Built	1995	**Domestic Hot Water Generation**	Electric Storage-type Water Heater
Floor Area (ft2)	134,570	**Heating / Cooling / Vent Distribution**	Constant volume Air-Handlers
Stories	3	**Electric Rate Structure**	Hawaiian Electric P LARGE POWER SERVICE
Window Type	Double-pane, Aluminum Frame		
Wall Type	Concrete and steel structure, with storefront windows	**Natural Gas Rate Structure**	N/A
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Mostly fluorescent; some LED	**Weekday Operating Hours**	47.5
Exterior Lighting System	HPS HID pole mounted	**Weekday Opening Time**	Monday-Friday, 7:30am – 5pm
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

Figure 28. Hawaiʻi State Laboratory

C.2 Energy-using Systems Addressed

The Waimano State Laboratory – Kamauleule Building was remotely assessed for operational energy performance improvement opportunities. The assessment used design and as-built drawings, previous reports and facility assessments, and utility bills, along with written facility narratives and interviews conducted with facilities management personnel to investigate the energy-using systems and equipment in the facility. Specific energy-using systems investigated as part of this assessment include:

- Building envelope
- HVAC
- Domestic hot water

- Lighting – interior / exterior
- Plug loads
- Water fixtures

C.3 Energy Performance Analysis

The facility's operational energy consumption in units of kilowatt hours was obtained from utility bill summaries provided by Hawaiian Electric, the electric utility. The facility does not use any other energy types as a primary energy source. Utility bill summaries were analyzed for the 12-month period from July 2024 through June 2025.

One method for measuring a facility's energy efficiency is to determine its energy use intensity (EUI), which is the energy consumption per gross square foot. Two types of EUI are typically determined for a facility. The first is the site EUI, which is defined as the energy use at the site divided by the building's gross square footage. The second is the source EUI, which is defined as the energy used by the various energy plants to provide energy to the site. This value is always higher than the site EUI because it accounts for inefficiencies and losses in generation and distribution. For the State Facilities Energy Strategy, US EPA's national site-to-source energy conversion factor of 2.80[15] is used to calculate source energy. Because EUI looks at total consumption of all types of energy used in a facility, the unit of measurement for energy is typically expressed in kilo British thermal units (kBtu), which allows for an apples-to-apples comparison of different energy types in a common unit. Moreover, because EUI is a measure of intensity, there is a defined time period of 1 calendar year and efficiency is calculated by dividing the total energy usage by the floor area of the building. The units for EUI are typically expressed as kBtu/sf/yr.

C.3.1 Energy Consumption and Energy Use Intensity

During the year of July 2024 through June 2025, the Waimano State Laboratory – Kamauleule Building consumed 5,895,198 kWh of site energy, which cost $1,890,150 during the year. This equates to a site Energy Use Intensity (EUI) of 149.5 kBtu/sf/yr and source EUI of 418.5 kBtu/sf/yr. Total greenhouse gas emissions for the year are estimated to be 4,008.3 metric tons CO2e, equivalent to a greenhouse gas emissions intensity of 29.79 kgCO2e/sf/yr.

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15 https://portfoliomanager.energystar.gov/pdf/reference/Source%20Energy.pdf?_gl=1*3nkuy*_ga*NTI0NjA3MDA0LjE3NTI1OTAzMzI.*_ga_S0KJTVVLQ6*czE3NjI0NzM2MDEkbzU5JGcxJHQxNzYyNDczNjYwJGoxJGwwJGgw

Figure 29. Waimano State Laboratory – Kamauleule Building Monthly Site Energy Usage, July 2024 - June 2025

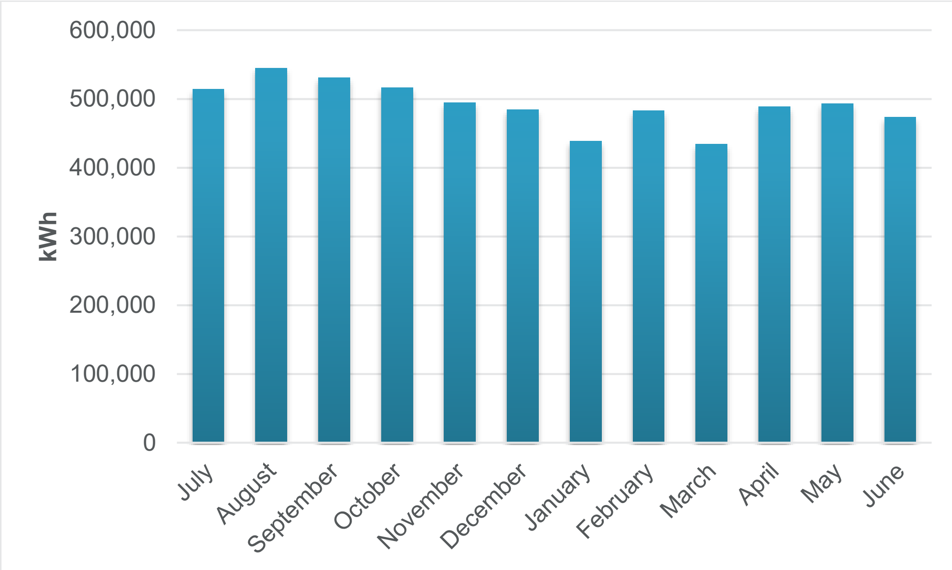


Table 73. Energy Consumption and Energy Use Intensity, Waimano State Laboratory – Kamauleule Building

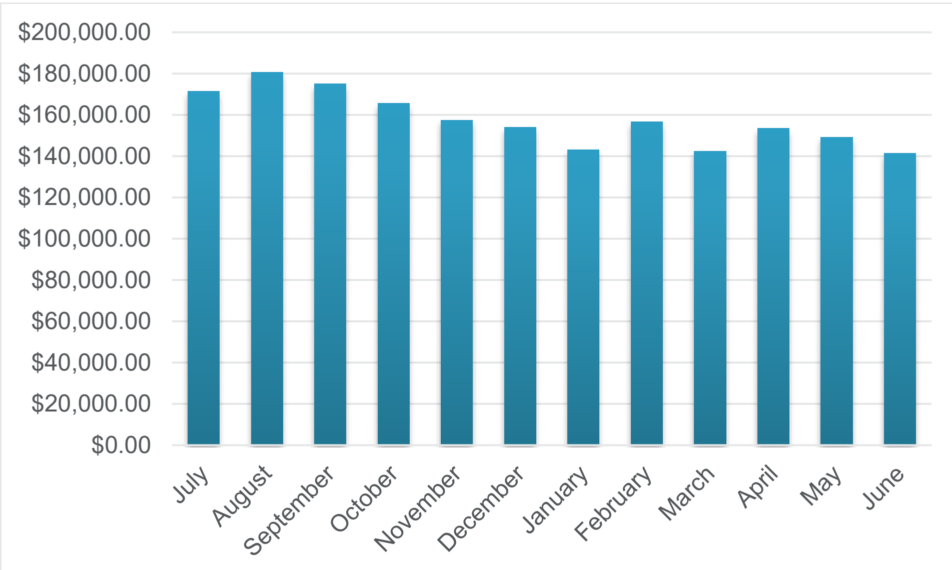
Metric	Current Year (7/24 – 6/25)
Source EUI (kBTU/sf)	418.5
Site EUI (kBTU/sf)	149.5
Source Energy Use (kBtu)	56,320,364
Site Energy Use (kBtu)	20,114,416
Energy Cost ($)	$1,890,150
Energy Cost Index, ECI ($/sf-yr)	$14.05
Total Location-based Greenhouse Gas (GHG) Emissions[16] (Metric tonsCO2e/yr)	4,008.3
Total Location-based GHG Emissions Intensity (kgCO2e/sf/yr)	29.8

[16] Emission factors derived from US EPA E-grid for the HIOA (Hawaiʻi – Oʻahu) region: https://www.epa.gov/egrid

C.3.2 Energy Cost

The Waimano State Laboratory – Kamauleule Building spent $1,890,150 on electricity during the year, which yields an Energy Cost Index (ECI) of $14.05/sf/yr. A summary of the monthly energy costs is in Figure 30 below. The actual costs are inclusive of the cost per unit of energy, as well as all fees, tariffs, and other charges.

Figure 30. Waimano State Laboratory – Kamauleule Building Monthly Energy Costs, July 2024 - June 2025



C.4 Facility Energy Strategy

C.4.1 Building Efficiency: Energy

The Waimano State Laboratory – Kamauleule Building is identified as a high energy-using facility with significant potential for energy cost savings. A desktop assessment revealed a set of potential energy conservation measures (ECMs). Only those opportunities viewed to be the most feasible based on analysis, experience and interviews with onsite personnel are included in the sections below.

The potential projects encompassing both low-cost/no-cost and capital investment projects are categorized by type. Low-cost/no-cost opportunities involve little to no capital investment and typically require changes to setpoints or methods of operation to obtain energy savings.

Capital investment measures are defined as energy conservation, energy efficiency, or time-of use management projects with a capital cost of greater than $3,000 in first-cost implementation costs or are non-BAS (Building Automation System) controls optimization, where BAS optimization typically is included in the low-cost/no-cost measures section. These measures can significantly reduce energy consumption and costs but also require more significant first cost investments.

Potential opportunities or concepts that require further development or investigations by owner/contractor are presented at the end under "Non-Quantifiable Measures."

C.4.1.1 QUANTIFIED ENERGY CONSERVATION MEASURES

Calculations for the quantifiable ECMs are based on a combination of algorithms from the Hawai'i State-approved technical resource manual (TRM). A TRM is a resource used to help plan and evaluate energy efficiency programs. TRMs outline how much energy can be expected to be saved for certain measures, either through deemed savings values or engineering algorithms. TRMs also contain source documentation, specified assumptions, and other metrics associated with energy efficiency measures.

Three ECMs were identified during the assessment that can be quantified for the energy usage reduction, peak demand savings and life cycle cost implications. Table 74 below lists the ECMs, which are described below the table.

Table 74. Waimano State Laboratory – Kamauleule Building Summary of Energy Conservation Measures

ECM Improvement Description	ECM Improvement ID	ECM Type
COMPLETE INTERIOR LED LIGHTING RETROFIT	DOH - Lab - ECM #1	Capital
COMPLETE EXTERIOR LED LIGHTING RETROFIT (150W-220W)	DOH - Lab - ECM #2	Capital
RETRO-COMMISSIONING	DOH – Lab ECM #3	Capital

C.4.1.2 MEASURE DESCRIPTIONS

DOH-Lab – ECM #1: Interior LED Lighting Retrofit – Linear and U-bend Lamps

The Waimano State Laboratory – Kamauleule Building's interior lights are all fluorescent, primarily linear T8 fluorescents and U-bend fluorescents, mixed with CFL downlights and other types of fluorescent lighting. The Hawai'i Clean Lighting Standards (Act 225, 2023[17]) prohibits the sale of fluorescent lighting in Hawai'i, as of January 1, 2025. In order to ensure that replacement bulbs are available, DAGS will need to retrofit the lighting to be all LED. Retrofitting the lighting to be all LED will also save the facility money, while saving electricity. Per the TRM, this measure pertains to the installation of an LED luminaire or retrofit kit for general area illumination in place of a fluorescent light source. These luminaires and retrofit kits are typically recessed, suspended, or surface-mounted and intended to provide ambient lighting in office spaces, schools, retail stores, and other commercial environments. Because of the improved optical control afforded by LED luminaires and retrofit kits, LED lighting systems can typically reduce total lumen output while maintaining required illuminance on work surfaces.

[17] https://hawaiienergy.com/wp-content/uploads/Lighting-Ban-FAQ-1.pdf

Figure 31. TRM Algorithms Used to Calculate Energy and Peak Demand Savings – Light General

First Baseline Peak Demand Reduction, kW

$$\Delta kW_{1st} = (kW_{base,1} - kW_{EE}) * ISR * CF * IE_{C,D} * PF \quad (1)$$

Second Baseline Peak Demand Reduction, kW

$$\Delta kW_{2nd} = (kW_{base,2} - kW_{EE}) * ISR * CF * IE_{C,D} * PF \quad (2)$$

First Baseline Annual Energy Savings, kWh/yr

$$\Delta kWh_{1st} = (kW_{base,1} - kW_{EE}) * ISR * HOU_{year} * IE_{C,E} * PF \quad (3)$$

Second Baseline Annual Energy Savings, kWh/yr

$$\Delta kWh_{2nd} = (kW_{base,2} - kW_{EE}) * ISR * HOU_{year} * IE_{C,E} * PF \quad (4)$$

Lifetime Energy Savings, kWh (Dual Baseline, ROB)

$$\Delta kWh_{life,dual} = \Delta kWh_{1st} * EUL_{1st} + \Delta kWh_{2nd} * (EUL_{EE} - EUL_{1st}) \quad (5)$$

Lifetime Energy Savings, kWh (Dual Baseline, Early Replacement)

$$\Delta kWh_{life,dual} = \Delta kWh_{1st} * RUL + \Delta kWh_{2nd} * (EUL_{EE} - RUL) \quad (6)$$

Lifetime Energy Savings, kWh (Single Baseline)

$$\Delta kWh_{life,single} = \Delta kWh_{2nd} * EUL_{EE} \quad (7)$$

Remaining Useful Life

$$RUL = ROUND(1/3 * EUL_{pre-existing}) \quad (8)$$

<u>DOH-Lab – ECM #2: Exterior LED Lighting Replacement</u>

The facility's exterior lighting is mostly high-pressure sodium, high-intensity discharge pole mounted lighting, as well as wall packs for egress along the perimeter of the building envelope. Per the TRM, this measure pertains to the installation of an LED outdoor pole/arm- or wall-mounted luminaire or retrofit kit for parking lot, street, or general area illumination in place of a high-intensity discharge light source.

Figure 32. TRM Algorithms Used to Calculate Energy and Peak Demand Savings – Light Exterior

ALGORITHMS

Peak Demand Reduction, kW

$$\Delta kW = (kW_{base} - kW_{EE}) * ISR * CF * PF \quad (1)$$

Annual Energy Savings, kWh/yr

$$\Delta kWh = (kW_{base} - kW_{EE}) * ISR * HOU_{year} * PF \quad (2)$$

Lifetime Energy Savings, kWh

$$\Delta kWh_{life} = \Delta kWh * EUL_{EE} \quad (3)$$

DOH-Lab – ECM #3: Retro-commissioning

Retro-commissioning (RCx) is a systematic process that seeks to improve the performance of an existing building and how equipment and systems function together by optimizing the building controls or building management system. RCx can often resolve problems that occurred during design or construction or address those that have developed throughout the building's life. RCx uses a whole-building systems approach to identify operational improvements in a building's O&M procedures that will save energy and increase occupant comfort.

Estimated percent savings opportunities for implementing RCx on a given existing building range anywhere from 5% to 15% across the board, varying for different building typologies and build dates.

There are up to fourteen controls optimization measures that offer the highest opportunity for energy/carbon savings for non-residential facilities, and six of those have been determined to be appropriate for the Waimano State Laboratory – Kamauleule Building, including:

Table 75. RCx measures that could improve energy performance at Waimano State Laboratory – Kamauleule Building

Controls Measure	Measure and Description
1	Scheduling equipment: AHUs, Fans, Pumps, Electrical Heat, VAV/FPBs, Lighting
2	Duct static pressure reset/ reduction
3	Supply air temperature reset
4	Optimum start for AHU
5	Reduce supply air
6	Chilled water temperature reset

C.4.1.3 NON-QUANTIFIED ENERGY CONSERVATION MEASURES

Additionally, six ECMs were identified during the assessment that requires further information to quantify the impacts. These measures require further investigation, either via an onsite inventory of individual pieces of equipment for condition and remaining useful life, review of the controls programming by a Controls Contractor, or further trending to verify that the occurrences happen regularly.

Table 76. Non-quantified ECMs, Waimano State Laboratory – Kamauleule Building

Energy Conservation Measure	ECM Improvement ID
Weatherize or replace the emergency exit doors	DOH – Lab - ECM #NQ-1
Repair seals and gaskets of window assemblies	DOH – Lab – ECM #NQ-2
Add/replace window film on south-facing windows to reduce solar heat gains	DOH – Lab – ECM #NQ-3
Install one, facility-wide DDC control system for all energy using equipment	DOH – Lab – ECM #NQ-4
Resize ventilation system and replace AHUs with more efficient units	DOH – Lab – ECM #NQ-5
Install HVAC duct insulation	DOH – Lab – ECM #NQ-6

<u>DOH - Lab – ECM #NQ1: Weatherize or replace the emergency exit doors</u>

The emergency exit doors were observed to have air gaps between the door and the door frame, allowing outside air to infiltrate and conditioned air to exfiltrate the facility. A poorly sealed envelope is energy inefficient in multiple ways, including causing a need to heat or cool the air more to meet comfort needs and having to move larger volumes of air throughout the facility. Improving the seal of the building envelope will enhance occupant comfort while helping to save energy.

<u>DOH Lab – ECM #NQ2: Repair seals and gaskets of window assemblies</u>

Similarly, several windows and window frames were noted to be broken, damaged or outside of a state of good repair. As described above, a poorly sealed building envelope leads to energy losses and makes it more challenging to maintain occupant comfort.

<u>DOH Lab – ECM #NQ3: Add/replace window film on south-facing windows to reduce solar heat gains</u>

There are 164 south facing, storefront-type windows at the Waimano State Laboratory – Kamauleule Building, with views to the ocean and the surrounding landscape. Windows can be a double-edged sword with regard to facility energy use, with improved daylight penetration helping to reduce the need for electric lighting, in addition to the human health and quality of life benefits from views to the outside. At the same time, windows serve as a thermal transfer to the exterior, where excessive solar gains can cause the need for increased cooling and air circulation, resulting in an energy penalty. Facilities personnel report that some of the south facing windows have tinting on them but the condition, thermal properties and extent of coverage of the existing tinting is not clear. Although it is not possible to quantify the potential energy cost savings from this measure at this time, based on the information made available for this study, we encourage facility management to investigate the potential costs and energy savings benefits from adding and/or replacing window film designed to minimize solar heat gain on the facility's south-facing windows.

