Crafton Hills College
NZE Implementation Plan

P2S Project #1083

Issued May 14, 2021

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CHAPTER 1

Executive Summary

BACKGROUND AND SCOPE

San Bernardino Community College District (SBCCD) serves 27,000 students through Crafton Hills College and San Bernardino Valley College. Since 1926, the District has provided access to affordable, award-winning higher education and career training programs for families in 22 cities and communities in the Inland Empire.

The District has embarked on an aggressive facilities master plan that provides the campus with improved and expanded facilities and resources over the next twenty years. A total of approximately 490,000 square feet is planned to be added to the campus inventory as part of this proposed Long Range Development Master Plan. The projected build out of the campus is expected in 2040.

This growth at the campus will have a tremendous impact on the current campus systems and will result in increased use of fossil fuels, potable water use, depletion of green space, requirement of more goods and services, generation of more waste and increased use of vehicles at the campus. All these factors will contribute to an increase in the greenhouse gas emissions if the campus plans to maintain status quo and conduct its business as usual. In addition, the campus would experience:

- Reduction in overall enrollment and revenues due to lack of sustainable facilities and practices
- Higher utilities cost in operating facilities (in absence of reducing energy imports and becoming energy independent)
    - Electricity
    - Water
    - Natural gas
- Carbon tax for offsetting carbon emissions leading to additional annual costs (due to lack of alternative transportation, energy efficiency, alternative/renewable energy sources etc.)
- Higher deferred maintenance costs and infrastructure costs

The proposed campus growth planned as part of the long range development master plan needs to be accommodated in a sustainable way by minimizing use of fossil fuels, minimizing natural resources, efficient use of land and reuse of existing facilities, minimizing waste and promoting alternative transportation.

SBCCD contracted with P2S Engineering to develop a Net Zero Energy Implementation Plan (NZE) that would outline goals, strategies, and tactics based on current and future best practices to promote this culture of sustainability throughout the campus, minimize greenhouse gas emissions and help migrate the campus towards a carbon neutral campus by 2045.

The Plan applies to all facets of the District, including the College departments and facilities, students, faculty, staff, former students and campus visitors. This plan was constructed from a variety of sources including review of sustainability programs at other leading universities/ Colleges, review of data provided by the campus, interviews with facilities staff, and the Association for the Advancement of Sustainability in Higher Education Sustainability Tracking and Rating System (STARS).

PLAN DEVELOPMENT

The Net Zero Energy Implementation was developed based on data gathered on campus through existing documents, information provided by the campus, discussions with facility staff and directions provided by the campus Administration.

Other relevant environmental and sustainability policies and programs were also consulted, such as the CCC Governors Sustainability Policy and the American College and University Presidents' Climate Commitment (ACUPCC). The Plan incorporates criteria from each of these sources to allow for possible future fulfillment and make this Plan relevant to the vision and mission of the campus and the District Active Stakeholder participation was promoted to not only build a sense of ownership, but provide key insights to promote the successful implementation of the Plan.

The campus will use this document to guide campus's path to promoting sustainable practices and moving the campus and hence the District towards carbon neutrality.

Implementation plan for each component and target are included in the Plan. The Plan provides a roadmap by which to achieve carbon neutrality goals and enhance long-term social, environmental and financial stewardship identified and committed to by campus.

The overall priorities of this plan include promoting energy efficiency, electrification and renewable energy and storage systems to not only provide reduction in green house gas emissions (GHG) but also make each of the campuses self reliant, shield them against the rising utility prices and limit their dependence on utility power.

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The ZNE Plan also supports the goals outlined in the State Chancellor's Office of Sustainability Policies, incorporates applicable best practices drawn from analogous campuses. and include continuous facility optimization, operations improvements with an ultimate goal to recommend a financially sustainable energy mix (portfolio) for the District.

The plan was developed via a collaborative approach between all appropriate stakeholders. The team met weekly through online collaboration tools and/or in-person to develop tasks and provide project updates. The collaboration allowed the team to understand all aspects affecting the energy master plan and work through opportunities and solutions. In addition to weekly meetings, the team provided monthly updates to the District to review progress and receive additional input.

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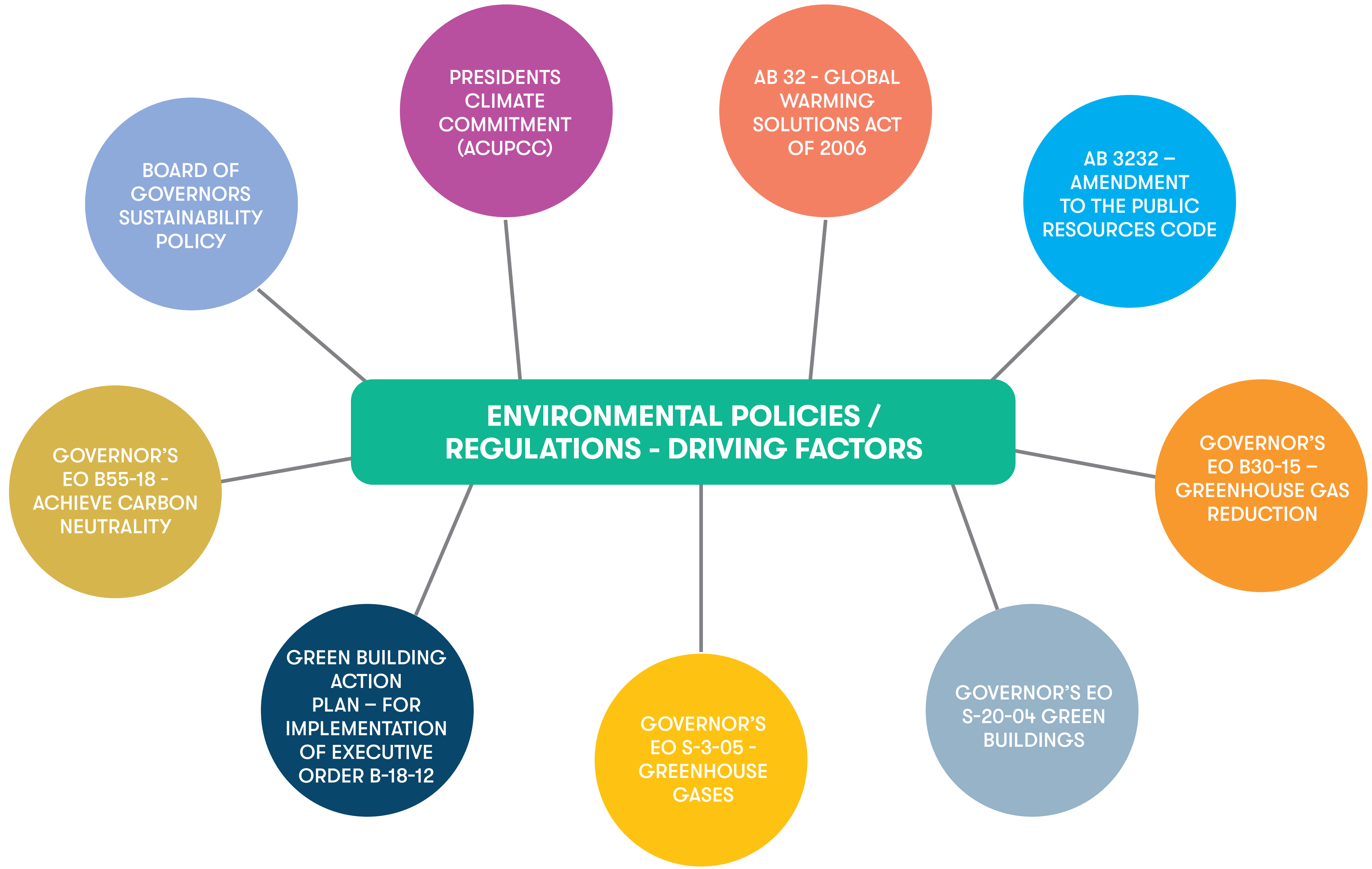
ENVIRONMENTAL POLICIES / REGULATIONS - DRIVING FACTORS

It is evident that climate change has become a main focus in the pursuit of sustainable solutions. As more evidence grows on the significant changes in the weather patterns in the past few decades and the impacts it has on disrupting human and natural systems far more quickly then what has been predicted, actions need to be made in order to maintain efforts in eliminating greenhouse gas emissions.