DOH Lab – ECM #NQ4: Install one, facility-wide DDC control system for all energy using equipment

The Waimano State Laboratory – Kamauleule Building currently has a patchwork of systems that control the operation of the facility's energy using equipment. There are different systems to control different systems and parts of the building, making active energy management challenging. Installing one centralized, automated building management system with direct digital controls (DDC) will facilitate tighter control over the facility's equipment, limit unnecessary runtime, reduce total energy consumption and improve occupant comfort.

DOH Lab – ECM #NQ5: Air balance, resize ventilation system and replace AHUs with more efficient units

The air handler units at the Waimano State Laboratory – Kamauleule Building are at or near the end of their useful and need to replaced with new units. Although this is considered a capital replacement measure and not quantified for this assessment, there is an opportunity to select a replacement air handling unit that is more energy efficient.

In addition to doing a like-for-like equipment replacement, there is also an opportunity to re-balance air distribution in the facility and consider re-sizing and adjusting the air handling system to meet the current needs of the facility. During the assessment, it was noted that many spaces are used differently than originally intended and, in particular, there is a surplus of under- and un-utilized fume hoods. The original design envisioned substantially more air being moved through the facility than is currently required, meaning more energy is used to move air in the current setup than would be necessary with a properly sized and balanced system.

DOH Lab – ECM #NQ6: Install HVAC duct insulation

Facilities staff reported that the air ducts serving the basement, 1st floor and a portion of the second floor have had insulation replaced within the past several years, as a strategy to prevent thermal losses. We recommend continuing the insultation replacement project to cover all of the air ducts serving the facility, which should reduce thermal losses due to distribution, maintaining occupant comfort and reducing energy consumption.

C.4.1.4 PERFORMANCE ANALYSIS

The energy and GHG performance impacts of each of the quantified ECMs described above are listed in Table 77 below.

Table 77. ECM Performance Results, Hawai'i State Laboratory

Measure ID	Energy Conservation Measure	CapEx (2025$)	Annual Electric Savings (kWh/yr)	Annual Peak Electric Savings (kW)	Annual GHG Savings (mtCO2e/yr)
DOH – Lab – ECM #1	COMPLETE INTERIOR LED LIGHTING RETROFIT	$32,467	22,599	3.60	15.4
DOH – Lab – ECM #2	COMPLETE EXTERIOR LED LIGHTING RETROFIT (150W-220W)	$36,150	40,098	6.06	27.3
DOH – Lab – ECM #3	RETRO-COMMISSIONING	$37,679	491,070	n/a	333.9

C.4.2 Building Efficiency: Water

The desktop facility assessment of the Waimano State Laboratory – Kamauleule Building revealed potential measures that could save water at the facility, referred to here as water conservation measures (WCMs). Water use and cost conservation at State-owned facilities will provide direct reductions in resource consumption, while also lowering operating costs for State agencies and reducing the amount of energy required to pump the water from its source to its sink.

C.4.2.1 WATER CONSERVATION MEASURES

The Waimano State Laboratory – Kamauleule Building has water conservation opportunities for both indoor and exterior water use. Due to limitations in the available data, only measures impacting indoor water use are quantifiably assessed as part of this study.

Table 78. Waimano State Laboratory – Kamauleule Building Summary of Water Conservation Measures

WCM Improvement Description	WCM Improvement ID
Replace toilets/ water closets with 1.28 GPF Units	DOH - Lab - WCM #1
Replace urinals with 0.25 GPF Units	DOH - Lab - WCM #2
Replace lavatory faucets with 0.4 GPM Units	DOH - Lab - WCM #3
Replace showerheads with 1.6 GPM Units	DOH – Lab – WCM #4

<u>DOH – Lab – WCM #1: Replace Toilets/ Water Closets with 1.28 GPF Units</u>

The Waimano State Laboratory – Kamauleule Building still has its original indoor plumbing system and fixtures. Based on photos, interviews and as-built information provided, it is assumed that there are 12 toilets/ water closets installed in the facility, each with a flush rate of 3.4 gallons per flush (GPF). There have been great advances in low-cost, water saving technology since the facility's plumbing fixtures were installed, with 1.28 GPF commonly and commercially available.

<u>DOH – Lab – WCM #2: Replace Urinals with 0.25 GPF Units</u>

The facility has three original urinals, rated at 1.6 GPF. Many lower flush options for urinals are commonly and commercially available, including low flow, ultra-low flow and waterless urinals. While waterless urinals offer the greatest potential water savings of those options, older buildings with original plumbing systems sometimes experience operational issues with the waterless system being able to properly clear the pipes. Ultra-low flow 0.25 GPF urinals provide an optimal balance by still offering substantial water use savings but with a more functional configuration.

<u>DOH – Lab – WCM #3: Replace Lavatory Faucets with 0.4 GPM Units</u>

The 12 original lavatory faucets have a 0.6 gallons per minute (GPM) flow rate and are manually turned on and off. Newer low flow faucets can deliver higher pressure using only 0.4 GPM with a timed release that closes the faucet after 5-15 seconds.

DOH – Lab – WCM #4: Replace Showerheads with 1.6 GPM Units

The four original lavatory showerheads have a 2.5 gallons per minute (GPM) flow rate. Newer low flow showerheads can deliver high pressure with a flow rate of only 1.6 GPM.

C.4.2.2 PERFORMANCE ANALYSIS

The expected annual water savings from implementing each of the recommended WCMs is detailed in Table 79 below.

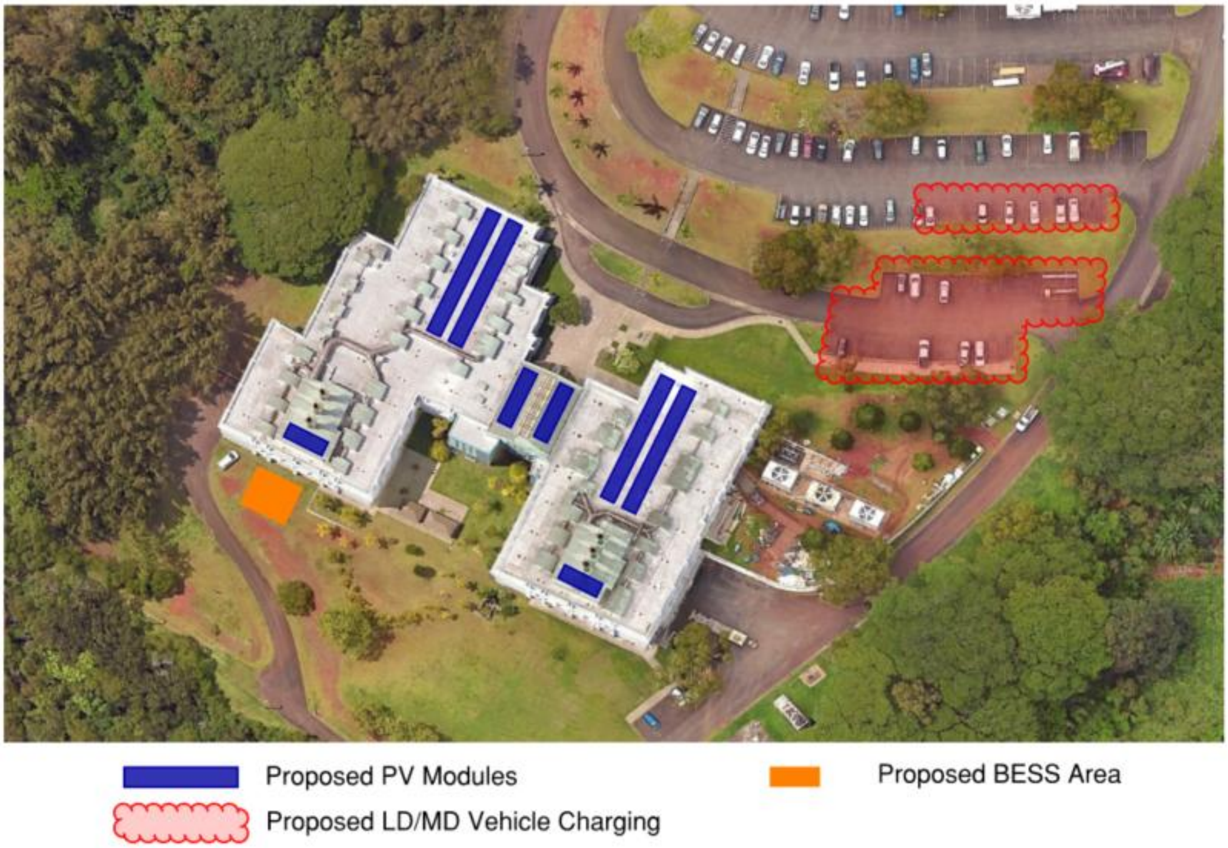
Table 79. Water Conservation Measure Impacts, Waimano State Laboratory – Kamauleule Building

Measure ID	Water Conservation Measure	Water Conservation Measures Assumptions	
		CapEx (2025$)	Annual Water Savings (gallons)
DOH – Lab – WCM1	Replace toilets/ water closets	$8,184	99,546
DOH – Lab – WCM2	Replace urinals	$2,046	31,730
DOH – Lab – WCM3	Replace lavatory faucets	$3,306	7,046
DOH – Lab – WCM4	Replace showerheads	$296	14,053

C.4.3 Solar PV and BESS Analysis

The Waimano State Laboratory Kamauleule Building rooftop has various large pieces of equipment located on the roof that will produce shading and impact on the available solar footprint. The roof is primarily flat with some taller sloped sections and has a parapet wall surrounding the perimeter. The estimated roof capacity is 100 kW DC between the flat and sloped roof sections (Figure 33).

Figure 33. Waimano State Laboratory – Kamauleule Building Concept Solar and EV Layout



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software as discussed under the Solar Analysis Methodology. The annual energy consumption for the past year is approximately 6,017,000 kWh. The initial HOMER analysis indicates an optimal potential PV system nameplate size of 66 kW.

HOMER model results indicate that multiple PV system configurations possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems tend to have unfavorable payback periods and IRR due to the high capital cost of BESS.

The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 80.

Table 80. Waimano State Laboratory – Kamauleule Building Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (HE Sch P - Smart Export)	6,017,000	N/A	N/A	N/A
66 kW PV Only	5,910,000	108,000	N/A	1.8
66 kW PV + 2000 kWh BESS	5,923,000	108,000	75,000	1.6

Cost performance for the three systems is provided in Table 81.

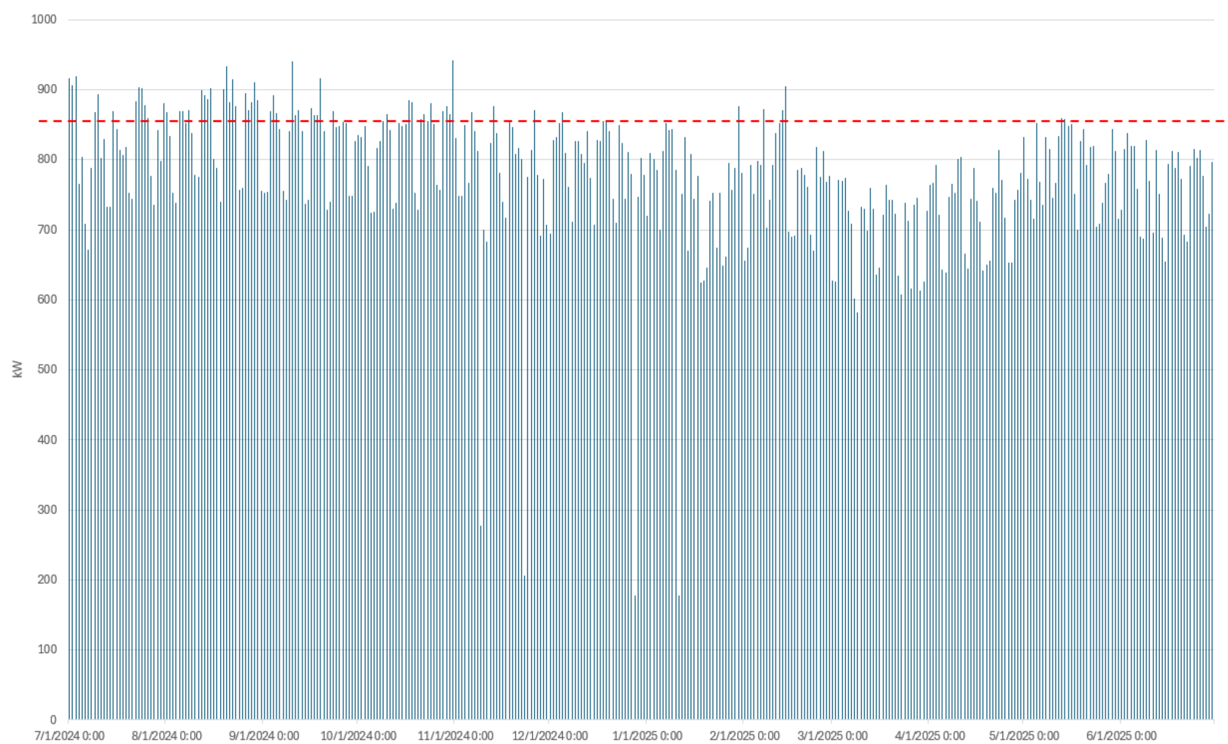
Table 81. Waimano State Laboratory – Kamauleule Building Renewables Cost Summary

System Configuration	CAPEX	Net Present Cost ($)	IRR (%)	Discounted Payback Period (yr)
Base Case (HE Sch P - Smart Export)	N/A	5,930,000	N/A	N/A
66 kW PV Only	125,000	5,890,000	18	7.7
66 kW PV + 2000 kWh BESS	982,000	6,860,000	N/A	>25

C.4.4 Demand Management and Demand Response

15-minute interval data from the Waimano State Laboratory – Kamauleule Building's Hawaiian Electric meter covering the 12-month period from July 2024 through June 2025 was assessed. The whole facility-level energy usage data allowed for an initial screening of the annual electricity demand profile. Electricity demand is a measure of the peak electrical load in the facility at any given point in time during the year. This annual load profile is used to identify the frequency of peak loads recorded at the facility that could be high enough to trigger a demand response event, providing an indicator of the suitability of the facility to participate in a demand response program.

Figure 34. Annual Electricity Demand Profile from 15-minute Interval Data, Waimano State Laboratory – Kamauleule Building



The Waimano State Laboratory – Kamauleule Building has a base load demand of approximately 670kW, but can spike as high as 935kW during the warmest months. There were more than 50 times during the course of the year where the peak demand met or exceeded 850kW. Although demand response events are not triggered based on a whole facility exceeding a specific threshold of demand, having at least a dozen high spikes in the year is an indicator that the facility is a candidate for demand response. However, given that the process loads in the Waimano State Laboratory – Kamauleule Building are often critical and may spike due to emergency conditions, there are limited loads in the facility that could be easily curtailed. Vertical transportation, including elevators is one option but further coordination with Hawaiian Electric is necessary to determine whether this facility is a viable candidate to participate in a demand response program.

C.4.5 Vehicle Electrification

The Waimano State Laboratory Kamauleule Building does not have fleet vehicles assigned to it. The facility has approximately 230 existing parking stalls northeast of the building. If 46 parking stalls (20%) were converted to Level 2 EV chargers, then approximately 330 kW of electrical capacity would be required.

C.4.6 Financial Feasibility

Table 82 shows the discounted payback period along with the benefit cost ratio of applicable ECM, WCM, and PV/BESS measures for Waimano State Laboratory – Kamauleule Building. The WCM measure of Showerhead Replacements has the shortest payback period for this facility at 4.3 years, which is followed by the ECM measure of Complete Exterior LED Lighting Retrofit (150W-220W) (ECM #2) at 5.2 years. WCMs of toilet/water closet and urinal replacements have the longest payback periods, which are 16.3 years and 12.4 years, respectively. A standalone PV installation has a payback period of 7.7 years, while incorporating a BESS system into the PV configuration results in the payback period being beyond the study period. The only other measure that has a payback period beyond the study period for the Laboratory is the lavatory faucet replacements.

Table 82. Efficiency and PV/BESS Results, Waimano State Laboratory – Kamauleule Building

Measure ID	Improvement Type	Waimano State Lab	
		Payback Period (years)	Benefit Cost Ratio
DOH – Lab – RE1	PV Only	7.7	5.1
DOH – Lab – ECM #1	COMPLETE INTERIOR LED LIGHTING RETROFIT	7.7	3.0
DOH – Lab – ECM #2	COMPLETE EXTERIOR LED LIGHTING RETROFIT (150W-220W)	5.2	2.8
DOH – Lab – WCM4	Replace showerheads	4.3	2.3
DOH – Lab – WCM2	Replace urinals	12.4	1.6
DOH – Lab – WCM1	Replace toilets/ water closets	16.3	1.3
DOH – Lab – RE2	PV+BESS	N/A	0.2
DOH – Lab – WCM3	Replace lavatory faucets	N/A	0.2

D

Appendix D – Hale Ola Building

D. Hale Ola Building

D.1 Facility Description

The Department of Health's Hale Ola Building is a 41,186 square foot originally built in 1921 and substantially renovated in 2017. The insulated concrete structure includes three stories, as well as a basement.

DOH | Hale Ola Building | Building Characteristics

Location | Envelope Basics		Heating | Cooling | Ventilation	
Location	2827 Waimano Home Road, Pearl City, O'ahu 96782	**Heating Primary Fuel**	Electricity
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	1	**Heating Generation**	N/A
Building Type	Office	**Cooling Generation**	Carrier air-cooled chillers (x2)
Year Built	1921 (renovated 2017)	**Domestic Hot Water Generation**	Solar Thermal Hot Water Panels; Electric Storage-type Water Heater
Floor Area (ft2)	41,186	**Heating / Cooling / Vent Distribution**	VAV Air-Handlers (x4)
Stories	4, including basement	**Electric Rate Structure**	Hawaiian Electric J GENERAL SERVICE - DEMAND
Window Type	Double-pane, Aluminum Frame		
Wall Type	Concrete, insulated	**Natural Gas Rate Structure**	N/A
Lighting System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Mostly LED	**Weekday Operating Hours**	11.25
Exterior Lighting System	HPS HID pole mounted	**Weekday Opening Time**	Monday-Friday, 6:30am – 5:45pm
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

Figure 35. Photo of Exterior of Hale Ola Building

D.2 Energy-using Systems Assessed

The Hale Ola Building facility was remotely assessed for operational energy performance improvement opportunities. The assessment used design and as-built drawings, previous reports and facility assessments, and utility bills, along with written facility narratives and interviews conducted with facilities management personnel to investigate the energy-using systems and equipment in the facility. Specific energy-using systems investigated as part of this assessment include:

- Building envelope
- HVAC
- Domestic hot water
- Lighting – interior / exterior
- Plug loads
- Water fixtures

D.3 Energy Performance Analysis

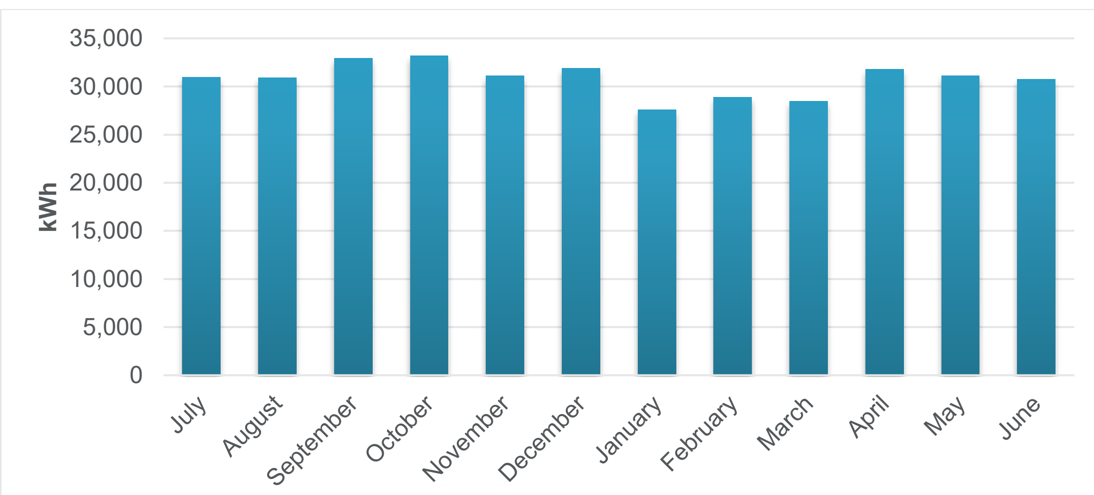
The facility's operational energy consumption in units of kilowatt hours was obtained from utility bill summaries provided by Hawaiian Electric, the electric utility. The facility does not use any other energy types as a primary energy source. Utility bill summaries were analyzed for the 12-month period from July 2024 through June 2025.

One method for measuring a facility's energy efficiency is to determine its energy use intensity (EUI), which is the energy consumption per gross square foot. Two types of EUI are typically determined for a facility. The first is the site EUI, which is defined as the energy use at the site divided by the building's gross square footage. The second is the source EUI, which is defined as the energy used by the various energy plants to provide energy to the site. This value is always higher than the site EUI because it accounts for inefficiencies and losses in generation and distribution. For the State Facilities Energy Strategy, US EPA's national site-to-source energy conversion factor of 2.80[18] is used to calculate source energy. Because EUI looks at total consumption of all types of energy used in a facility, the unit of measurement for energy is typically expressed in kilo British thermal units (kBtu), which allows for an apples-to-apples comparison of different energy types in a common unit. Moreover, because EUI is a measure of intensity, there is a defined time period of 1 calendar year and efficiency is calculated by dividing the total energy usage by the floor area of the building. The units for EUI are typically expressed as kBtu/sf/yr.

D.3.1 Energy Consumption and Energy Use Intensity

During the year of July 2024 through June 2025, the Hale Ola Building facility consumed 1,260,615 kWh of site energy, which cost $138,679 during the year. This equates to a site Energy Use Intensity (EUI) of 30.6 kBtu/sf/yr and source EUI of 85.7 kBtu/sf/yr. Total greenhouse gas emissions for the year are estimated to be 251.2 metric tons CO2e, equivalent to a greenhouse gas emissions intensity of 6.1 kgCO2e/sf/yr.

Figure 36. Hale Ola Building Monthly Site Energy Usage, July 2024 - June 2025



18 https://portfoliomanager.energystar.gov/pdf/reference/Source%20Energy.pdf?_gl=1*3nkuy*_ga*NTI0NjA3MDA0LjE3NTI1OTAzMzI.*_ga_S0KJTVVLQ6*czE3NjI0NzM2MDEkbzU5JGcxJHQxNzYyNDczNjYwJGoxJGwwJGgw

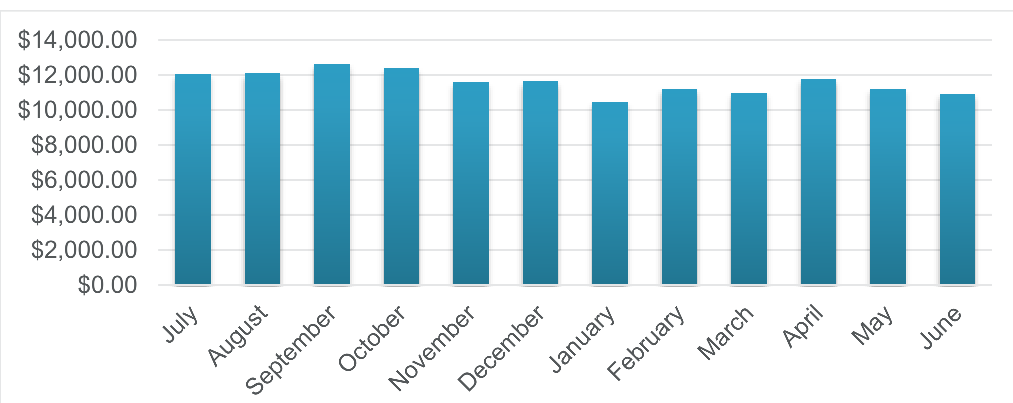
Table 83. Energy Consumption and Energy Use Intensity, Hale Ola Building

Metric	Current Year (7/24 – 6/25)
Source EUI (kBTU/sf)	85.7
Site EUI (kBTU/sf)	30.6
Source Energy Use (kBtu)	3,529,721
Site Energy Use (kBtu)	1,260,615
Energy Cost ($)	$138,679
Energy Cost Index, ECI ($/sf-yr)	$3.37
Total Location-based Greenhouse Gas (GHG) Emissions[19] (Metric tonsCO2e/yr)	251.2
Total Location-based GHG Emissions Intensity (kgCO2e/sf/yr)	6.1

D.3.2 Energy Cost

The Hale Ola Building spent $138,679 on electricity during the year, which yields an Energy Cost Index (ECI) of $3.37/sf/yr. A summary of the monthly energy costs is in Figure 37 below. The actual costs are inclusive of the cost per unit of energy, as well as all fees, tariffs, and other charges.

Figure 37. Hale Ola Building Monthly Energy Costs, July 2024 - June 2025



[19] Emission factors derived from US EPA E-grid for the HIOA (Hawai'i – O'ahu) region: https://www.epa.gov/egrid

D.4 Facility Energy Strategy

D.4.1 Building Efficiency: Energy

The Hale Ola Building facility is identified as a high energy-using facility with significant potential for energy cost savings. A desktop assessment revealed a set of potential energy conservation measures (ECMs). Only those opportunities viewed to be the most feasible based on analysis, experience and interviews with onsite personnel are included in the sections below.

The potential projects encompassing both low-cost/no-cost and capital investment projects are categorized by type. Low-cost/no-cost opportunities involve little to no capital investment and typically require changes to setpoints or methods of operation to obtain energy savings.

Capital investment measures are defined as energy conservation, energy efficiency, or time-of use management projects with a capital cost of greater than $3,000 in first-cost implementation costs or are non-BAS (Building Automation System) controls optimization, where BAS optimization typically is included in the low-cost/no-cost measures section. These measures can significantly reduce energy consumption and costs but also require more significant first cost investments.

Potential opportunities or concepts that require further development or investigations by owner/contractor are presented at the end under “Non-Quantifiable Measures.”

D.4.1.1 QUANTIFIED ENERGY CONSERVATION MEASURES

Calculations for the quantifiable ECMs are based on a combination of algorithms from the Hawai‘i State-approved technical resource manual (TRM). A TRM is a resource used to help plan and evaluate energy efficiency programs. TRMs outline how much energy can be expected to be saved for certain measures, either through deemed savings values or engineering algorithms. TRMs also contain source documentation, specified assumptions, and other metrics associated with energy efficiency measures.

Two ECMs were identified during the assessment that can be quantified for the energy usage reduction, peak demand savings and life cycle cost implications. Table 84 below lists the ECMs, which are described below the table.

Table 84. Hale Ola Building Summary of Energy Conservation Measures

ECM Improvement Description	ECM Improvement ID	ECM Type
COMPLETE EXTERIOR LED LIGHTING RETROFIT (150W-220W)	DOH - Hale Ola - ECM #1	Capital
RETRO-COMMISSIONING	DOH – Hale Ola – ECM #2	Capital

D.4.1.2 MEASURE DESCRIPTIONS

DOH – Hale Ola – ECM #1: Exterior LED Lighting Replacement

The facility's exterior lighting is mostly high-pressure sodium, high-intensity discharge pole mounted lighting, as well as wall packs for egress along the perimeter of the building envelope. Per the TRM, this measure pertains to the installation of an LED outdoor pole/arm- or wall-mounted luminaire or retrofit kit for parking lot, street, or general area illumination in place of a high-intensity discharge light source.

Figure 38. TRM Algorithms Used to Calculate Energy and Peak Demand Savings – Light Exterior

ALGORITHMS

Peak Demand Reduction, kW

$$\Delta kW = (kW_{base} - kW_{EE}) * ISR * CF * PF \quad (1)$$

Annual Energy Savings, kWh/yr

$$\Delta kWh = (kW_{base} - kW_{EE}) * ISR * HOU_{year} * PF \quad (2)$$

Lifetime Energy Savings, kWh

$$\Delta kWh_{life} = \Delta kWh * EUL_{EE} \quad (3)$$

DOH – Hale Ola – ECM #2: Retro-commissioning

Retro-commissioning (RCx) is a systematic process that seeks to improve the performance of an existing building and how equipment and systems function together by optimizing the building controls or building management system. RCx can often resolve problems that occurred during design or construction or address those that have developed throughout the building's life. RCx uses a whole-building systems approach to identify operational improvements in a building's O&M procedures that will save energy and increase occupant comfort.

Estimated percent savings opportunities for implementing RCx on a given existing building range anywhere from 5% to 15% across the board, varying for different building typologies and build dates.

There are up to fourteen controls optimization measures that offer the highest opportunity for energy/carbon savings for non-residential facilities, and four of those have been determined to be appropriate for the Hale Ola Building, including:

Table 85. RCx measures that could improve energy performance at Hale Ola Building

Controls Measure	Measure and Description
1	Duct static pressure reset
2	Supply air temperature reset
3	Optimum start for AHU
4	Raise temperature set point to 72F

D.4.1.3 NON-QUANTIFIED ENERGY CONSERVATION MEASURES

Additionally, two ECMs were identified during the assessment that requires further information to quantify the impacts. These measures require further investigation, either via an onsite inventory of individual pieces of equipment for condition and remaining useful life, review of the controls programming by a Controls Contractor, or further trending to verify that the occurrences happen regularly.

Table 86. Non-quantified Energy Conservation Measures, Hale Ola Building

Energy Conservation Measure	ECM Improvement ID
REPLACE VFD FOR CHILLER #2	DOH Hale Ola - ECM #NQ-1
INSTALL PLUG LOAD OCCUPANCY SENSORS	DOH Hale Ola – ECM #NQ-2

DOH – Hale Ola – ECM #NQ1: REPLACE VFD FOR CHILLER #2

Facilities staff reported that the variable frequency drive (VFD) for chiller #2 is beyond the end of its useful life and needs to be replaced. VFDs save energy by modulating the speed and frequency of the motor running the piece of equipment the VFD is attached to, reducing energy consumption and extending the life of the equipment. Sizing and detailed equipment information about the existing VFD was not available so quantitative analysis was not possible.

DOH – Hale Ola – ECM #NQ2: INSTALL PLUG LOAD OCCUPANCY SENSORS

Facilities staff reported that a relatively high amount of equipment plugged into outlets, as opposed to being hard wire installed. There are also portions of the building that are under-utilized but may still have equipment present. Plug load occupancy sensors work to turn off power to devices that are plugged into that outlet when no occupants are detected and/or the equipment has been used for an extended period of time. Most plug load occupancy sensors allow users to designate critical loads that bypass the occupancy sensor, but it is important to note that not all plug loads are appropriate to be put onto occupancy sensors.

D.4.1.4 PERFORMANCE ANALYSIS

The energy and GHG performance impacts of the quantified ECMs described above are listed in Table 87 below.

Table 87. ECM Performance Results, Hale Ola Building

Measure ID	Energy Conservation Measures	CapEx (2025$)	Annual Electric Savings (kWh/yr)	Annual Peak Electric Savings (kWh)	Annual GHG Savings (mtCO2e)
DOH – Hale Ola – ECM #2	COMPLETE EXTERIOR LED LIGHTING RETROFIT (150W-220W)	$24,100	26,732	4.04	18.2
DOH – Hale Ola – ECM #3	RETRO-COMMISSIONING	$11,532	22,574	n/a	15.3

D.4.2 Building Efficiency: Water

The desktop facility assessment of the Hale Ola Building revealed potential measures that could save water at the facility, referred to here as water conservation measures (WCMs). Water use and cost conservation at State-owned facilities will provide direct reductions in resource consumption, while also lowering operating costs for State agencies and reducing the amount of energy required to pump the water from its source to its sink.

D.4.2.1 WATER CONSERVATION MEASURES

The Hale Ola Building has water conservation opportunities for both indoor and exterior water use. Due to limitations in the available data, only measures impacting indoor water use are quantifiably assessed as part of this study.

Table 88. Hale Ola Building Summary of Water Conservation Measures

WCM Improvement Description	WCM Improvement ID
Replace toilets/ water closets	DOH – Hale Ola - WCM #1
Replace urinals	DOH – Hale Ola - WCM #2
Replace lavatory faucets	DOH – Hale Ola - WCM #3

<u>DOH – Hale Ola – WCM #1: Replace Toilets/ Water Closets with 1.28 GPF Units</u>

The Hale Ola Building still has its original indoor plumbing system and fixtures. Based on photos, interviews and as-built information provided, it is assumed that there are 12 toilets/ water closets installed in the facility, each with a flush rate of 3.4 gallons per flush (GPF). There have been great advances in low-cost, water saving technology since the facility's plumbing fixtures were installed, with 1.28 GPF commonly and commercially available.

DOH – Hale Ola – WCM #2: Replace Urinals with 0.25 GPF Units

The facility has two original urinals, rated at 1.7 GPF. Many lower flush options for urinals are commonly and commercially available, including low flow, ultra-low flow and waterless urinals. While waterless urinals offer the greatest potential water savings of those options, older buildings with original plumbing systems sometimes experience operational issues with the waterless system being able to properly clear the pipes. Ultra-low flow 0.25 GPF urinals provide an optimal balance by still offering substantial water use savings but with a more functional configuration.

DOH – Hale Ola – WCM #3: Replace Lavatory Faucets with 0.4 GPM Units

The 12 original lavatory faucets have a 0.6 gallons per minute (GPM) flow rate and are manually turned on and off. Newer low flow faucets can deliver higher pressure using only 0.4 GPM with a timed release that closes the faucet after 5-15 seconds.

D.4.2.2 PERFORMANCE ANALYSIS

The expected annual water savings from implementing each of the recommended WCMs is detailed in Table 89 below.

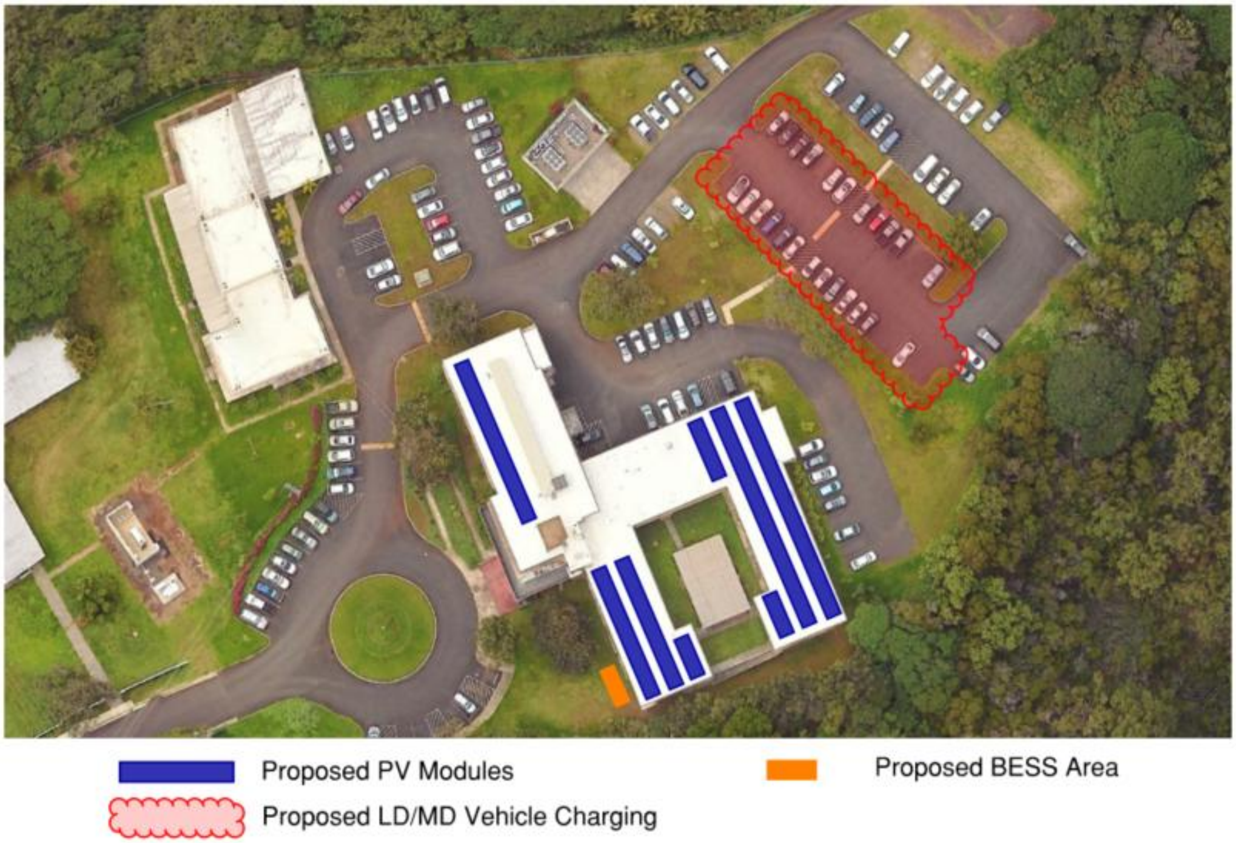
Table 89. Water Conservation Measure Impacts, Hale Ola Building

Measure ID	Water Conservation Measures	CapEx (2025$)	Annual Water Savings (gallons)
DOH – Hale Ola – WCM1	Replace toilets/ water closets	$8,184	172,172
DOH – Hale Ola – WCM2	Replace urinals	$1,364	56,862
DOH – Hale Ola – WCM3	Replace lavatory faucets	$3,306	12,532

D.4.3 Solar PV and BESS Analysis

The Hale Ola Building has a multi-level flat roof with open areas and multiple pieces of existing equipment. Multiple unobstructed areas on the lower, and upper, roof sections have Southwest and Northeast facing azimuths for a potential PV installation. There is minimal concern for shading from nearby trees to cause decreased PV energy output. As shown on Figure 39 the roof has an estimated available capacity of 95 kW DC.