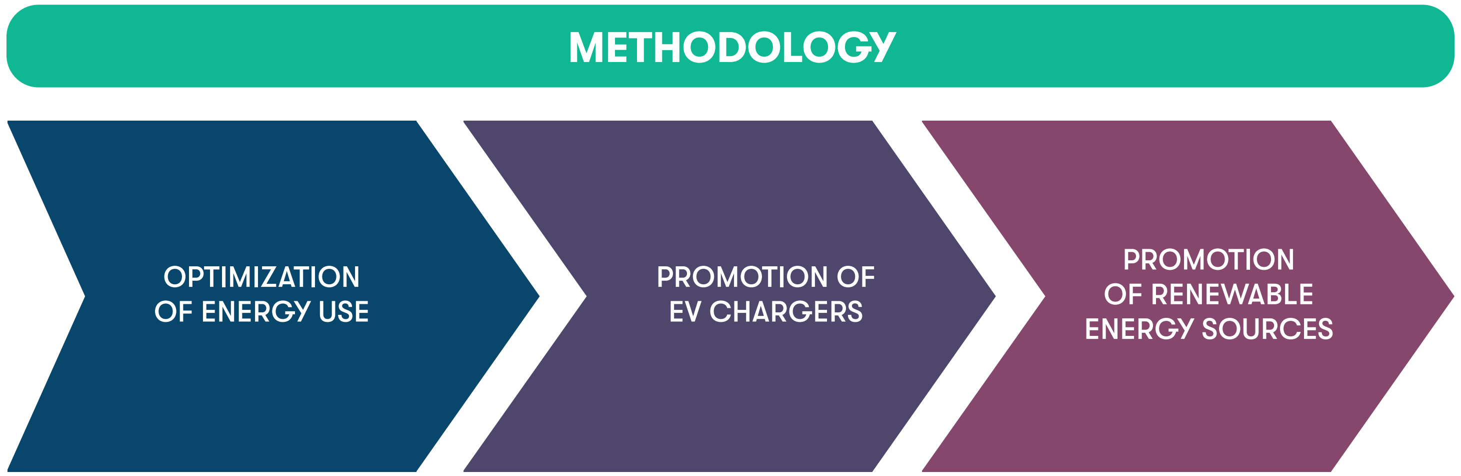
A combination of government reinforcing policies and Districts taking their own steps to sustain this world through efforts around their own campuses to further reduce these emissions are an important step towards minimizing the effect of climate change. These policies and regulations are depicted In the graphic below:



METHODOLOGY

A NZE campus is defined as a campus that generates as much energy on site as it consumes over the course of the year on a source basis. The definition was adopted by Department of Energy (DOE) and converts all energy sources into common units of kBtu using national average conversion factors.

The following methodology was adopted in formulating the NZE plan.



OVERVIEW OF FINDINGS AND ANALYSIS

Greenhouse gas emissions, typically caused from the burning of fossil fuels such as coal, natural gas, and oil, are generally recognized as contributing factor to the climate change experienced over the years. It is thus important to be good stewards and minimize the use of these fuels by promoting energy conservation, providing clean renewable sources to offset overall energy use and minimizing natural gas consumption by promoting electrification. Several legislations and programs have been implemented into action to track and encourage Educational Institutions to minimize their greenhouse gas emissions while promoting the research and educational efforts of higher education to equip society to-stabilize the earth's climate   Consistent with these legislations and programs, the campus is adopting an aggressive role to promote an NZE campus. To meet this campus objective, P2S was contracted by the District to develop an NZE implementation plan for the campus that not only provides a clear roadmap of achieving an NZE status but is practical and identifies clear measures to be adopted along with their source of funding.

Following approach was adopted in developing the subject implementation plan:

- Identifying and prioritizing energy conservation measures to minimize overall energy consumption and associated greenhouse gas emissions at the campus
- Evaluating renewable energy sources, identifying locations of providing these at the campus and analyzing their v and delivery methods
- Promoting the provision of electric vehicle charging stations to minimize overall green house gas emissions
- Setting standards for future facilities to be NZE facilities

Following is an overview of our findings and analysis in achieving an NZE status for the campus:

P2S conducted an audit of the existing MEP systems currently serving each of the facilities at the campus and identified energy conservation measures and associated costs and paybacks for each of the measures. The implementation of the recommended measures will not only reduce overall energy consumption but also reduce associated greenhouse gas emissions and bring the campus closer to becoming an NZE campus. Following is a table providing a list of recommended energy conservation measures along with associated reduction in greenhouse gas emissions, cost savings and paybacks.

The savings are primarily in the retrofit of existing light fixtures, retro commissioning and mechanical upgrades.

An analysis of the various in site generation sources revealed that PV system would be the most economical and the right renewable energy source to achieve net zero energy status.

An analysis of the existing and future electrical demand at the campus was undertaken to determine the capacity and viability of providing photovoltaic systems at the campus to achieve net zero energy status.

The campus already has a solar farm installed on the north east side of the campus. A total of six areas on the north east side are populated with ground mount concentrator PV system and integrated with the campus 4160V system. A total of 1.21MW and 1,561,545 kWh is currently being generated annually by the existing solar farm. Discussions with campus and an evaluation report undertaken in 2019 reveal that almost 15-20% of the concentrator PV system do not function as designed and intended and are awaiting parts to enable them track the sun and optimize their production.

A review of the campus buildings rooftops, ground areas around the campus and the parking lots and discussions had with the District and campus personnel revealed that the most optimum location for the campus to provide PV systems in phase 1 would be at the following areas as depicted in the proposed solar system exhibit. Consideration was given to aesthetics, costs, existing roof condition, effective utilization of the areas to maximize production and its proximity to the campus infrastructure.

- Area 2, 3, 4, & 6 (Solar Farm area on the north east side of the campus)

The replacement of the existing solar farm area with ground mount stationary PV systems will produce approximately 95% of the overall source energy utilized by the campus annually in kBtus.

As the rest of the concentrator PV solar farm areas experience failures and the overall production degrades, we recommend the same be replaced in phases to not only effectively utilize the current area but also maximize overall kW and kWh production to achieve net zero energy status. A total of 1154 kW can be replaced with 2,120kW thus not only increasing the overall efficiency of utilization of the current areas but also increasing overall kW and kWh production. The replacement of the existing solar farm areas with ground mount stationary PV systems will produce approximately 100% of the overall source energy utilized by the campus annually in kBtus. The campus can evaluate the second phase comprising of Parking lots, and new building rooftops to enhance PV production in the future as the demand increases and offset the remaining energy use at the campus.