Figure 39. Hale Ola Building Concept Solar and EV Layout



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software as discussed under the Solar Analysis Methodology. The annual building consumption for the past year is approximately 369,000 kWh. The initial HOMER analysis indicates that only a 95 kW DC nameplate PV system would be optimal.

HOMER model results indicate that multiple PV system configurations possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems also tend to have favorable payback periods but only provide marginal increases in renewable fraction.

The base case, PV only and PV and BESS system configurations with the fastest payback periods are provided in Table 90.

Table 90. Hale Ola Building Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (HE Sch J - Smart Export)	369,000	N/A	N/A	N/A
95 kW PV Only	241,200	154,500	N/A	39.1
95 kW PV + 52 kWh BESS	231,800	154,500	11,211	39.6

Cost performance for the three systems is provided in Table 91.

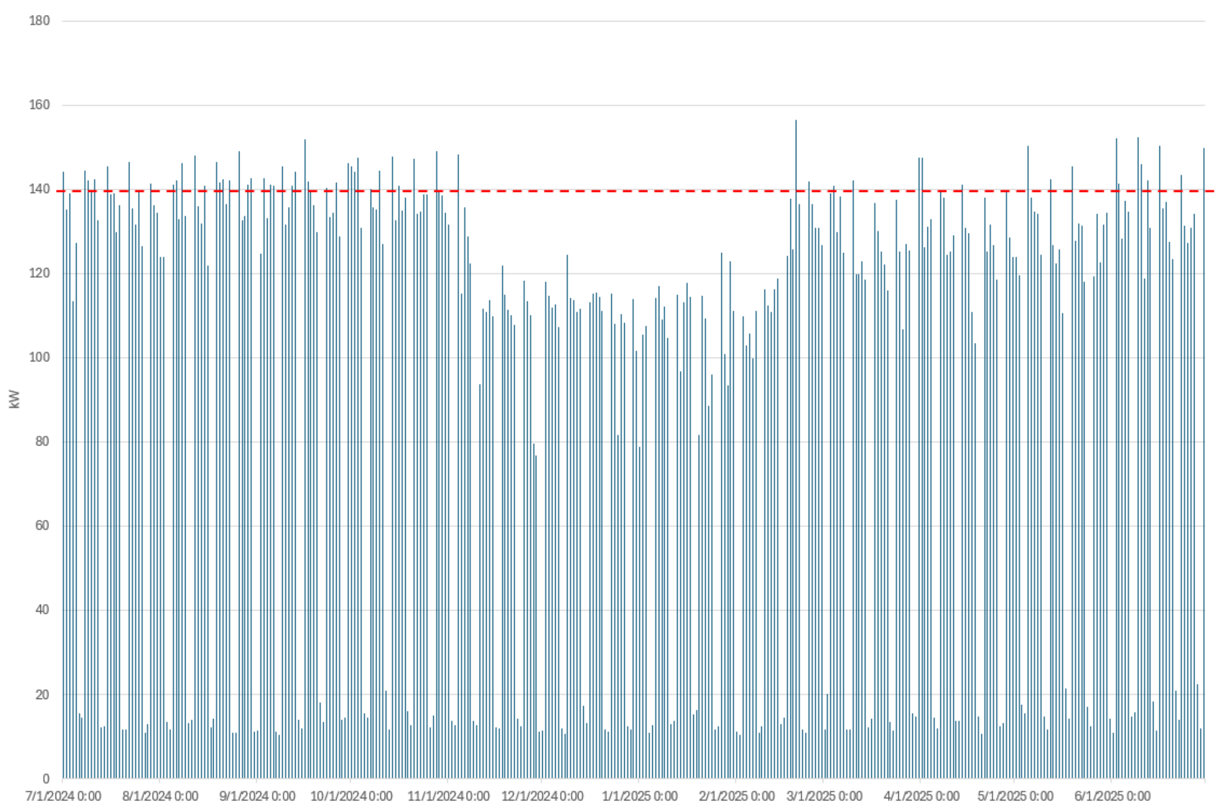
Table 91. Hale Ola Building Renewables Cost Summary

System Configuration	CAPEX	Net Present Cost ($)	IRR (%)	Discounted Payback Period (yr)
Base Case (HE Sch J - Smart Export)	N/A	1,960,000	N/A	N/A
95 kW PV Only	177,000	1,510,000	15	8.6
95 kW PV + 52 kWh BESS	207,000	1,510,000	14	9.3

D.4.4 Demand Management and Demand Response

15-minute interval data from the Hale Ola Building's Hawaiian Electric meter covering the 12-month period from July 2024 through June 2025 was assessed. The whole facility-level energy usage data allowed for an initial screening of the annual electricity demand profile. Electricity demand is a measure of the peak electrical load in the facility at any given point in time during the year. This annual load profile is used to identify the frequency of peak loads recorded at the facility that could be high enough to trigger a demand response event, providing an indicator of the suitability of the facility to participate in a demand response program.

Figure 40. Annual Electricity Demand Profile from 15-minute Interval Data, Hale Ola Building



The Hale Ola Building has a base load demand of approximately 10kW, but can spike as high as 156kW, with regular high peaks throughout much of the year. There were more than 50 times during the course of the year where the peak demand met or exceeded 140kW. Although demand response events are not triggered based on a whole facility exceeding a specific threshold of demand, having at least a dozen high spikes in the year is an indicator that the facility is a candidate for demand response. It is unclear, however, if the facility has a building management system and would be capable of communicating with Hawaiian Electric and automatically curtailing loads at the facility. The energy demand profile suggests that Hale Ola is a good candidate to participate in a demand response program but further coordination with Hawaiian Electric is necessary to determine if the facility is physically capable of doing so.

D.4.5 Vehicle Electrification

A total of 14 vehicles are housed at the Hale Ola Building; the assigned fleet is predominantly light-duty passenger vehicles made up of sedans and SUVs. Vehicle mileage was provided for all 14 vehicles assigned to this location, including lifetime mileage for 11 vehicles and March 2025 monthly data for the remaining three vehicles. Table 92 provides the vehicle type, quantity, average daily mileage and equivalent BEB information for the vehicle data provided by the State Laboratory.

Table 92. Hale Ola Fleet Model Inputs

Vehicle Type	Fleet Size	BEV Equivalent Modeled	Battery Capacity	Range
Light-Duty Vehicles				
Sedan	6	Hyundai Ioniq 6	53 kWh	240 miles
SUV	6	Hyundai Ioniq 5	63 kWh	245 miles
Pick-Up Truck	1	Ford F-150 Lightning	98 kWh	240 miles
Passenger Van	1	Volkswagen ID.Buzz	91 kWh	231 miles
Total	**14**			

D.4.5.1 ENERGY REQUIREMENTS

Based on the results of the energy modeling analysis, a fully electrified vehicle fleet is expected to require roughly 244 kWh of energy daily to recharge vehicles with a daily peak power demand of 50.4 kW. The total daily energy and total daily power requirements are based on a mix of average and maximum daily requirements and assume that a portion of vehicles may experience maximum mileage, while others experience average mileage. Table 93 details average and maximum energy use and power requirements per vehicle type.

Table 93. Hale Ola EV Fleet Energy and Power Requirements

Vehicle Type	Fleet Size	Average Daily Energy Requirements per Vehicle	Maximum Daily Energy Requirements per Vehicle	Total Daily Energy Requirements	Total Daily Power Requirements
Sedan	6	12.8 kWh	25.7 kWh	96.3 kWh	21.6 kW
SUV	6	14.3 kWh	28.6 kWh	107.1 kWh	21.6 kW
Pick-Up Truck	1	16.3 kWh	32.7 kWh	20.4 kWh	3.6 kW
Passenger Van	1	15.8 kWh	31.5 kWh	19.7 kWh	3.6 kW
Total	**14**			**243.5 kWh**	**50.4 kW**

Table 94 details the average and maximum percentage of battery capacity used daily per vehicle type.

Table 94. Hale Ola Daily Battery Usage per Vehicle Type

Vehicle Type	Electric Equivalent	Maximum Battery Capacity	Average Daily Use	Average % Use	Maximum Daily Use	Maximum % Use
Sedan	Hyundai Ioniq 6	53 kWh	12.8 kWh	24.2%	25.7 kWh	48.5%
SUV	Hyundai Ioniq 5	63 kWh	14.3 kWh	22.7%	28.6 kWh	45.4%
Pick-Up Truck	Ford F-150 Lightning	98 kWh	16.3 kWh	16.6%	32.7 kWh	33.4%
Passenger Van	Volkswagen ID.Buzz	91 kWh	15.8 kWh	17.4%	31.5 kWh	34.6%

D.4.5.2 CHARGING STRATEGY

Based on these mileage assumptions, vehicles can feasibly charge on average every 2 to 3 days to maintain the current operational parameters using AC Level 2 chargers with a power output between 3.5 to 6.2 kW. This would enable the Hale Ola Building to adopt a shared charging strategy using 4 dual-port chargers (8 ports total) that is cost-effective in terms of charging infrastructure, maintenance and fueling (recharging) costs. The peak electrical load required for 8 Level 2 ports is approximately 50 kW.

Table 95 below details the required charging frequency per vehicle type.

Table 95. Hale Ola Charging Requirements by Vehicle Type

Vehicle Type	Number of Vehicles	Charging Frequency	Max # of Vehicles Charging Per Day
Sedan	6	Every 2 days	3
SUV	6	Every 2 days	3
Pick-Up Truck	1	Every 4 days	1
Passenger Van	1	Every 3 days	1

D.4.5.3 VEHICLE AND INFRASTRUCTURE IMPLEMENTATION STRATEGY

Fleet vehicles at Hale Ola are often kept in excess of 10 years, and vehicle and charger deployments can be staggered to align with planned vehicle replacements. However, any required upgrades to the site's underlying electrical infrastructure or underground conduit expansions necessary for EV charging infrastructure are recommended to be completed all at once to minimize redundant construction costs and multiple construction phases.

D.4.6 Financial Feasibility

Table 96 shows the discounted payback period along with the benefit cost ratio of applicable ECM, WCM, and PV/BESS measures for DOH - Hale Ola. The WCM measure of Urinals Replacements has the shortest payback period for this facility at 4.8 years and a benefit cost ratio of 4.4. This is followed by the ECM measure of Complete Exterior LED Lighting Retrofit (150W-220W) (ECM #1) payback period of 5.2 years, and a benefit cost ratio of 2.8. In contrast, the PV+BESS and toilet/water closet replacements options have the longest payback periods of 9.3 years and 9.0 years, respectively. The PV only system exhibits a payback period of 8.6 years.

Lavatory Faucet Replacements is the sole measure analyzed that have a payback period beyond the study period for the DOH - Hale Ola facility, and a benefit cost ratio of 0.3.

Table 96. Efficiency and PV/BESS Results, DOH - Hale Ola

Measure ID	Improvement Type	DOH - Hale Ola	
		Payback Period (years)	Benefit Cost Ratio
DOH – Hale Ola – RE1	PV Only	8.6	4.4
DOH – Hale Ola – WCM2	Replace urinals	4.8	4.4
DOH – Hale Ola – RE2	PV+BESS	9.3	4.0
DOH – Hale Ola – ECM #1	COMPLETE EXTERIOR LED LIGHTING RETROFIT (150W-220W)	5.2	2.8
DOH – Hale Ola – WCM1	Replace toilets/ water closets	9.0	2.2
DOH – Hale Ola – WCM3	Replace lavatory faucets	N/A	0.3

The discounted payback period analysis reveals notable variation across vehicle types, reflecting differences in capital costs, operating expenses, and energy efficiency. As shown in the table below, the sedan is immediately cost effective since the capital cost of an EV is lower than the ICEV. None of the other vehicles offer a payback under the discounted payback period analysis, primarily due to higher upfront costs and lower relative fuel efficiency. These results suggest that smaller vehicles may offer more favorable financial returns under current cost structures and energy prices, though operational needs and service capacity must also be considered in fleet planning.

Table 97. EVSE Financial Analysis Results, DOH - Hale Ola

Vehicle Type	Breakeven	Useful Life	Calculated Breakeven Year
Sedan	Immediate	12	0.0
Pick-Up Truck	Exceeds useful life	12	15.5
SUV	Beyond study period	12	N/A
Passenger Van	Exceeds useful life	12	24.0

For the Hale Ola building, the total cost of electric vehicle implementation is $1.6 million in 2025 dollar terms, including the unit costs of individual chargers and the total vehicle cost to convert current ICEVs to EVs on a 1:1 basis, assuming all vehicles are purchased in a single year. This reflects a $1.4 million premium over a baseline scenario where vehicles are not transitioned to EVs and no chargers are installed. This result, along with the discounted payback period results shown above, suggest that the incrementally higher capital costs may not be offset by operating and maintenance cost savings of operating an EV fleet.

E

Appendix E – OR&L Main Building

E. OR&L Main Building

E.1 Facility Description

The Oʻahu Railway & Land Co. (OR&L) Main Building is a two-story Spanish Mission Revival Style building constructed of stucco-covered, reinforced concrete with a gable-on-hip roof covered with red barrel tile and a four-sided clock tower and first story arcade. The historic structure was originally constructed as a terminal depot for OR&L, which built the rail system on Oʻahu.

DAGS | OR&L Main Building | Building Characteristics

Location | Envelope Basics		Heating | Cooling | Ventilation	
Location	333 N. King Street, Honolulu, Oʻahu 96817	**Heating Primary Fuel**	n/a
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	1	**Heating Generation**	n/a
Building Type	Office	**Cooling Generation**	Air cooled chiller
Year Built	925, renovated in 1964	**Domestic Hot Water Generation**	Electric Storage-type Water Heater
Floor Area (ft2)	20,711	**Heating / Cooling / Vent Distribution**	VAV Air-Handlers
Stories	2	**Electric Rate Structure**	Hawaiian Electric J GENERAL SERVICE DEMAND
Window Type	Single-pane, Aluminum Frame		
Wall Type	Reinforced Concrete	**Natural Gas Rate Structure**	N/A
Lighting System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	50
Exterior Lighting System	HPS HID pole mounted	**Weekday Opening Time**	Monday-Friday, 8:00am – 6:00pm
		Weekend Operating Hours	n/a
		Weekend Opening Time	Saturday and Sunday – Typically Closed

Figure 41. Photos of OR&L Main Building

E.2 Energy-using Systems Assessed

The OR&L Main Building facility was remotely assessed for operational energy performance improvement opportunities. The assessment used design and as-built drawings, previous reports and facility assessments, and utility bills, along with written facility narratives and interviews conducted with facilities management personnel to investigate the energy-using systems and equipment in the facility. Specific energy-using systems investigated as part of this assessment include:

- Building envelope
- HVAC
- Domestic hot water
- Lighting – interior / exterior
- Plug loads
- Water fixtures

E.3 Energy Performance Analysis

The facility's operational energy consumption in units of kilowatt hours was obtained from utility bill summaries provided by Hawaiian Electric, the electric utility. The facility does not use any other energy types as a primary energy source. Utility bill summaries were analyzed for the 12-month period from July 2024 through June 2025.

One method for measuring a facility's energy efficiency is to determine its energy use intensity (EUI), which is the energy consumption per gross square foot. Two types of EUI are typically determined for a facility. The first is the site EUI, which is defined as the energy use at the site divided by the building's gross square footage. The second is the source EUI, which is defined as the energy used by the various energy plants to provide energy to the site. This value is always higher than the site EUI because it accounts for inefficiencies and losses in generation and distribution. For the State Facilities Energy Strategy, US EPA's national site-to-source energy conversion factor of 2.80[20] is used to calculate source energy. Because EUI looks at total consumption of all types of energy used in a facility, the unit of measurement for energy is typically expressed in kilo British thermal units (kBtu), which allows for an apples-to-apples comparison of different energy types in a common unit. Moreover, because EUI is a measure of intensity, there is a defined time period of 1 calendar year and efficiency is calculated by dividing the total energy usage by the floor area of the building. The units for EUI are typically expressed as kBtu/sf/yr.

E.3.1 Energy Consumption and Energy Use Intensity

During the year of July 2024 through June 2025, the OR&L Main Building facility consumed 184,935 kWh of site energy, which cost $73,621 during the year. This equates to a site Energy Use Intensity (EUI) of 30.5 kBtu/sf/yr and source EUI of 85.3 kBtu/sf/yr. Total greenhouse gas emissions for the year are estimated to be 125.7 metric tons CO_2e, equivalent to a greenhouse gas emissions intensity of 6.1 kgCO_2e/sf/yr.

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20 https://portfoliomanager.energystar.gov/pdf/reference/Source%20Energy.pdf?_gl=1*3nkuy*_ga*NTI0NjA3MDA0LjE3NTI1OTAzMzI.*_ga_S0KJTVVLQ6*czE3NjI0NzM2MDEkbzU5JGcxJHQxNzYyNDczNjYwJGoxJGwwJGgw

Figure 42. OR&L Main Building Monthly Site Energy Usage, July 2024 - June 2025

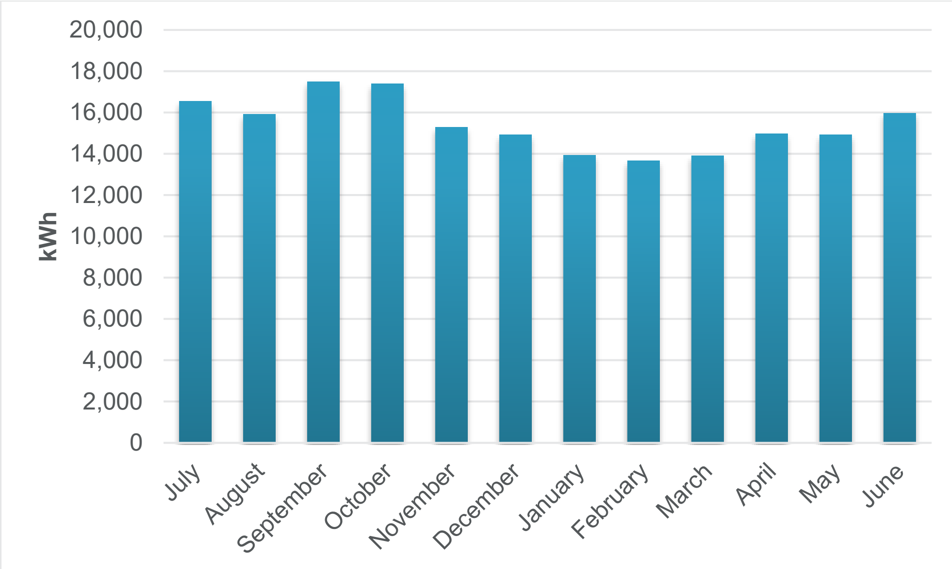


Table 98. Energy Consumption and Energy Use Intensity, OR&L Main Building

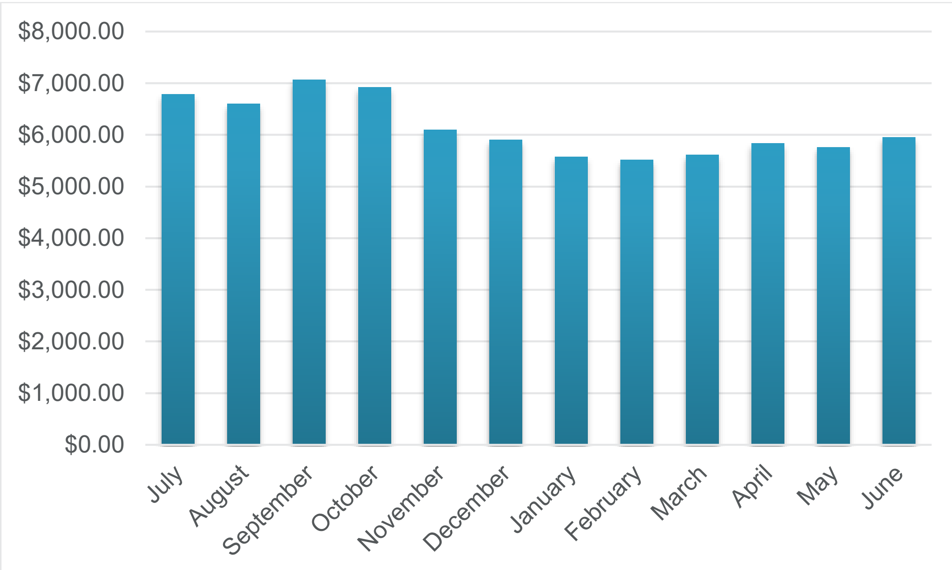
Metric	Current Year (7/24 – 6/25)
Source EUI (kBTU/sf)	85.3
Site EUI (kBTU/sf)	30.5
Source Energy Use (kBtu)	1,766,795
Site Energy Use (kBtu)	630,998
Energy Cost ($)	$73,621
Energy Cost Index, ECI ($/sf-yr)	3.55
Total Location-based Greenhouse Gas (GHG) Emissions[21] (Metric tonsCO2e/yr)	125.7
Total Location-based GHG Emissions Intensity (kgCO2e/sf/yr)	6.1

[21] Emission factors derived from US EPA E-grid for the HIOA (Hawaiʻi – Oʻahu) region: https://www.epa.gov/egrid

E.3.2 Energy Cost

The OR&L Main Building spent $73,621 on electricity during the year, which yields an Energy Cost Index (ECI) of $3.55/sf/yr. A summary of the monthly energy costs is in Figure 43 below. The actual costs are inclusive of the cost per unit of energy, as well as all fees, tariffs, and other charges.

Figure 43. OR&L Main Building Monthly Energy Costs, July 2024 - June 2025



E.4 Facility Energy Strategy

E.4.1 Building Efficiency: Energy

The OR&L Main Building facility is identified as a high energy-using facility with significant potential for energy cost savings. A desktop assessment revealed a set of potential energy conservation measures (ECMs). Only those opportunities viewed to be the most feasible based on analysis, experience and interviews with onsite personnel are included in the sections below.

The potential projects encompassing both low-cost/no-cost and capital investment projects are categorized by type. Low-cost/no-cost opportunities involve little to no capital investment and typically require changes to setpoints or methods of operation to obtain energy savings.

Capital investment measures are defined as energy conservation, energy efficiency, or time-of use management projects with a capital cost of greater than $3,000 in first-cost implementation costs or are non-BAS (Building Automation System) controls optimization, where BAS optimization typically is included in the low-cost/no-cost measures section. These measures can significantly reduce energy consumption and costs but also require more significant first cost investments.

Potential opportunities or concepts that require further development or investigations by owner/contractor are presented at the end under “Non-Quantified Measures.”

E.4.1.1 QUANTIFIED ENERGY CONSERVATION MEASURES

Calculations for the quantifiable ECMs are based on a combination of algorithms from the Hawaiʻi State-approved technical resource manual (TRM). A TRM is a resource used to help plan and evaluate energy efficiency programs. TRMs outline how much energy can be expected to be saved for certain measures, either through deemed savings values or engineering algorithms. TRMs also contain source documentation, specified assumptions, and other metrics associated with energy efficiency measures.

Four ECMs were identified during the assessment that can be quantified for the energy usage reduction, peak demand savings and life cycle cost implications. Table 99 below lists the ECMs, which are described below the table.

Table 99. OR&L Main Building Summary of Energy Conservation Measures

ECM Improvement Description	ECM Improvement ID	ECM Type
1ST FLOOR WINDOW FILM REPLACEMENT (SW - 52 SQFT)	DAGS OR&L - ECM #1	Low Cost/ No Cost
COMPLETE INTERIOR LED LIGHTING RETROFIT	DAGS OR&L - ECM #2	Capital
EXTERIOR HALLWAYS LIGHTING REPLACEMENT (150W-220W)	DAGS OR&L - ECM #3	Capital
RETRO-COMMISSIONING	DAGS OR&L – ECM #4	Capital

E.4.1.2 MEASURE DESCRIPTIONS

DAGS OR&L – ECM #2: Complete Interior LED Lighting Retrofit

The OR&L Main Building facility’s interior lights are all fluorescent, primarily linear T8 fluorescents mixed with CFL downlights and other types of fluorescent lighting. The Hawai‘i Clean Lighting Standards (Act 225, 2023[22]) prohibits the sale of fluorescent lighting in Hawai‘i, as of January 1, 2025. In order to ensure that replacement bulbs are available, DAGS will need to retrofit the lighting to be all LED. Retrofitting the lighting to be all LED will also save the facility money, while saving electricity. Per the TRM, this measure pertains to the installation of an LED luminaire or retrofit kit for general area illumination in place of a fluorescent light source. These luminaires and retrofit kits are typically recessed, suspended, or surface-mounted and intended to provide ambient lighting in office spaces, schools, retail stores, and other commercial environments. Because of the improved optical control afforded by LED luminaires and retrofit kits, LED lighting systems can typically reduce total lumen output while maintaining required illuminance on work surfaces.

[22] https://hawaiienergy.com/wp-content/uploads/Lighting-Ban-FAQ-1.pdf

Figure 44. TRM Algorithms Used to Calculate Energy and Peak Demand Savings – Light General

First Baseline Peak Demand Reduction, kW

$$\Delta kW_{1st} = \left(kW_{base,1} - kW_{EE}\right) * ISR * CF * IE_{C,D} * PF \quad (1)$$

Second Baseline Peak Demand Reduction, kW

$$\Delta kW_{2nd} = \left(kW_{base,2} - kW_{EE}\right) * ISR * CF * IE_{C,D} * PF \quad (2)$$

First Baseline Annual Energy Savings, kWh/yr

$$\Delta kWh_{1st} = \left(kW_{base,1} - kW_{EE}\right) * ISR * HOU_{year} * IE_{C,E} * PF \quad (3)$$

Second Baseline Annual Energy Savings, kWh/yr

$$\Delta kWh_{2nd} = \left(kW_{base,2} - kW_{EE}\right) * ISR * HOU_{year} * IE_{C,E} * PF \quad (4)$$

Lifetime Energy Savings, kWh (Dual Baseline, ROB)

$$\Delta kWh_{life,dual} = \Delta kWh_{1st} * EUL_{1st} + \Delta kWh_{2nd} * (EUL_{EE} - EUL_{1st}) \quad (5)$$

Lifetime Energy Savings, kWh (Dual Baseline, Early Replacement)

$$\Delta kWh_{life,dual} = \Delta kWh_{1st} * RUL + \Delta kWh_{2nd} * (EUL_{EE} - RUL) \quad (6)$$

Lifetime Energy Savings, kWh (Single Baseline)

$$\Delta kWh_{life,single} = \Delta kWh_{2nd} * EUL_{EE} \quad (7)$$

Remaining Useful Life

$$RUL = ROUND(1/3 * EUL_{pre-existing}) \quad (8)$$

<u>DAGS – OR&L – ECM #3: Exterior LED Lighting Replacement</u>

The facility's exterior lighting is mostly high-pressure sodium, high-intensity discharge pole mounted lighting, as well as wall packs for egress along the perimeter of the building envelope. Per the TRM, this measure pertains to the installation of an LED outdoor pole/arm- or wall-mounted luminaire or retrofit kit for parking lot, street, or general area illumination in place of a high-intensity discharge light source.

Figure 45. TRM Algorithms Used to Calculate Energy and Peak Demand Savings – Light Exterior

ALGORITHMS

Peak Demand Reduction, kW

$$\Delta kW = (kW_{base} - kW_{EE}) * ISR * CF * PF \quad (1)$$

Annual Energy Savings, kWh/yr

$$\Delta kWh = (kW_{base} - kW_{EE}) * ISR * HOU_{year} * PF \quad (2)$$

Lifetime Energy Savings, kWh

$$\Delta kWh_{life} = \Delta kWh * EUL_{EE} \quad (3)$$

DAGS OR&L – ECM #4: Retro-commissioning

Retro-commissioning (RCx) is a systematic process that seeks to improve the performance of an existing building and how equipment and systems function together by optimizing the building controls or building management system. RCx can often resolve problems that occurred during design or construction or address those that have developed throughout the building's life. RCx uses a whole-building systems approach to identify operational improvements in a building's O&M procedures that will save energy and increase occupant comfort.

Estimated percent savings opportunities for implementing RCx on a given existing building range anywhere from 5% to 15% across the board, varying for different building typologies and build dates.

There are up to fourteen controls optimization measures that offer the highest opportunity for energy/carbon savings for non-residential facilities, and three of those have been determined to be appropriate for the Hale Ola Building, including:

Table 100. RCx measures that could improve energy performance at OR&L Main Building

Controls Measure	Measure and Description
1	Scheduling equipment: AHUs, Fans, Pumps, Electrical Heat, VAV/FPBs, Lighting
2	Economizer and outside air control
3	Supply air temperature reset

E.4.1.3 NON-QUANTIFIED ENERGY CONSERVATION MEASURES

Additionally, one ECM was identified during the assessment that requires further information to quantify the impacts. These measures require further investigation, either via an onsite inventory of individual pieces of equipment for condition and remaining useful life, review of the controls programming by a Controls Contractor, or further trending to verify that the occurrences happen regularly.

Table 101. Non-quantified Energy Conservation Measures, OR&L Main Building

Energy Conservation Measure	ECM Improvement ID
Weatherize and re-seal the building envelope, including doors and window assemblies	DAGS – OR&L - ECM #NQ-1

DAGS OR&L – ECM #NQ1: Weatherize and re-seal the building envelope, including doors and window assemblies

Based on photographs of the facility and interviews with facilities personnel, there are a number of damaged elements of the building envelope, including air gaps between exterior door and their frames, damaged or deteriorated window frames and assemblies and cracks in walls. A poorly sealed building envelope allows outside air to infiltrate and conditioned air to exfiltrate the facility. This is energy inefficient in multiple ways, including causing a need to heat or cool the air more to meet comfort needs and having to move larger volumes of air throughout the facility. Improving the seal of the building envelope will enhance occupant comfort while helping to save energy.

E.4.1.4 PERFORMANCE ANALYSIS

The energy and GHG performance impacts of each of the quantified ECMs described above are listed in Table 102 below.

Table 102. Energy Conservation Measure Performance Impacts, OR&L Main Building

Measure ID	Energy Conservation Measures	CapEx (2025$)	Annual Electric Savings (kWh/yr)	Annual Peak Electric Savings (kWh)	Annual GHG Savings (mtCO2e)
DAGS OR&L – ECM#1	1ST FLOOR WINDOW FILM REPLACEMENT (SW - 52 SQFT)	$48	1,026	0.08	0.7
DAGS OR&L – ECM#2	COMPLETE INTERIOR LED LIGHTING RETROFIT	$15,326	12,004	0.90	8.2
DAGS OR&L – ECM#3	EXTERIOR HALLWAYS LIGHTING REPLACEMENT (150W-220W)	$12,050	13,366	2.02	9.1
DAGS OR&L – ECM#4	RETRO-COMMISSIONING	$5,799	9,247	n/a	6.3

E.4.2 Building Efficiency: Water

The desktop facility assessment of the OR&L Main Building revealed potential measures that could save water at the facility, referred to here as water conservation measures (WCMs). Water use and cost conservation at State-owned facilities will provide direct reductions in resource consumption, while also lowering operating costs for State agencies and reducing the amount of energy required to pump the water from its source to its sink.

E.4.2.1 WATER CONSERVATION MEASURES

The OR&L Main Building has water conservation opportunities for both indoor and exterior water use. Due to limitations in the available data, only measures impacting indoor water use are quantifiably assessed as part of this study.

Table 103. OR&L Main Building Summary of Water Conservation Measures

Measure ID	WCM Improvement Description	WCM Improvement ID
DAGS OR&L – WCM1	Replace toilets/ water closets	DAGS OR&L - WCM #1
DAGS OR&L – WCM2	Replace urinals	DAGS OR&L - WCM #2
DAGS OR&L – WCM3	Replace lavatory faucets	DAGS OR&L - WCM #3

<u>DAGS – OR&L – WCM #1: Replace Toilets/ Water Closets with 1.28 GPF Units</u>

The OR&L Main Building still has its original indoor plumbing system and fixtures. Based on photos, interviews and as-built information provided, it is assumed that there are four toilets/ water closets installed in the facility, each with a flush rate of 1.6 gallons per flush (GPF). There have been great advances in low-cost, water saving technology since the facility's plumbing fixtures were installed, with 1.28 GPF commonly and commercially available.

<u>DAGS – OR&L – WCM #2: Replace Urinals with 0.25 GPF Units</u>

The facility has two original urinals, rated at 1.0 GPF. Many lower flush options for urinals are commonly and commercially available, including low flow, ultra-low flow and waterless urinals. While waterless urinals offer the greatest potential water savings of those options, older buildings with original plumbing systems sometimes experience operational issues with the waterless system being able to properly clear the pipes. Ultra-low flow 0.25 GPF urinals provide an optimal balance by still offering substantial water use savings but with a more functional configuration.

<u>DAGS – OR&L – WCM #3: Replace Lavatory Faucets with 0.4 GPM Units</u>

The four original lavatory faucets have a 0.5 gallons per minute (GPM) flow rate and are manually turned on and off. Newer low flow faucets can deliver higher pressure using only 0.4 GPM with a timed release that closes the faucet after 5-15 seconds.

E.4.2.2 PERFORMANCE ANALYSIS

The expected annual water savings from implementing each of the recommended WCMs is detailed below.