A review and analysis of the battery storage system integrated with proposed solar system was also conducted. Considering the electric utilities migrating to a 4-9pm peak Time-of-Use rates, Campus shall plan to add battery energy storage system to store the excess on site generation during daytime and utilize the stored energy to offset the demand during the 4-9pm period. Based on the existing demand and PV systems installed under phase 1, 740kW/2960kWh Battery Energy Storage System shall be integrated into the campus distribution system. The availability of enhanced self generation incentives due to location of the campus (Equity Incentives), the paybacks are really attractive to combine the solar system with the battery storage to not only offset the overall peak demand charges but also offset overall peak energy consumption charges and save overall operational costs. Payback analysis and associated costs for integrating the solar system with battery storage is included at the end of the section.

The campus can also evaluate the provision of solar charging stations to not only demonstrate their commitment towards green power and towards fulfilling the campus goal of reducing carbon emissions but also providing a clean and renewable source of energy for charging the multitude of mobile devices typically found on campus while offering much needed shade.

The provision of the subject PV systems will limit dependence of the campus on non-renewable power sources, reduce greenhouse gas emissions and eliminate the impact of fluctuation of energy prices in the future.

The overall PV system installations comprising of solar farm areas, indicated parking lots and new building rooftops would offset 100% of the current energy consumption in kBtu's comprising of both electric and gas consumption and reduce campus carbon emissions by 1,695 metric tons per year.

GROUP 1 PV SYSTEMS FINANCIAL ANALYSIS

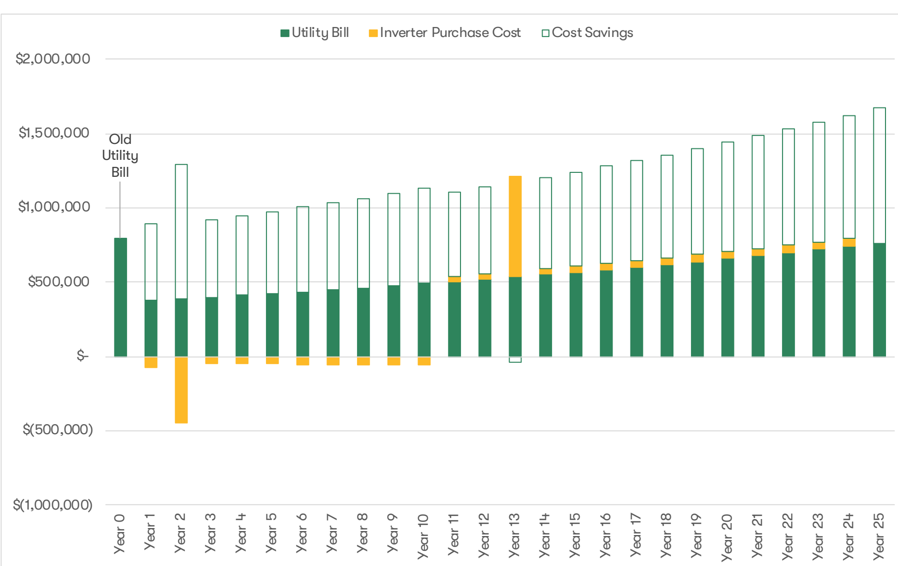
CHC GROUP 1	
PV SYSTEM SIZE (KW)	2,120
TYPE	GROUNDMOUNT
ANNUAL ENERGY GENERATED [KWH]	4,056,468
OVERALL CAMPUS ELECTRIC CONSUMPTION OFFSET (%)	97.9%
AVERAGE ANNUAL GENERAL FUND SAVINGS	$574,253
GHG OFFSET (LBS)	6,337,734

3,177,411	Pounds of coal burned
282,392	gallons of diesel consumed
7,224,810	Miles driven by an average passenger vehicle
978	Tons of waste recycled instead of landfilled
108,956	Incandescent lamps switched to LEDs
47,535	tree seedlings grown for 10 years

Cash Purchase (PV Only)

CASH PURCHASE	
SYSTEM COST	$4,452,000
AVERAGE ANNUAL GENERAL FUND SAVINGS *	$574,253
GENERAL FUND SAVINGS (YEAR 1)	$422,319
ANNUAL O&M COST (YEAR 1)	$30,000
BREAKEVEN PERIOD (YEARS)	10.2
CUMULATIVE GENERAL FUND SAVINGS (25 YEARS)*	$14,356,322

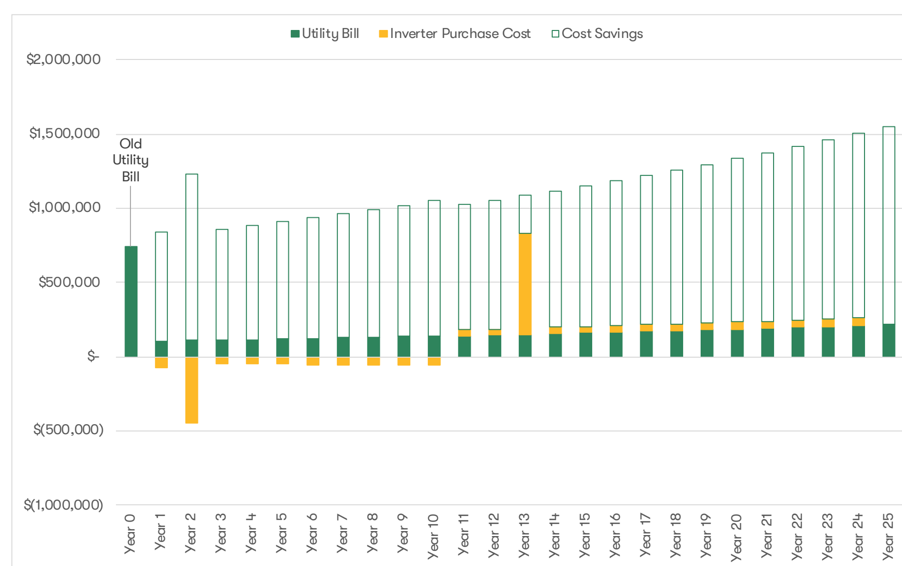
* ACCOUNTS FOR INVERTER REPLACEMENT AND M&O COSTS
UTILITY RATE ESCALATION - 2.5%
PV DEGREDATION OUTPUT - 0.5%



Cash Purchase (PV & Battery)

CASH PURCHASE	
BATTERY ENERGY STORAGE SYSTEM SIZE (KWH/KW)	2958KWH/739KW
SYSTEM COST	$7,550,763
AVERAGE ANNUAL GENERAL FUND SAVINGS *	$814,815
SCE BESS SGIP EQUITY RESILIENCY INCENTIVE	$2,479,000
GENERAL FUND SAVINGS (YEAR 1)	$632,253
ANNUAL O&M COST (YEAR 1)	$30,000
BREAKEVEN PERIOD (YEARS)	7.8
CUMULATIVE GENERAL FUND SAVINGS (25 YEARS)*	$20,370,363