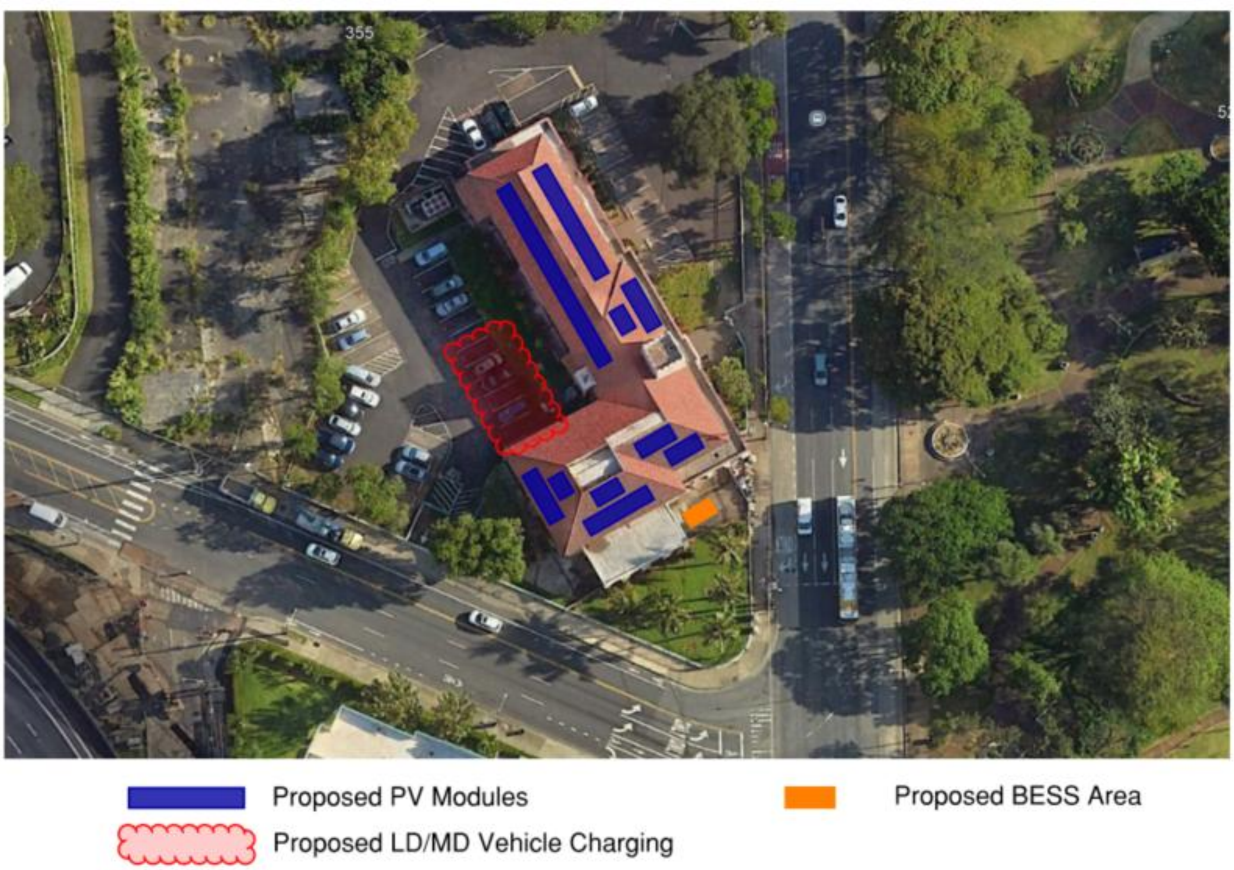
Table 104. OR&L Main Building Summary of Water Conservation Measures

Measure ID	Water Conservation Measures	CapEx (2025$)	Annual Water Savings (gallons)
DAGS OR&L – WCM1	Replace toilets/ water closets	$2,728	8,428
DAGS OR&L – WCM2	Replace urinals	$1,364	9,984
DAGS OR&L – WCM3	Replace lavatory faucets	$1,102	1,983

E.4.3 Solar PV and BESS Analysis

The OR&L facility has a sloped roof with minimal concern for shading and obstructions. The Southwest, Southeast and Northeast areas are suitable for a potential PV system. The age of the roof was not confirmed, and the replacement cycle was not identified. As shown in Figure 46, the estimated total capacity is 65 kW DC.

Figure 46. OR&L Main Building Concept Solar and EV Layout



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software as discussed under the Solar Analysis Methodology. The annual building consumption for the past year is approximately 185,200 kWh. The initial HOMER analysis indicates that a 62.5 kW DC nameplate PV system would be optimal.

HOMER model results indicate that multiple combinations of PV possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems tend to possess slightly less favorable payback periods and a marginal increase in renewable fraction.

The base case, PV only, and PV and BESS system configurations with the fastest payback period are provided in Table 105.

Table 105. OR&L Main Building Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (HE Sch J - Smart Export)	185,200	N/A	N/A	N/A
62.5 kW PV	114,442	102,347	N/A	47.2
62.5 kW PV + 31 kWh BESS	107,800	102,347	7,740	48.3

Cost performance for the three systems is provided in Table 106.

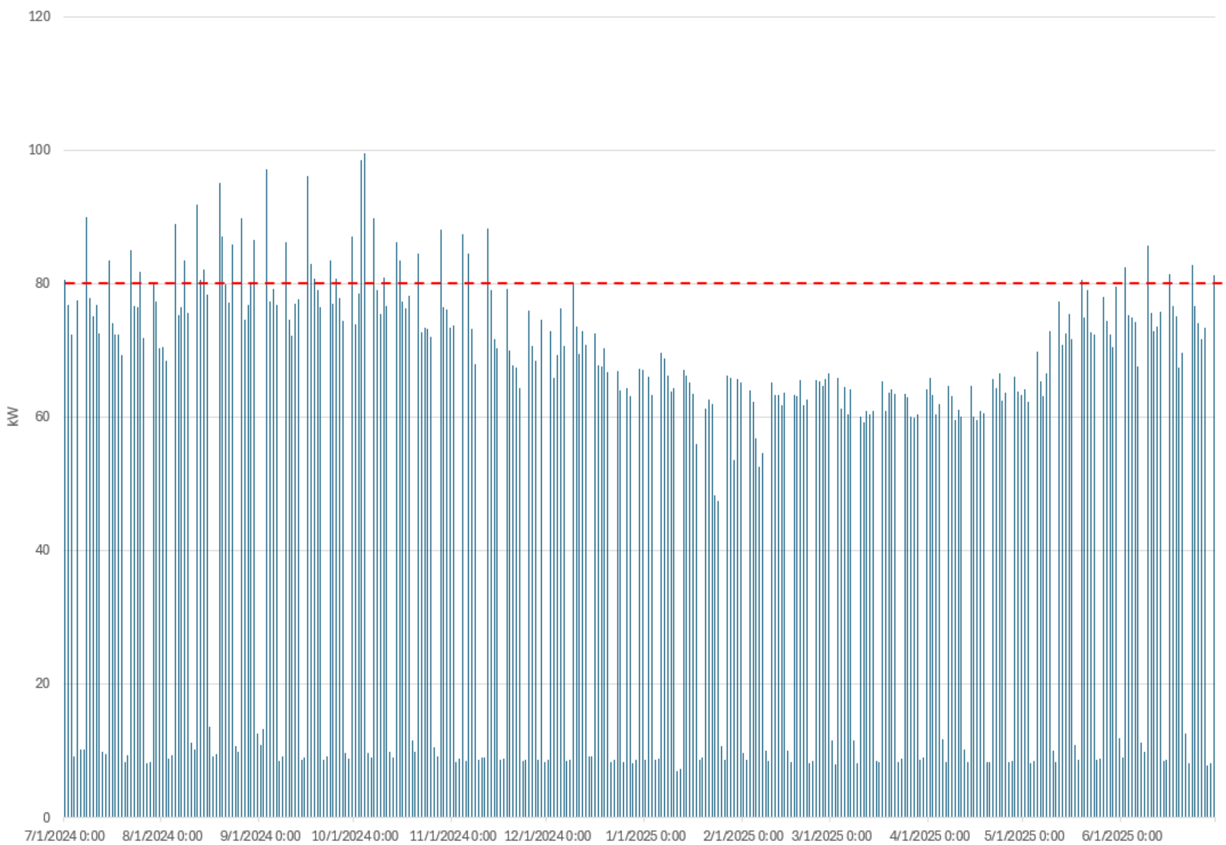
Table 106. OR&L Main Building Renewables Cost Summary

System Configuration	CAPEX ($)	Net Present Cost ($)	IRR (%)	Discounted Payback Period (yr)
Base Case (HE Sch J - Smart Export)	N/A	989,400	N/A	N/A
62.5 kW PV	116,500	736,100	14	9.2
62.5 kW PV + 31 kWh BESS	134,904	739,000	11	10.9

E.4.4 Demand Management and Demand Response

15-minute interval data from the OR&L Main Building's Hawaiian Electric meter covering the 12-month period from July 2024 through June 2025 was assessed. The whole facility-level energy usage data allowed for an initial screening of the annual electricity demand profile. Electricity demand is a measure of the peak electrical load in the facility at any given point in time during the year. This annual load profile is used to identify the frequency of peak loads recorded at the facility that could be high enough to trigger a demand response event, providing an indicator of the suitability of the facility to participate in a demand response program.

Figure 47. Annual Electricity Demand Profile from 15-minute Interval Data, OR&L Main Building



The OR&L Main Building has a base load demand of approximately 8kW, but can spike as high as 100kW during the warmest months. There were 36 times during the course of the year where the peak demand met or exceeded 80kW. Although demand response events are not triggered based on a whole facility exceeding a specific threshold of demand, having at least a dozen high spikes in the year is an indicator that the facility is a candidate for demand response. Furthermore, the facility's Automated Logic building management system is capable of communicating with Hawaiian Electric and automatically curtailing loads at the facility. These conditions make the OR&L Main Building a good candidate for further discussions with Hawaiian Electric about participating in one of their demand response programs.

E.4.5 Vehicle Electrification

There are no fleet vehicles assigned to the OR&L Main Building. The OR&L Main Building has 28 existing parking stalls near the building. If 6 parking stalls (20 percent) were converted to Level 2 EV chargers, then approximately 43 kW of electrical capacity would be required.

E.4.6 Financial Feasibility

Table 107 shows the discounted payback period along with the benefit cost ratio of applicable ECM, WCM, and PV/BESS measures for DAGS OR&L. ECM #1, First Floor Window Film Replacement, offers an immediate payback based on the energy savings. Exterior Hallways Lighting Replacement (150W-220W) (ECM #3) has the shortest payback period for this facility at 5.2 years, which is followed by the Complete Interior LED Lighting Retrofit (ECM #2) option at 6.9 years. PV configurations have longer payback periods of 9.2 years for the standalone option; and 10.9 years for the combined PV+BESS option.

For DAGS OR&L, none of the water control measures have a payback period within the study period, and have benefit-cost ratios lower than 1.

Table 107. Efficiency and PV/BESS Results, DAGS OR&L

Measure ID	Improvement Type	DAGS OR&L	
		Payback Period (years)	Benefit Cost Ratio
DAGS OR&L – ECM#1	1ST FLOOR WINDOW FILM REPLACEMENT (SW - 52 SQFT)	0.2	44.4
DAGS OR&L – RE1	PV Only	9.2	3.9
DAGS OR&L – ECM#2	COMPLETE INTERIOR LED LIGHTING RETROFIT	6.9	3.4
DAGS OR&L – RE2	PV+BESS	10.9	3.2
DAGS OR&L – ECM#3	EXTERIOR HALLWAYS LIGHTING REPLACEMENT (150W-220W)	5.2	2.8
DAGS OR&L – WCM2	Replace urinals	N/A	0.8
DAGS OR&L – WCM1	Replace toilets/ water closets	N/A	0.3
DAGS OR&L – WCM3	Replace lavatory faucets	N/A	0.1

F

Appendix F – Central Services Division Administration Office

F. Central Services Division – Administration Office

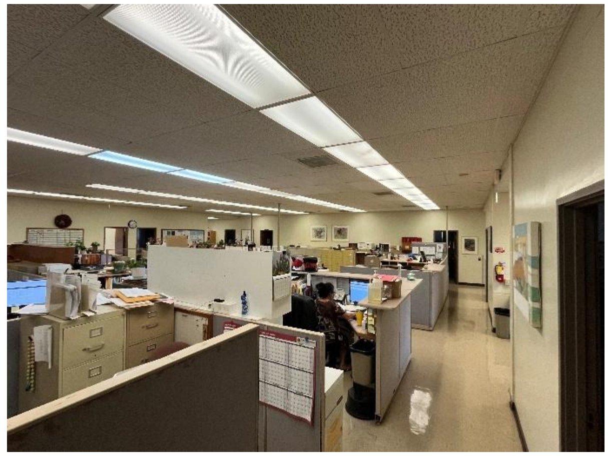
F.1 Facility Description

The Department of General Services' Central Services Division (CSD) – Administration Office is a one-story office building with an attached 2-story storage annex. The facility is one of several facilities located within the CSD Yard. The facility is a concrete masonry unit (CMU) structure with a steel roof.

DAGS | CSD Administration Office | Building Characteristics

Location | Envelope Basics		Heating | Cooling | Ventilation	
Location	729 Kakoi Street Honolulu, O'ahu 96819	**Heating Primary Fuel**	n/a
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	1	**Heating Generation**	n/a
Building Type	Office and Storage	**Cooling Generation**	Air-Cooled Chillers; window AC units
Year Built	1939	**Domestic Hot Water Generation**	Point of use, electric
Floor Area (ft2)	5,355	**Heating / Cooling / Vent Distribution**	Multi-Zone Air-Handlers
Stories	2	**Electric Rate Structure**	Hawaiian Electric
Window Type	unknown		
Wall Type	Masonry	**Natural Gas Rate Structure**	n/a
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	T8 Linear fluorescents	**Weekday Operating Hours**	10
Exterior Lighting System	Pole mounted HPS lamps	**Weekday Opening Time**	Monday-Friday, 7:30am – 5:30pm
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

Figure 48. Photos of the CSD Administration Office Facility



F.2 Energy-using Systems Assessed

The CSD Administration Office facility was remotely assessed for operational energy performance improvement opportunities. The assessment used design and as-built drawings, previous reports and facility assessments, and utility bills, along with written facility narratives and interviews conducted with facilities management personnel to investigate the energy-using systems and equipment in the facility. Specific energy-using systems investigated as part of this assessment include:

- Building envelope
- HVAC
- Domestic hot water
- Lighting – interior / exterior
- Plug loads
- Water fixtures

F.3 Energy Performance Analysis

The facility's operational energy consumption in units of kilowatt hours was obtained from utility bill summaries provided by Hawaiian Electric, the electric utility. The facility does not use any other energy types as a primary energy source. Utility bill summaries were analyzed for the 12-month period from July 2024 through June 2025.

One method for measuring a facility's energy efficiency is to determine its energy use intensity (EUI), which is the energy consumption per gross square foot. Two types of EUI are typically determined for a facility. The first is the site EUI, which is defined as the energy use at the site divided by the building's gross square footage. The second is the source EUI, which is defined as the energy used by the various energy plants to provide energy to the site. This value is always higher than the site EUI because it accounts for inefficiencies and losses in generation and distribution. For the State Facilities Energy Strategy, US EPA's national site-to-source energy conversion factor of 2.80 [23]is used to calculate source energy. Because EUI looks at total consumption of all types of energy used in a facility, the unit of measurement for energy is typically expressed in kilo British thermal units (kBtu), which allows for an apples-to-apples comparison of different energy types in a common unit. Moreover, because EUI is a measure of intensity, there is a defined time period of 1 calendar year and efficiency is calculated by dividing the total energy usage by the floor area of the building. The units for EUI are typically expressed as kBtu/sf/yr.

F.3.1 Energy Consumption and Energy Use Intensity

During the year of July 2024 through June 2025, the CSD Administration Office facility consumed 487,490 kWh of site energy, which cost $174,839 during the year. This equates to a site Energy Use Intensity (EUI) of 310.6 kBtu/sf/yr and source EUI of 869.7 kBtu/sf/yr. Total greenhouse gas emissions for the year are estimated to be 331.45 metric tons CO2e, equivalent to a greenhouse gas emissions intensity of 61.9 kgCO2e/sf/yr.

Figure 49. CSD Administration Office Monthly Energy Usage, July 2024 - June 2025

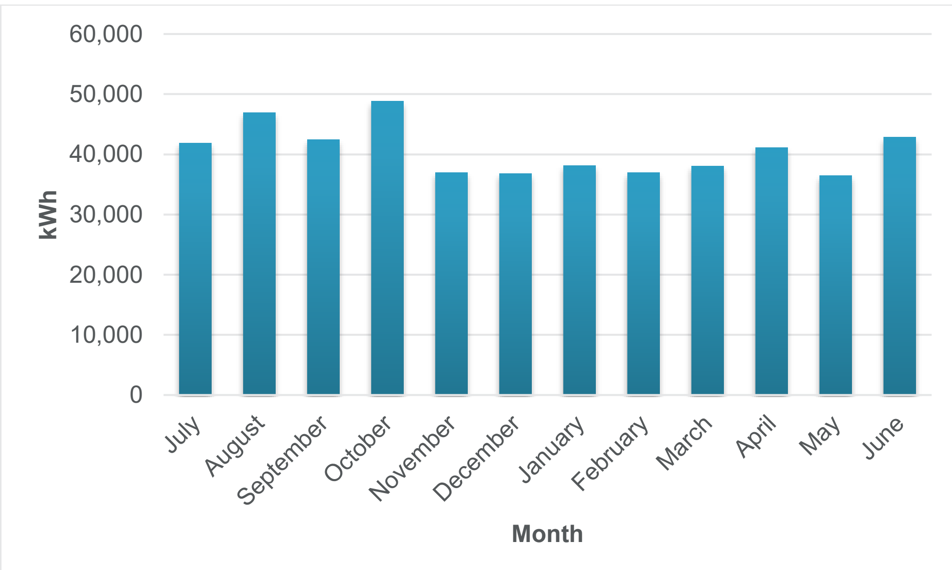


Table 108. Annual Energy Use and Cost, CSD Administration Building

Metric	Current Year (7/24 – 6/25)
Source EUI (kBTU/sf)	869.7
Site EUI (kBTU/sf)	310.6
Source Energy Use (kBtu)	4,657,284
Site Energy Use (kBtu)	1,663,315