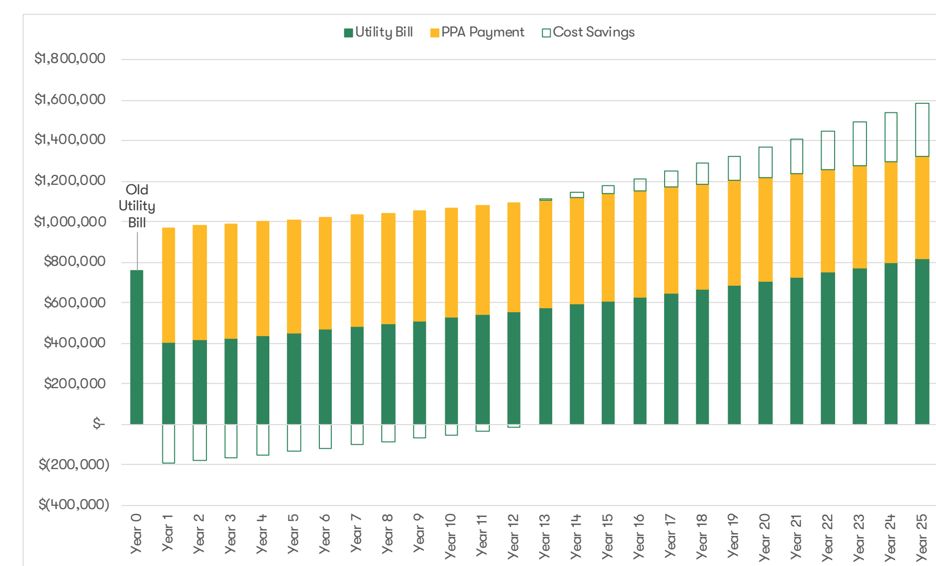
* ACCOUNTS FOR INVERTER REPLACEMENT AND M&O COSTS
UTILITY RATE ESCALATION - 2.5%
PV DEGREDATION OUTPUT - 0.5%



PPA Payment (PV Only)

PPA PURCHASE	
PPA RATE	$0.14 PER KWH
PPA PAYMENT (YEAR 1)	$566,885
TERM (YEARS)	25
AVERAGE ANNUAL GENERAL FUND SAVINGS	($90,412)
BREAKEVEN PERIOD (YEARS)	N/A
CUMULATIVE GENERAL FUND SAVINGS (25 YEARS)	($2,260,291)

PV DEGREDATION OUTPUT - 0.5%



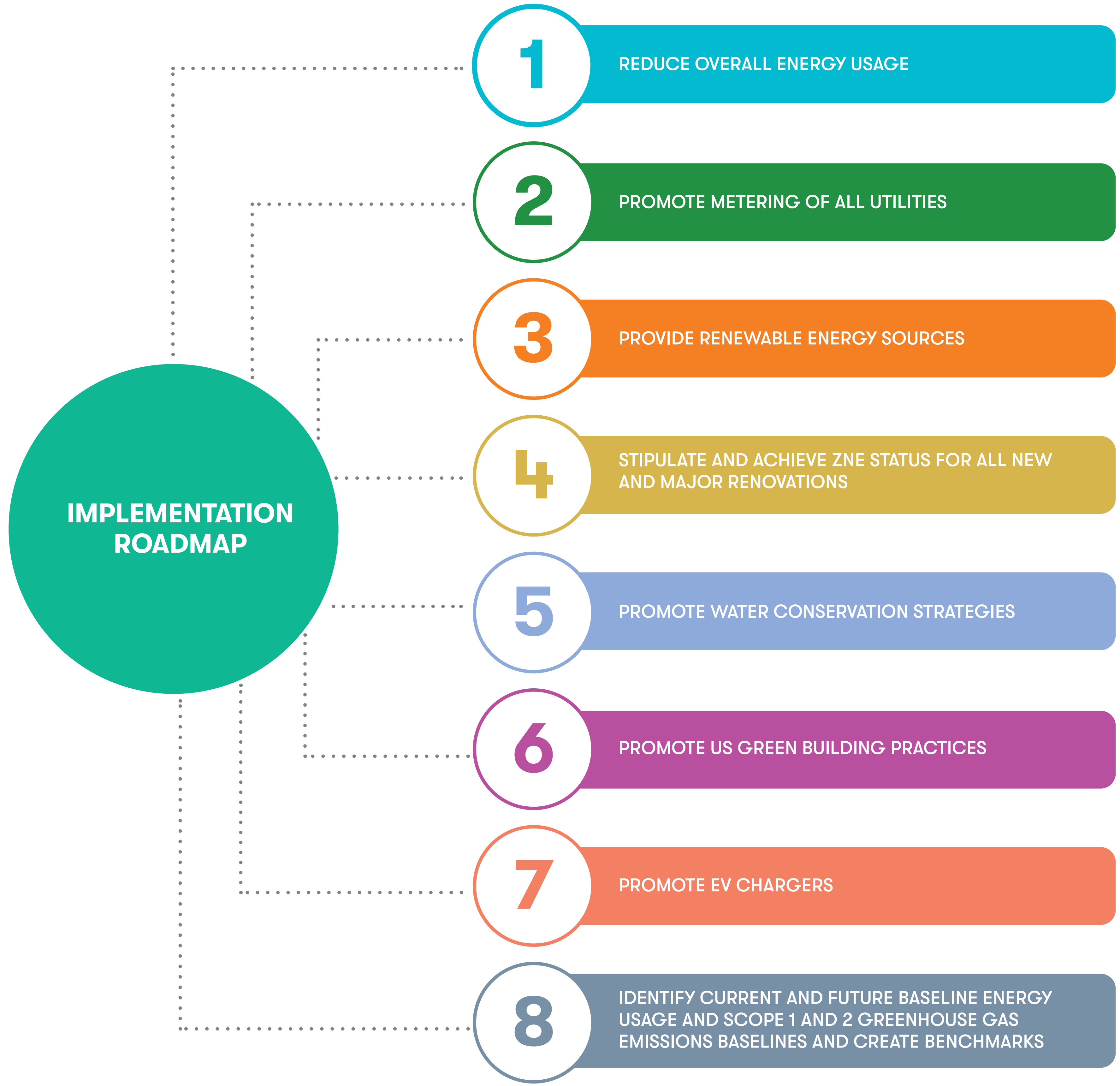
IMPLEMENTATION ROADMAP

The following is an implementation roadmap for achieving NZE status at the campus. The primary objective or target is to promote electrification and offset overall energy usage in kBtu's by implementing overall energy reduction measures at each of the buildings and providing renewable energy sources to achieve overall net zero energy (NZE) status on a source basis.

The most critical aspect of any NZE plan is the tracking of the efforts and ensuring each of the action plans presented get implemented. This implementation plan specifically addresses the importance of maximizing energy efficiency, promoting renewable energy sources, promoting electrification, promoting water conservation strategies and create sustainable and net zero energy facilities at the campus. tracking aspect of GHG emissions. In order to effectively address the action plans the District must first identify the current standing in terms of GHG emissions and the resulting effects of individual action plans. This plan would allow for a quantification of GHG reductions and be able to compare the reduction to the cost associated with the efforts to best determine practices that are within the target area and practical in implementation.

The major aspect is to set an example so that more Educational Institutions can make substantial efforts to improve sustainability and achieve NZE status and in turn receive tangible valuable results both environmentally and economically.

Upon acting on each of the individual plans outlined above, the campus would be in a position to continually reduce the overall effect of greenhouse gasses on climate change.



REPORT OVERVIEW

Our following Net Zero Energy Implementation Plan provides an analysis of the existing energy baseline of the campus, identifies energy conservation measures and their associated costs and paybacks, evaluates the provision of EV chargers and its impact on the existing electrical infrastructure and identifies potential for promoting renewable sources at each of the campus to achieve carbon neutrality. The plan also provides a roadmap for the campus to achieve an NZE status along with potential costs, delivery methods and available funding sources. An overview of the chapters forming our plan is provided below.

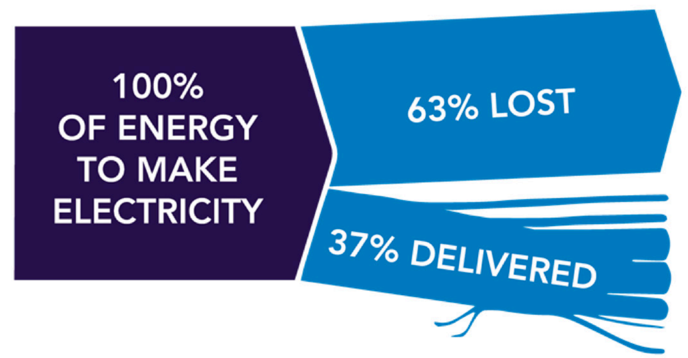
Chapter 2 provides description of existing MEP systems serving existing facilities at the campus, our findings and ASHRAE Level 1 audit results, EUI baselines and targets and recommended energy conservation measures and their associated costs and payback and applicable incentives and funding sources.

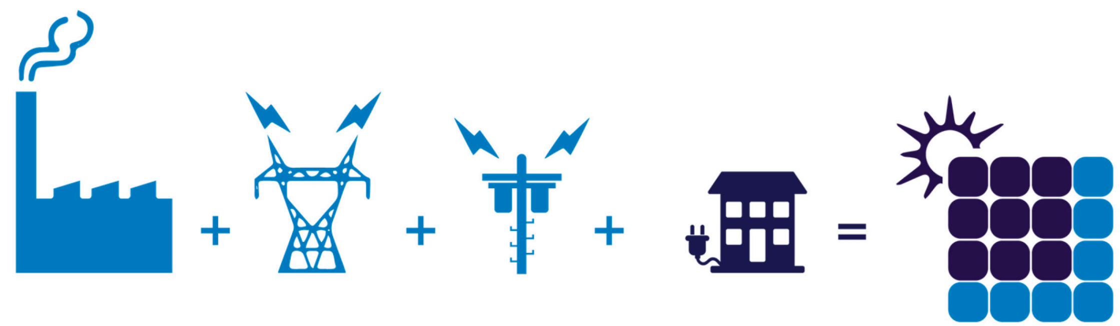
Chapter 3 provides a description of EV chargers, our phased implementation plan and recommendations for providing EV chargers at the campus and their impact on the current infrastructure.

Chapter 4 provides a description of available renewable energy sources and storage systems, our recommendations for providing these sources at the campus to achieve carbon neutrality and providing available funding sources and delivery methods.

Chapter 5 provides an overview of our findings and analysis, campus baselines and targets, a roadmap to implementing proposed NZE plan along with phased strategies and our recommendations along with potential costs, available incentives and funding sources.

Chapter 6 provides an overview of current and future emissions, benchmarking, strategies and technologies, high level action plan along with potential costs and funding sources.





SUMMARY OF OUR ANALYSIS AND RECOMMENDATIONS

The following action plan summarizes our analysis and our recommended solutions for the campus to support the implementation of a Net Zero Energy plan.

Priority 1	Projects within 2-5 years	Priority 3	Future Projects
Priority 2	Projects within 5 years		Ongoing Projects

Project Tracking #	Project	Phase	Proposed Year(s) of Execution	Brief Description of the Project	Priroty Level	Project Category	Total Projected Construction Costs ($) 1	Dollar Savings	Payback 2	Funding Source	Recommended Project Delivery Method and Funding Source
1	Energy Efficiency Upgrades	1A	2021-2024	Implementation of energy efficiency measures provided and detailed in Chapter 2 of the report with paybacks less than 10 years.	1	EE	$570,585	$62,978	9.4 years	On Bill Financing (OBF) and Cutomized Incentive Programs	Design Build with On Bill Financing
2	Provision of Group 1 PV Systems	1B	2021-2024	Implementation of PV systems in Group 1 areas as shown in PV Exhibit in Chapter 4	1	PV	$4.4M	$14.3M	10.2 years	Lease, PPA and Energy Loans	Design Build with Outright purchase
3	Provision of Group 1 PV & Battery Energy Storage System	1B-1	2021-2024	Implementation of PV systems in Group 1 areas as shown in PV exhibit in Chapter 4 and Battery Energy Storage System.	1	PV & Battery	$7.7M	$20.3M	7.8 years	Lease, PPA and Energy Loans	Design Build with Outright purchase
4	Provision of Metering	1C	2021-2024	Implementation of gas and electrical metering in each of the buildings at the campus to monitor existing energy consumption	1	EE	$630,000	N/A	N/A	On Bill Financing (OBF) and Cutomized Incentive Programs	Design Bid Build with Outright purchase
5	Provision of EV Chargers and Associated Infrastructure	2	2021-2024	Provision of EV Chargers and associated infrastructure as shown in EV Exhibit(s) in Chapter 3	2	EV	N/A	N/A	N/A	SCE Incentives and Grants	Design Bid Build with SCE Incentives and Grants
6	Provision of Group 2 PV Systems in Phases	3	2021-2024	Implementation of PV systems in Group 2 areas in phases as shown in PV Exhibit in Chapter 4	3	PV	$9.2M	$11.2M	$678,000	Lease, PPA and Energy Loans	Design Build with Outright purchase
7	New and Major Renovation of Facilities	Ongoing	Ongoing	Promoting sutainable strategies for new buildings and major renovations to achieve LEED Platinum and NZE certifications		New Buildings and Major Renovations	N/A	N/A	N/A	State and Bond Funds	