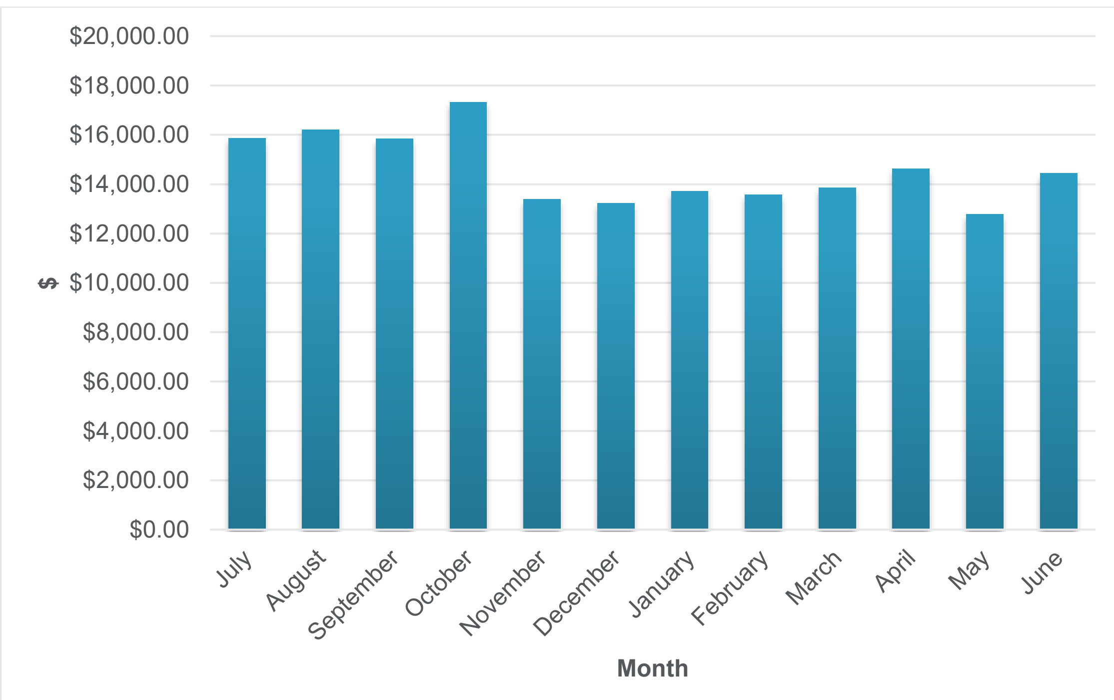
23 https://portfoliomanager.energystar.gov/pdf/reference/Source%20Energy.pdf?_gl=1*3nkuy*_ga*NTI0NjA3MDA0LjE3NTI1OTAzMzI.*_ga_S0KJTVVLQ6*czE3NjI0NzM2MDEkbzU5JGcxJHQxNzYyNDczNjYwJGoxJGwwJGgw

Metric	Current Year (7/24 – 6/25)
Energy Cost ($)	$174,839
Energy Cost Index, ECI **($/sf-yr)**	32.65
Total Location-based Greenhouse Gas (GHG) Emissions[24] (Metric tonsCO2e/yr)	331.45
Total Location-based GHG Emissions Intensity (kgCO2e/sf/yr)	61.9

F.3.2 Energy Cost

The CSD Administration Office spent $174,839 on electricity during the year, which yields an Energy Cost Index (ECI) of $32.65/sf/yr. A summary of the monthly energy costs is in Figure 50 below. The actual costs are inclusive of the cost per unit of energy, as well as all fees, tariffs, and other charges.

Figure 50. CSD Administration Office Monthly Energy Costs, July 2024 - June 2025



[24] Emission factors derived from US EPA E-grid for the HIOA (Hawai'i – O'ahu) region: https://www.epa.gov/egrid

F.4 Facility Energy Strategy

F.4.1 Building Efficiency: Energy

The CSD Administration Office facility is identified as a high energy-using facility with significant potential for energy cost savings. A desktop assessment revealed a set of potential energy conservation measures (ECMs). Only those opportunities viewed to be the most feasible based on analysis, experience and interviews with onsite personnel are included in the sections below.

The potential projects encompassing both low-cost/no-cost and capital investment projects are categorized by type. Low-cost/no-cost opportunities involve little to no capital investment and typically require changes to setpoints or methods of operation to obtain energy savings.

Capital investment measures are defined as energy conservation, energy efficiency, or time-of use management projects with a capital cost of greater than $3,000 in first-cost implementation costs or are non-BAS (Building Automation System) controls optimization, where BAS optimization typically is included in the low-cost/no-cost measures section. These measures can significantly reduce energy consumption and costs but also require more significant first cost investments.

Potential opportunities or concepts that require further development or investigations by owner/contractor are presented at the end under “Non-Quantifiable Measures”.

F.4.1.1 QUANTIFIED ENERGY CONSERVATION MEASURES

Calculations for the quantifiable ECMs are based on a combination of algorithms from the Hawai‘i State-approved technical resource manual (TRM). A TRM is a resource used to help plan and evaluate energy efficiency programs. TRMs outline how much energy can be expected to be saved for certain measures, either through deemed savings values or engineering algorithms. TRMs also contain source documentation, specified assumptions, and other metrics associated with energy efficiency measures.

Four ECMs were identified during the assessment that can be quantified for the energy usage reduction, peak demand savings and life cycle cost implications. Table 109 below lists the ECMs, which are described below the table.

Table 109. CSD Administration Office Summary of Energy Conservation Measures

Energy Conservation Measure	ECM Improvement ID	ECM Type
COMPLETE INTERIOR LED LIGHTING RETROFIT	DAGS Central Services - ECM #1	Capital
EXTERIOR LIGHTING REPLACEMENT (150W-220W)	DAGS Central Services - ECM #2	Capital
LIGHTING OCCUPANCY SENSORS (100% - 5,355 SQFT)	DAGS Central Services - ECM #3	Capital
RETRO-COMMISSIONING	DAGS Central Services – ECM #4	Low Cost/ No Cost

F.4.1.2 MEASURE DESCRIPTIONS

DAGS Central Services – ECM #1: Complete Interior LED Lighting Retrofit

The CSD Administration Office facility's interior lights are all fluorescent, primarily linear T8 fluorescents mixed with CFL downlights and other types of fluorescent lighting. The Hawai'i Clean Lighting Standards (Act 225, 2023[25]) prohibits the sale of fluorescent lighting in Hawai'i, as of January 1, 2025. In order to ensure that replacement bulbs are available, DAGS will need to retrofit the lighting to be all LED. Retrofitting the lighting to be all LED will also save the facility money, while saving electricity. Per the TRM, this measure pertains to the installation of an LED luminaire or retrofit kit for general area illumination in place of a fluorescent light source. These luminaires and retrofit kits are typically recessed, suspended, or surface-mounted and intended to provide ambient lighting in office spaces, schools, retail stores, and other commercial environments. Because of the improved optical control afforded by LED luminaires and retrofit kits, LED lighting systems can typically reduce total lumen output while maintaining required illuminance on work surfaces.

Figure 51. TRM Algorithms Used to Calculate Energy and Peak Demand Savings – Light General

First Baseline Peak Demand Reduction, kW

$$\Delta kW_{1st} = \left(kW_{base,1} - kW_{EE}\right) * ISR * CF * IE_{C,D} * PF \quad (1)$$

Second Baseline Peak Demand Reduction, kW

$$\Delta kW_{2nd} = \left(kW_{base,2} - kW_{EE}\right) * ISR * CF * IE_{C,D} * PF \quad (2)$$

First Baseline Annual Energy Savings, kWh/yr

$$\Delta kWh_{1st} = \left(kW_{base,1} - kW_{EE}\right) * ISR * HOU_{year} * IE_{C,E} * PF \quad (3)$$

Second Baseline Annual Energy Savings, kWh/yr

$$\Delta kWh_{2nd} = \left(kW_{base,2} - kW_{EE}\right) * ISR * HOU_{year} * IE_{C,E} * PF \quad (4)$$

Lifetime Energy Savings, kWh (Dual Baseline, ROB)

$$\Delta kWh_{life,dual} = \Delta kWh_{1st} * EUL_{1st} + \Delta kWh_{2nd} * (EUL_{EE} - EUL_{1st}) \quad (5)$$

Lifetime Energy Savings, kWh (Dual Baseline, Early Replacement)

$$\Delta kWh_{life,dual} = \Delta kWh_{1st} * RUL + \Delta kWh_{2nd} * (EUL_{EE} - RUL) \quad (6)$$

[25] https://hawaiienergy.com/wp-content/uploads/Lighting-Ban-FAQ-1.pdf

Lifetime Energy Savings, kWh (Single Baseline)

$$\Delta kWh_{life,single} = \Delta kWh_{2nd} * EUL_{EE} \quad (7)$$

Remaining Useful Life

$$RUL = ROUND(1/3 * EUL_{pre-existing}) \quad (8)$$

DAGS Central Services – ECM #2: Exterior LED Lighting Replacement

The facility's exterior lighting is mostly high-pressure sodium, high-intensity discharge pole mounted lighting, as well as wall packs for egress along the perimeter of the building envelope. Per the TRM, this measure pertains to the installation of an LED outdoor pole/arm- or wall-mounted luminaire or retrofit kit for parking lot, street, or general area illumination in place of a high-intensity discharge light source.

Figure 52. TRM Algorithms Used to Calculate Energy and Peak Demand Savings – Light Exterior

ALGORITHMS

Peak Demand Reduction, kW

$$\Delta kW = (kW_{base} - kW_{EE}) * ISR * CF * PF \quad (1)$$

Annual Energy Savings, kWh/yr

$$\Delta kWh = (kW_{base} - kW_{EE}) * ISR * HOU_{year} * PF \quad (2)$$

Lifetime Energy Savings, kWh

$$\Delta kWh_{life} = \Delta kWh * EUL_{EE} \quad (3)$$

DAGS Central Services – ECM #3: Lighting Occupancy Sensors

Based on as-built drawings and photographs, the facility only has manual lighting controls, such as wall switches. Adding lighting occupancy sensors throughout the facility will reduce electricity being used to power lighting for spaces that are unoccupied. Per the TRM, this measure defines the savings associated with installing a wall, fixture, or remote-mounted occupancy sensor that switches lights off after a brief delay when it does not detect occupancy.

The calculated implementation costs and energy savings in this report are based on installing 21 total remote (overhead) occupancy sensors throughout the facility, based on average coverage area of 250 square feet per sensor. A detailed lighting control audit was outside the scope of this assessment, and we recommend consulting a lighting control vendor to get a quote. Cost and savings calculations can be scaled based on the total number recommended.

The ECM from the TRM is identified as: COMMERCIAL – Light Occupancy Sensor. The algorithms used to calculate energy savings and peak demand savings are listed below.

Figure 53. TRM Algorithms Used to Calculate Energy and Peak Demand Savings: Light Occupancy Sensor

ALGORITHMS

Peak Demand Reduction, kW

$$\Delta kW = (P_{ctrl}/1000) * RTR * ISR * CF * IE_{C,D} * PF \quad (1)$$

Annual Energy Savings, kWh/yr

$$\Delta kWh = (P_{ctrl}/1000) * RTR * ISR * HRS * IE_{C,E} * PF \quad (2)$$

Lifetime Energy Savings, kWh

$$\Delta kWh_{life} = \Delta kWh * EUL_{EE} \quad (3)$$

<u>DAGS Central Services – ECM #4: Retro-commissioning</u>

Retro-commissioning (RCx) is a systematic process that seeks to improve the performance of an existing building and how equipment and systems function together by optimizing the building controls or building management system. RCx can often resolve problems that occurred during design or construction or address those that have developed throughout the building's life. RCx uses a whole-building systems approach to identify operational improvements in a building's O&M procedures that will save energy and increase occupant comfort.

Estimated percent savings opportunities for implementing RCx on a given existing building range anywhere from 5% to 15% across the board, varying for different building typologies and build dates.

There are up to fourteen controls optimization measures that offer the highest opportunity for energy/carbon savings for non-residential facilities, and four of those have been determined to be appropriate for the CSD Administration Office, including:

Table 110. RCx measures that could improve energy performance at CSD Administration Office

Controls Measure	Measure and Description
1	Scheduling equipment: AHUs, Fans, Pumps, Electrical Heat, VAV/FPBs, Lighting
2	Economizer and outside air control
3	Supply Air Temperature Reset
4	Set back space temperature

F.4.1.3 NON-QUANTIFIED ENERGY CONSERVATION MEASURES

Additionally, two ECMs were identified during the assessment that requires further information to quantify the impacts. These measures require further investigation, either via an onsite inventory of individual pieces of equipment for condition and remaining useful life, review of the controls programming by a Controls Contractor, or further trending to verify that the occurrences happen regularly.

Table 111. Non-quantified ECMs, CSD Administration Office

Energy Conservation Measure	ECM Improvement ID
REPLACE WINDOW AC UNITS W MORE EFFICIENT UNITS	DAGS Central Services - ECM #NQ-1
UPGRADE HVAC SYSTEM TO ELIMINATE NEED FOR WINDOW AC UNITS	DAGS Central Services – ECM #NQ-2

DAGS Central Services – ECM #NQ-1: Replace Window AC Units w More Efficient Units

There are a number of window-through air conditioning (AC) units in the front of the CSD Administration Office facility. Photographs and interviews with facilities personnel indicated that many of the units are at or beyond the end of their useful life and need to be replaced. A comprehensive survey of which units will need to be replaced at what time and what the Energy Efficiency Ratio (EER) of the existing units is beyond the scope of the State Facility Energy Strategy project and would have placed additional burden on DAGS facilities staff to gather that information on site.

When these AC units get replaced as part of the standard capital replacement cycle, we highly recommend procuring replacement units with an EER of 10.0 or higher, which is considered high energy efficiency.

DAGS Central Services – ECM #2: Upgrade HVAC System to Eliminate Need for Window AC Units

There is an existing, centralized HVAC system, including two air cooled chillers and a multizone air handling unit (AHU), located behind the CSD Administration Office. The presence of permanently installed window-through air conditioning units suggests that the centralized system is not capable of cooling the entire facility. This creates a worst case scenario where DAGS has made the capital investment in having a centralized HVAC system but still needs to supplement the energy use from that system with inefficient window through

AC units. A deeper analysis specific to the cooling capacity of the HVAC system should be done to re-size the system such that supplemental, window-through AC units are no longer necessary.

F.4.1.4 PERFORMANCE ANALYSIS

The energy and GHG performance impacts of each of the quantified ECMs described above are listed in Table 112 below.

Table 112. ECM Performance Results - CSD Administration Office

Measure ID	Energy Conservation Measure	CapEx (2025$)	Annual Electric Savings (kWh/yr)	Annual Peak Electric Savings (kW)	Annual GHG Savings (mtCO2e/ kWh)
DAGS Central Services – ECM #1	COMPLETE INTERIOR LED LIGHTING RETROFIT	$3,969	3,104	0.20	2.11
DAGS Central Services – ECM #2	EXTERIOR LIGHTING REPLACEMENT (150W-220W)	$4,820	5,346	0.81	3.64
DAGS Central Services – ECM #3	LIGHTING OCCUPANCY SENSORS (100% - 5,355 SQFT)	$6,169	2,226	0.26	1.51
DAGS Central Services – ECM #4	RETRO-COMMISSIONING	$1,499	29,786	n/a	20.25

F.4.2 Building Efficiency: Water

The desktop facility assessment of the CSD Administration Office revealed potential measures that could save water at the facility, referred to here as water conservation measures (WCMs). Water use and cost conservation at State-owned facilities will provide direct reductions in resource consumption, while also lowering operating costs for State agencies and reducing the amount of energy required to pump the water from its source to its sink.

F.4.2.1 WATER CONSERVATION MEASURES

The CSD Administration Office has water conservation opportunities for both indoor and exterior water use. Due to limitations in the available data, only measures impacting indoor water use are quantifiably assessed as part of this study.

Table 113. CSD Administration Office Summary of Water Conservation Measures

WCM Improvement Description	WCM Improvement ID
Replace toilets/ water closets	DAGS Central Services - WCM #1
Replace urinals	DAGS Central Services - WCM #2
Replace lavatory faucets	DAGS Central Services - WCM #3

DAGS Central Services – WCM #1: Replace Toilets/ Water Closets with 1.28 GPF Units

The CSD Administration Office still has its original indoor plumbing system and fixtures. Based on photos, interviews and as-built information provided, it is assumed that there are five toilets/ water closets installed in the facility, each with a flush rate of 3.4 gallons per flush (GPF). There have been great advances in low-cost, water saving technology since the facility's plumbing fixtures were installed, with 1.28 GPF commonly and commercially available.

DAGS Central Services – WCM #2: Replace Urinals with 0.25 GPF Units

The facility has one original urinal, rated at 1.6 GPF. Many lower flush options for urinals are commonly and commercially available, including low flow, ultra-low flow and waterless urinals. While waterless urinals offer the greatest potential water savings of those options, older buildings with original plumbing systems sometimes experience operational issues with the waterless system being able to properly clear the pipes. Ultra-low flow 0.25 GPF urinals provide an optimal balance by still offering substantial water use savings but with a more functional configuration.

DAGS Central Services – WCM #3: Replace Lavatory Faucets with 0.4 GPM Units

The four original lavatory faucets have a 0.6 gallons per minute (GPM) flow rate and are manually turned on and off. Newer low flow faucets can deliver higher pressure using only 0.4 GPM with a timed release that closes the faucet after 5-15 seconds.

F.4.2.2 PERFORMANCE ANALYSIS

The expected annual water savings from implementing each of the recommended WCMs is detailed in Table 114 below.