EXISTING SITE PLAN

PROPOSED SITE PLAN

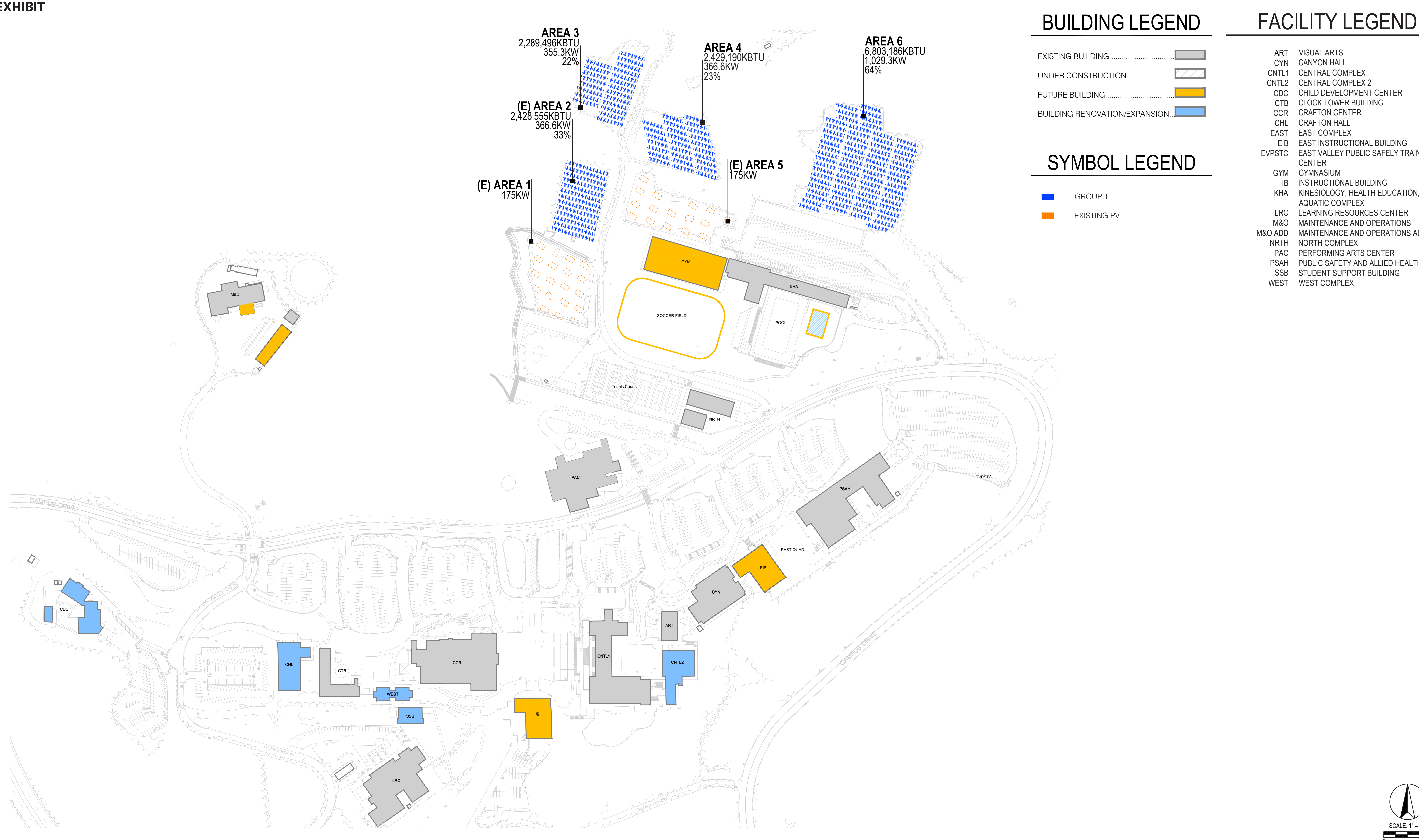
FACILITY LEGEND

ART	VISUAL ARTS
CYN	CANYON HALL
CNTL1	CENTRAL COMPLEX
CNTL2	CENTRAL COMPLEX 2
CDC	CHILD DEVELOPMENT CENTER
CTB	CLOCK TOWER BUILDING
CCR	CRAFTON CENTER
CHL	CRAFTON HALL
EAST	EAST COMPLEX
EIB	EAST INSTRUCTIONAL BUILDING
EVPSTC	EAST VALLEY PUBLIC SAFELY TRAINING CENTER
GYM	GYMNASIUM
IB	INSTRUCTIONAL BUILDING
KHA	KINESIOLOGY, HEALTH EDUCATION, AQUATIC COMPLEX
LRC	LEARNING RESOURCES CENTER
M&O	MAINTENANCE AND OPERATIONS
M&O ADD	MAINTENANCE AND OPERATIONS ADDITION
NRTH	NORTH COMPLEX
PAC	PERFORMING ARTS CENTER
PSAH	PUBLIC SAFETY AND ALLIED HEALTH
SSB	STUDENT SUPPORT BUILDING
WEST	WEST COMPLEX

BUILDING LEGEND

- EXISTING BUILDING
- UNDER CONSTRUCTION
- FUTURE BUILDING
- BUILDING RENOVATION/EXPANSION

PHASE 1 PV EXHIBIT



PHASE 2 PV EXHIBIT

BUILDING LEGEND

- EXISTING BUILDING
- UNDER CONSTRUCTION
- FUTURE BUILDING
- BUILDING RENOVATION/EXPANSION

SYMBOL LEGEND

- GROUP 2
- EXISTING PV

FACILITY LEGEND

ART	VISUAL ARTS
CYN	CANYON HALL
CNTL1	CENTRAL COMPLEX
CNTL2	CENTRAL COMPLEX 2
CDC	CHILD DEVELOPMENT CENTER
CTB	CLOCK TOWER BUILDING
CCR	CRAFTON CENTER
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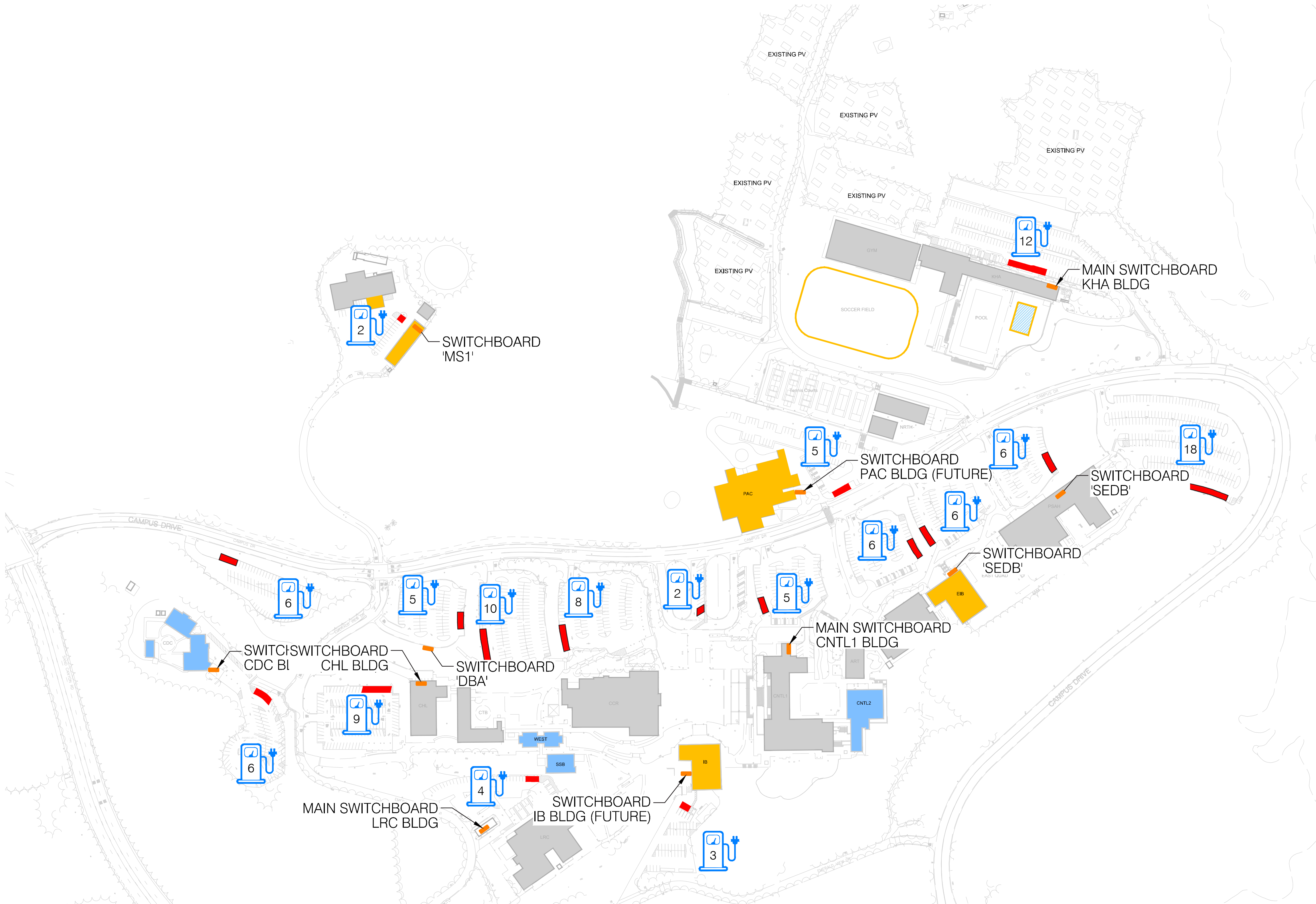
NRTH	NORTH COMPLEX
PAC	PERFORMING ARTS CENTER
PSAH	PUBLIC SAFETY AND ALLIED HEALTH
SSB	STUDENT SUPPORT BUILDING
WEST	WEST COMPLEX

SCALE: 1" = 30'

PROPOSED EV SITE PLAN



FACILITY LEGEND

ART	VISUAL ARTS
CYN	CANYON HALL
CNTL1	CENTRAL COMPLEX
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M&O	MAINTENANCE AND OPERATIONS
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NRTH	NORTH COMPLEX
PAC	PERFORMING ARTS CENTER
PSAH	PUBLIC SAFETY AND ALLIED HEALTH
SSB	STUDENT SUPPORT BUILDING
WEST	WEST COMPLEX

BUILDING LEGEND

EXISTING BUILDING.................................

UNDER CONSTRUCTION.......................

FUTURE BUILDING...................................

BUILDING RENOVATION/EXPANSION...

SYMBOL LEGEND

EV CAR CHARGER

EV CHARGING SPACES

SELECTOR SWITCH

EC CHARGER POC

SWITCHBOARD

Parking Lot	Parking Spaces	EV Spaces
A	74	5
B	137	10
C	120	8
D	23	2
E	74	5
F	80	6
G	83	6
H	79	6
I	252	18
J	173	12
K	128	9
L	85	6
M	80	6
N	62	4
P	57	5
R	46	3
M&O	35	2
Total	**1588**	**112**

0 300'

N

CHAPTER 2

Energy Use Benchmarking And Conservation Measures

CURRENT ENERGY USE AND TRENDS

Electricity

Electricity is supplied to Crafton Hills College (CHC) by one Southern California Edison (SCE) utility meters and an on-site 1.2 MW (megawatt) solar farm.

Figure 1 shows CHC's monthly energy usage in kWh from the previous 3 years (2017 to 2019) and peak kW demand of 2019 from the utility meter. The utility billing analysis excludes the year 2020 due to atypical usage from campus closure in response to COVID-19. The figure does not include solar production, only electricity imported from the utility.

During 2019, CHC imported a total of 2,636,039 kWh with a peak demand ranging between 672 kW and 1,152 kW from the utility grid. This usage does not reflect the solar farm production. The average monthly usage over the 12-month period is 219,670 kWh per month. The overall cost from the most recent 12 months is $380,810.29, resulting in a blended rate of $0.1445 per kWh.

Table 1 – Utility Meter Information

Meter Number	Rate	Service Address	City Name
359150-001340	TOU-8-S	11711 SAND CANYON RD	YUCAIPA
-	TOU-8-DL	11711 SAND CANYON RD	YUCAIPA

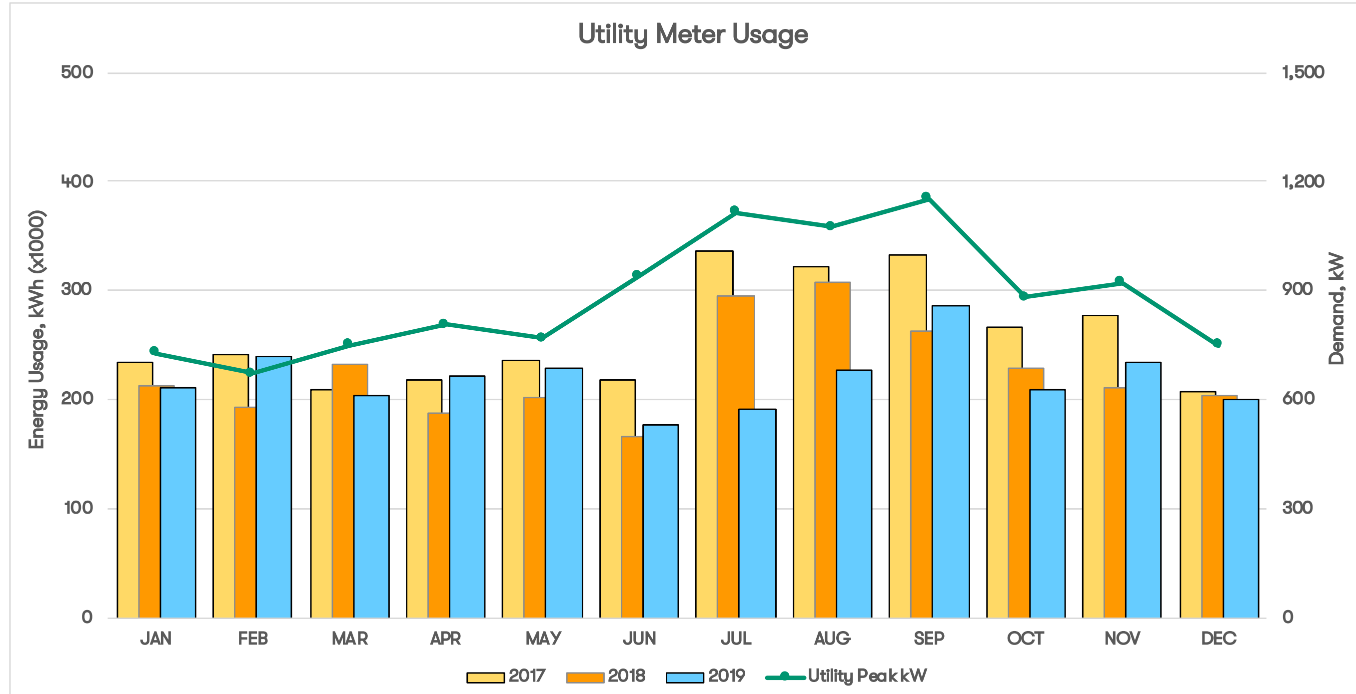


FIGURE 1 – MONTHLY ELECTRICAL USAGE IN KWH/DAY AND PEAK KW

Table 2 – 2019 Billing History

Month	Days	kWh	kWh/Day	Peak kW	Cost
JAN	29	212,035	7,312	730	$21,996.63
FEB	32	240,619	7,519	672	$23,602.79
MAR	29	204,782	7,061	749	$22,747.81
APR	30	221,770	7,392	806	$24,865.23
MAY	32	229,430	7,170	768	$24,700.68
JUN	29	177,840	6,132	941	$41,541.59
JUL	30	192,034	6,401	1,114	$44,650.84
AUG	29	227,645	7,850	1,075	$47,874.56
SEP	32	286,070	8,940	1,152	$53,571.77
OCT	30	208,738	6,958	883	$25,062.34
NOV	33	234,614	7,110	922	$27,759.65
DEC	30	200,462	6,682	749	$22,436.40
TOTAL:	**365**	**2,636,039**			**$380,810.29**

Normalized	$0.1445	$/KWH
	7,222	KWH/DAY
	$1,043.32	$/DAY

Annualized	$0.1445	$/kWh
	2,636,039	kWh/year
	$380,810.29	$/year

Figure 2 shows CHC's total monthly energy usage in kWh from 2017 to 2019 and utility kW demand. This figure includes both the utility meter usage and the solar farm production. The solar farm production data was sourced from SBCCD's Energy Dashboard.

During 2019, CHC consumed a total of 4,164,915 kWh with a peak demand ranging between 672 kW and 1,152 kW from the utility grid. The average monthly usage over the 12-month period is 347,076 kWh per month. The usage, demand, and cost are aggregated from the utility meter and the solar farm production.

Figure 3 shows CHC's monthly solar farm production in kWh from the previous 3 years (2017 to 2019). The solar farm production data was sourced from SBCCD's Energy Dashboard. The solar fam production for January 2017 to April 2017 was listed as zero on the Energy Dashboard.