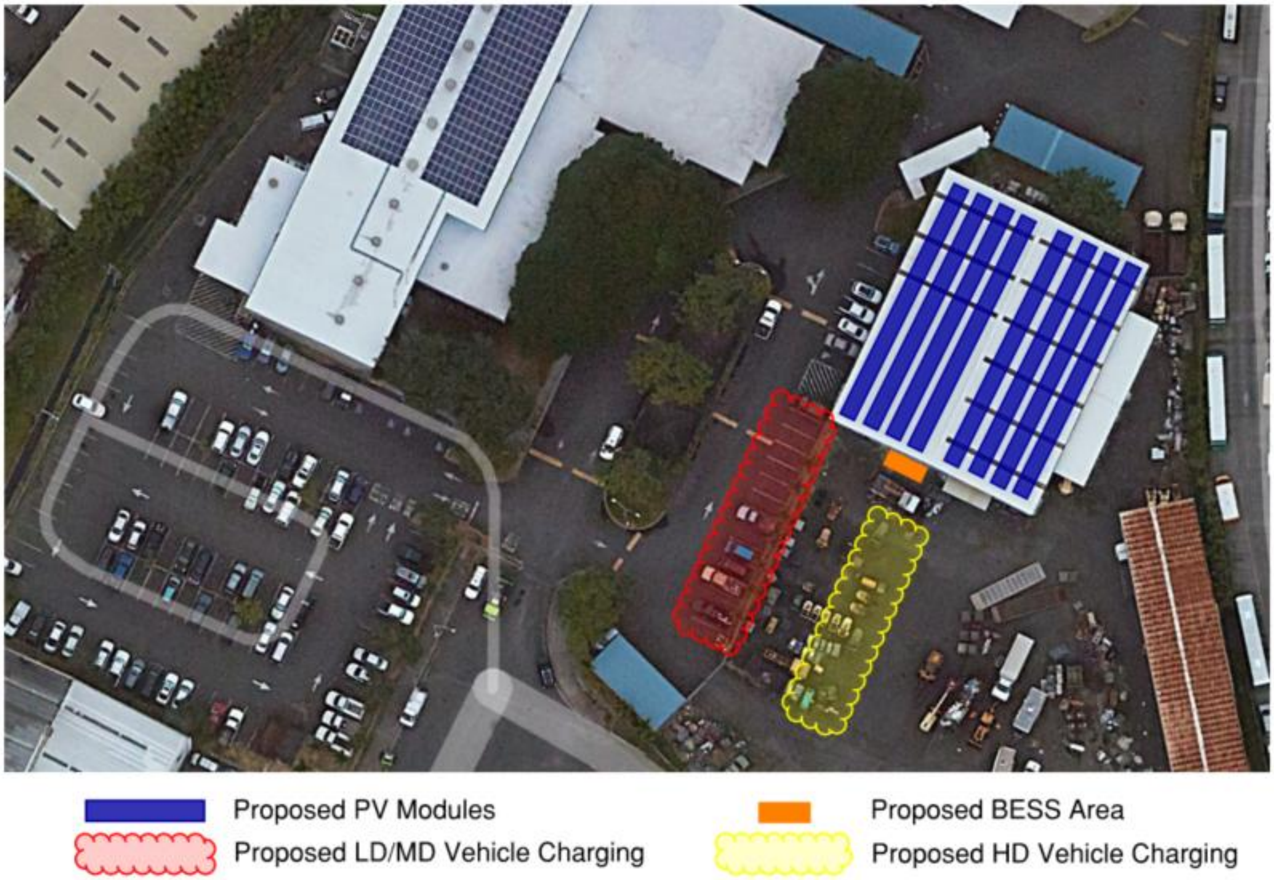
Table 114. WCM Performance Results - CSD Administration Office

Water Conservation Measure	Assumptions	
	CapEx (2025$)	Annual Water Savings (gallons)
Replace toilets/ water closets	$2,046	27,339
Replace urinals	$682	9,266
Replace lavatory faucets	$551	1,976

F.4.3 Solar PV and BESS

The Central Services Division Administration Office consists of 2 adjacent buildings. An existing 100 kW PV system is installed on the larger of the two buildings. Both sides of the sloped metal roof on the second (east) building were considered for a potential PV system. Accounting for setbacks and other existing obstacles, an estimated 74 kW could be installed on each side of the roof (Figure 54).

Figure 54. Central Services Division – Administration Office Concept Solar and EV Layout



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software as discussed under the Solar Analysis Methodology. The annual building consumption for the past year is approximately 339,000 kWh. The initial HOMER analysis indicates that a 148 kW DC nameplate PV system would be optimal.

HOMER model results indicate that multiple PV system configurations possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems tend to also have favorable payback periods but only provide a marginal increase in renewable fraction due to the limited amount of PV captured by the battery system.

The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 115.

Table 115. Central Services – Administration Office Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (HE Sch J - Smart Export)*	339,000	160,000	N/A	32
148 kW PV Only	280,900	377,000**	N/A	57.5
148 kW PV + 51 kWh BESS	268,500	377,000**	13,976	58.4

*Base Case Includes Existing 100 kW PV System

** Includes Generation from Existing PV System

Cost performance of the three system configurations is provided in Table 116.

Table 116. Central Services Division – Administration Office Renewables Cost Summary

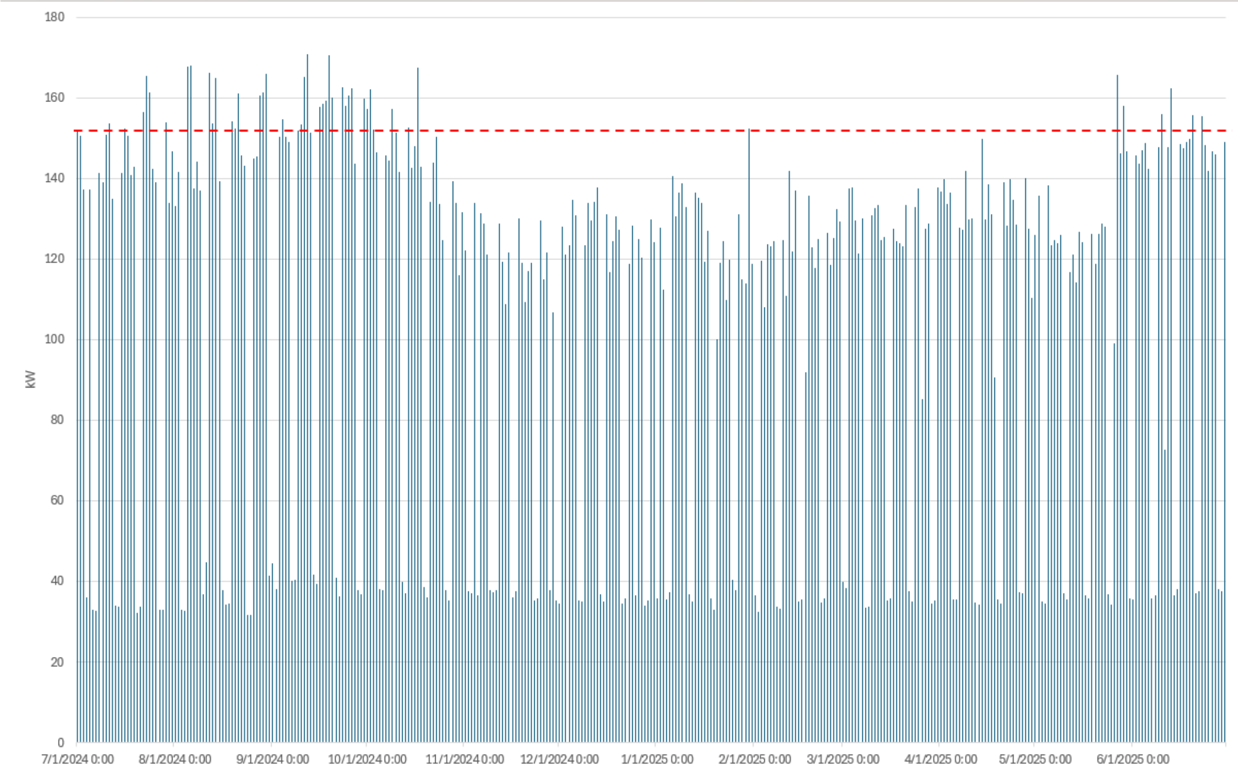
System Configuration	CAPEX	Net Present Cost ($)	IRR (%)	Discounted Payback Period (yr)
Base Case (HE Sch J - Smart Export)*	N/A	2,260,000	N/A	N/A
148 kW PV	267,000	1,940,000	4	18.7
148 kW PV + 51 kWh BESS	297,000	1,930,000	5	16.9

*Base Case Includes Existing 100 kW PV System

F.4.4 Demand Management and Demand Response

15-minute interval data from the CSD Administration Office's Hawaiian Electric meter covering the 12-month period from July 2024 through June 2025 was assessed. The whole facility-level energy usage data allowed for an initial screening of the annual electricity demand profile. Electricity demand is a measure of the peak electrical load in the facility at any given point in time during the year. This annual load profile is used to identify the frequency of peak loads recorded at the facility that could be high enough to trigger a demand response event, providing an indicator of the suitability of the facility to participate in a demand response program.

Figure 55. Annual Electricity Demand Profile, CSD Administration Office



The CSD Administration Office has a base load demand of approximately 23-26kW but can spike as high as 170kW during the warmest months. There were more than 40 times during the course of the year where the peak demand met or exceeded 150kW. Although demand response events are not triggered based on a whole facility exceeding a specific threshold of demand, having at least a dozen high spikes in the year is an indicator that the facility is a candidate for demand response. Furthermore, the facility's Automated Logic building management system is capable of communicating with Hawaiian Electric and automatically curtailing loads at the facility. These conditions make the CSD Administration Office a good candidate for further discussions with Hawaiian Electric about participating in one of their demand response programs.

F.4.5 Vehicle Electrification

A total of 55 vehicles are housed at the CSD Administration Office; the assigned fleet is predominantly light-duty passenger vehicles with a mix of several larger medium- and heavy-duty vehicles. Table 117 provides the vehicle type, quantity, average daily mileage and equivalent BEB information for the vehicle data provided by the CSD Administration Office.

Table 117. CSD Administration Office Fleet Model Inputs

Vehicle Type	Fleet Count	Average Daily Mileage	BEV Equivalent Modeled	Battery Capacity	Range
Light-Duty Vehicles					
Sedan	8	16	Hyundai Ioniq 6	53 kWh	240 miles
SUV	1	9	Hyundai Ioniq 5	63 kWh	245 miles
Pick-Up Truck	18	20	Ford F-150 Lightning	98 kWh	240 miles
Passenger Van	9	21	Volkswagen ID.Buzz	91 kWh	231 miles
Medium and Heavy-Duty Vehicles					
Utility Truck	14	18	Lightning eMotors ZEV4 Utility Truck	105 kWh	110 miles
Boom Truck	1	5	Altec 4x2 eMV	210 kWh	135 miles
Flatbed Truck	1	11	Mullen 3	89 kWh	125 miles
Stake Truck	1	11	Battle Motors Electric Stakebed	240 kWh	150 miles
Refuse Vehicle	5	47	Peterbilt Model 520EV	400 kWh	100 miles
Total	**55**				

F.4.5.1 ENERGY REQUIREMENTS

Based on the energy modeling analysis results, a fully electrified vehicle fleet which includes light, medium and heavy-duty vehicles is expected to require roughly 1,904 kWh of energy daily to recharge vehicles with a daily peak power demand of 316 kW. The total daily energy and total daily power requirements are based on a mix of average and maximum daily requirements and assume that a portion of vehicles may experience maximum mileage, while others experience average mileage. Table 118 details average and maximum energy use and power requirements per vehicle type.

Table 118. Administration Office EV Fleet Energy and Power Requirements

Vehicle Type	Fleet Count	Average Daily Energy Requirements per Vehicle	Maximum Daily Energy Requirements per Vehicle	Total Daily Energy Requirements	Total Daily Power Requirements
Light-Duty Vehicles					
Sedan	8	8.6 kWh	17.3 kWh	86.4 kWh	28.8 kW
SUV	1	9.4 kWh	18.8 kWh	11.8 kWh	3.6 kW
Pick-Up Truck	18	8.6 kWh	17.2 kWh	192.9 kWh	64.8 kW
Passenger Van	9	8.3 kWh	16.5 kWh	93.1 kWh	32.4 kW
Medium and Heavy-Duty Vehicles					
Utility Truck	14	23.2 kWh	46.4 kWh	405.7 kWh	50.4 kW
Boom Truck	1	28.0 kWh	56.0 kWh	35.0 kWh	3.6 kW
Flatbed Truck	1	19.2 kWh	38.4 kWh	24.0 kWh	3.6 kW
Stake Truck	1	43.2 kWh	86.4 kWh	54.0 kWh	3.6 kW
Refuse Vehicle	5	188.0 kWh	236.8 kWh	1001.0 kWh	125.0 kW
Total	**55**			**1903.8 kWh**	**315.8 kW**

Table 119 details the average and maximum percentage of battery capacity used daily per vehicle type.

Table 119. Administration Office Battery Usage per Vehicle Type

Vehicle Type	Electric Equivalent	Maximum Battery Capacity	Average Daily Use	Average % Use	Maximum Daily Use	Maximum % Use
Light-Duty Vehicles						
Sedan	Hyundai Ioniq 6	53 kWh	8.6 kWh	16%	17.3 kWh	33%
SUV	Hyundai Ioniq 5	63 kWh	9.4 kWh	15%	18.8 kWh	30%
Pick-Up Truck	Ford F-150 Lightning	98 kWh	8.6 kWh	9%	17.2 kWh	18%
Passenger Van	Volkswagen ID.Buzz	91 kWh	8.3 kWh	9%	16.5 kWh	18%
Medium and Heavy-Duty Vehicles						
Utility Truck	Lightning eMotors ZEV4 Utility Truck	105 kWh	23.2 kWh	34%	46.4 kWh	69%
Boom Truck	Altec 4x2 eMV	210 kWh	28.0 kWh	21%	56.0 kWh	42%
Flatbed Truck	Mullen 3	89 kWh	19.2 kWh	34%	38.4 kWh	68%
Stake Truck	Battle Motors Electric Stakebed	240 kWh	43.2 kWh	28%	86.4 kWh	56%
Refuse Truck	Peterbilt Model 520EV	400 kWh	188.0 kWh	73%	236.8 kWh	93%

F.4.5.2 CHARGING STRATEGY

Vehicles housed at the CSD Administration Office travel relatively low daily mileage on average. Based on these mileage assumptions, light and medium-duty vehicles can feasibly charge every 2 to 7 days to maintain the current operational parameters using AC Level 2 chargers with a power output of 3.6 kW per port. This would enable CSD to adopt a shared charging strategy using 10 dual-port chargers (20 ports total) that is cost-effective in terms of charging infrastructure, maintenance and fueling (recharging) costs. Refuse vehicles would need to recharge everyday using a dedicated port with a minimum power supply of 25 kW DC fast charging. The peak electrical load required for 20 Level 2 ports and five DCFCs is approximately 200 kW.

Table 120 details the required charging frequency per vehicle type.

Table 120. Central Services Division Administration Office Charging Requirements by Vehicle Type

Vehicle Type	Number of Vehicles	Charging Frequency	Max # of Vehicles Charging Per Day
Light-Duty Vehicles			
Sedan	8	Every 3 days	3
SUV	1	Every 4 days	1
Pick-Up Truck	18	Every 7 days	3
Passenger Van	9	Every 7 days	2
Medium- and Heavy-Duty Vehicles			
Utility Truck	14	Every 2 days	7
Boom Truck	1	Every 4 days	1
Flatbed Truck	1	Every 2 days	1
Stake Truck	1	Every 3 days	1
Refuse Truck	5	Every day	5

F.4.5.3 VEHICLE AND INFRASTRUCTURE IMPLEMENTATION STRATEGY

Fleet vehicles at the Administration Office are often kept in excess of 10 years, and vehicle and charger deployments can be staggered to align with planned vehicle replacements. However, any required upgrades to the site's underlying electrical infrastructure or underground conduit expansions necessary for EV charging infrastructure are recommended to be completed all at once to minimize redundant construction costs and multiple construction phases.

F.4.6 Financial Feasibility

Table 121 shows the discounted payback period along with the benefit cost ratio of applicable ECM, WCM, and PV/BESS projects for DAGS Central Services building. Exterior Lighting Replacement (ECM #2) has the shortest payback period for this facility at 5.2 years, which is followed by Complete Interior LED Lighting Retrofit (ECM #1) at 6.9 years. WCMs of toilet/water closet and urinal replacements have the longest payback period of 14.6 and 14.4 years respectively. A standalone PV replacement has a payback period of 18.7 years, while incorporating a BESS system to the PV decreases the payback period to 16.9 years.

Measures that have a payback period beyond the study period for DAGS Central Se include the installation of Lighting Occupancy Sensors (100% - 5,355 SQFT) (ECM #3) and lavatory faucets replacements.

Table 121. Efficiency and PV/BESS Results, DAGS CSD Administration Office

Measure ID	Improvement Type	DAGS Central Services	
		Payback Period (years)	Benefit Cost Ratio
DAGS Central Services – ECM #1	COMPLETE INTERIOR LED LIGHTING RETROFIT	6.9	3.4
DAGS Central Services – ECM #2	EXTERIOR LIGHTING REPLACEMENT (150W-220W)	5.2	2.8
DAGS Central Services – RE1	PV+BESS	16.9	1.7
DAGS Central Services – RE2	PV Only	18.7	1.6
DAGS Central Services – WCM2	Replace urinals	14.4	1.4
DAGS Central Services – WCM1	Replace toilets/ water closets	14.6	1.4
DAGS Central Services – ECM #3	LIGHTING OCCUPANCY SENSORS (100% - 5,355 SQFT)	N/A	0.6
DAGS Central Services – WCM3	Replace lavatory faucets	N/A	0.3

The discounted payback period analysis reveals notable variation across vehicle types, reflecting differences in capital costs, operating expenses, and energy efficiency. As shown in the table below, the sedan is immediately cost effective since the capital cost of an EV is lower than the ICEV. None of the other vehicles offer a payback under the discounted payback period analysis, primarily due to higher upfront costs and lower relative fuel efficiency. These results suggest that smaller vehicles may offer more favorable financial returns under current cost structures and energy prices, though operational needs and service capacity must also be considered in fleet planning.

Table 122. EVSE Financial Analysis Results, DAGS Central Services

Vehicle Type	Breakeven	Useful Life	Calculated Breakeven Year
Sedan	Immediate	12	0.0
Pick-Up Truck	Exceeds useful life	12	15.5
SUV	Beyond study period	12	N/A
Passenger Van	Exceeds useful life	12	24.0

For the CSD Administration Office, the total cost of implementation is $3.3 million in 2025 dollar terms, including the unit costs of individual chargers and the total vehicle cost to convert current ICEVs to EVs on a 1:1 basis, assuming all vehicles are purchased in a single year. This reflects a $1.8 million premium over a baseline scenario where vehicles are not transitioned to EVs and no chargers are installed. This result, along with the discounted payback period results shown above, suggest that the incrementally higher capital costs may not be offset by operating and maintenance cost savings of operating an EV fleet.