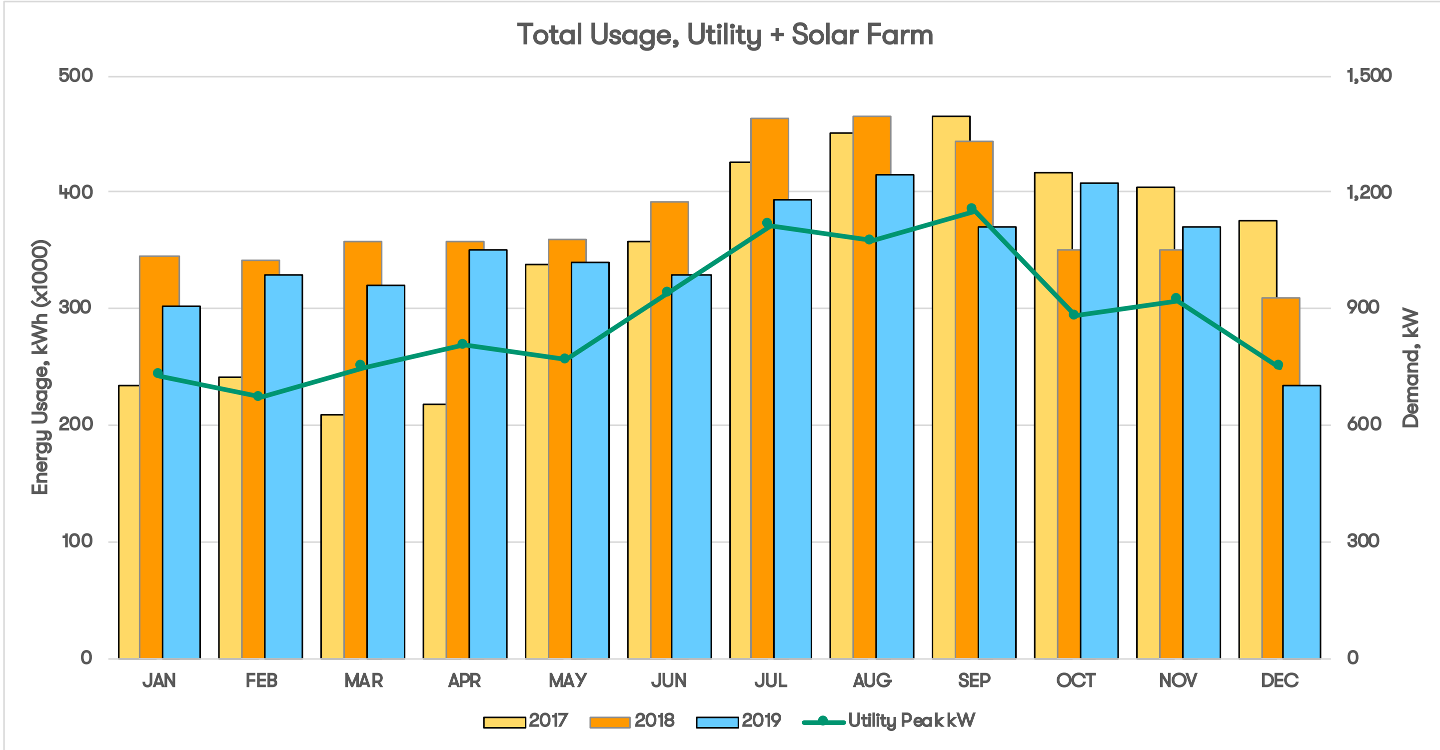


FIGURE 2 – MONTHLY ELECTRICAL USAGE IN KWH/DAY AND PEAK KW, UTILITY AND SOLAR FARM

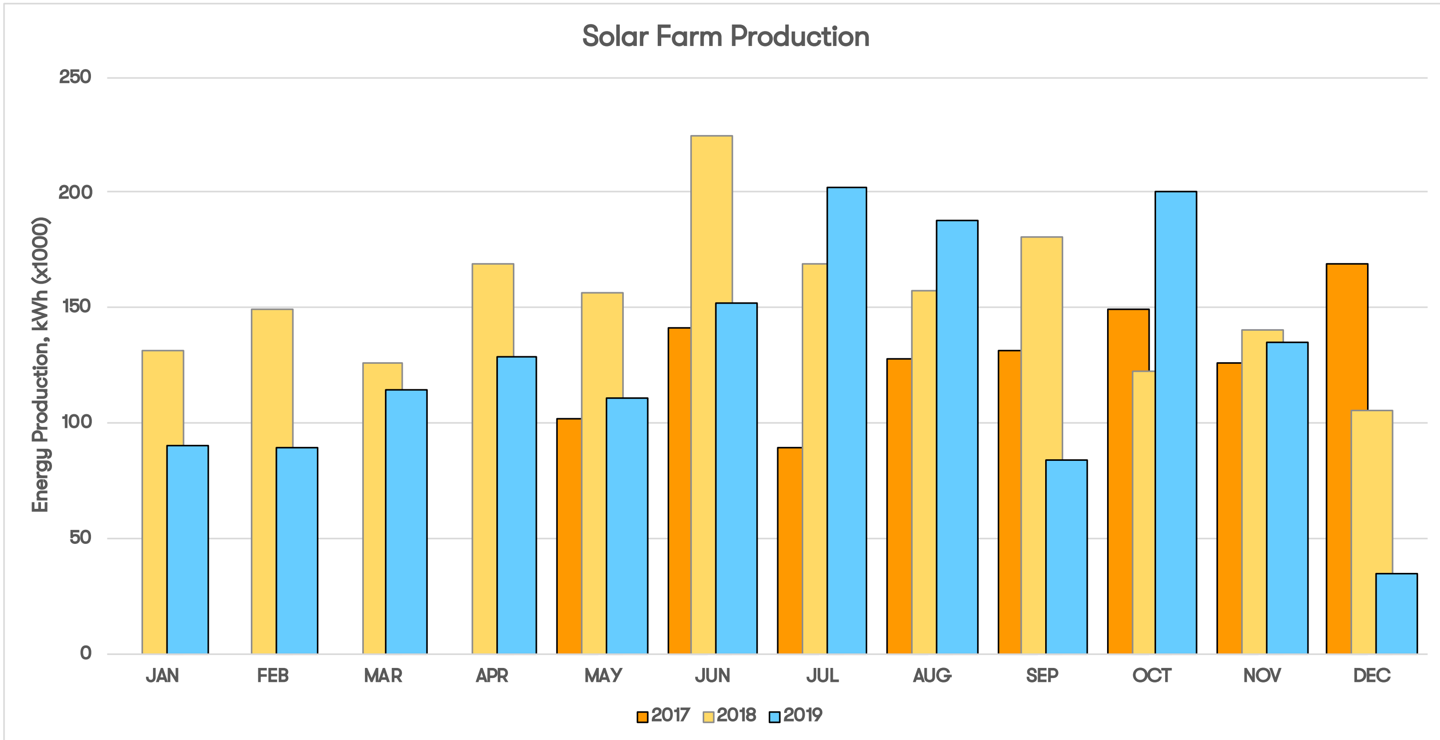


FIGURE 3 – MONTHLY SOLAR FARM PRODUCTION IN KWH/DAY

Natural Gas

Natural gas is supplied to CHC by Southern California Gas Company (SCG). Utility information, meter descriptions, and rate schedules were not available. The natural gas consumption and cost is sourced from the SBCCD's Energy Dashboard. The natural gas usage follows a seasonal trend with increased usage during winter months and decreased usage during summer months. There appears to be sustained baseload that may be attributed to domestic hot water and residual heating hot water consumption.

During 2019, CHC consumed a total of 145,182 therms. The average monthly usage over the 12-month period is 12,099 therms. The overall cost from the most recent 12 months is $103,034.99 resulting in a blended rate of $0.7097 per therm. The usage and cost are aggregated from SBCCD's Energy Dashboard.

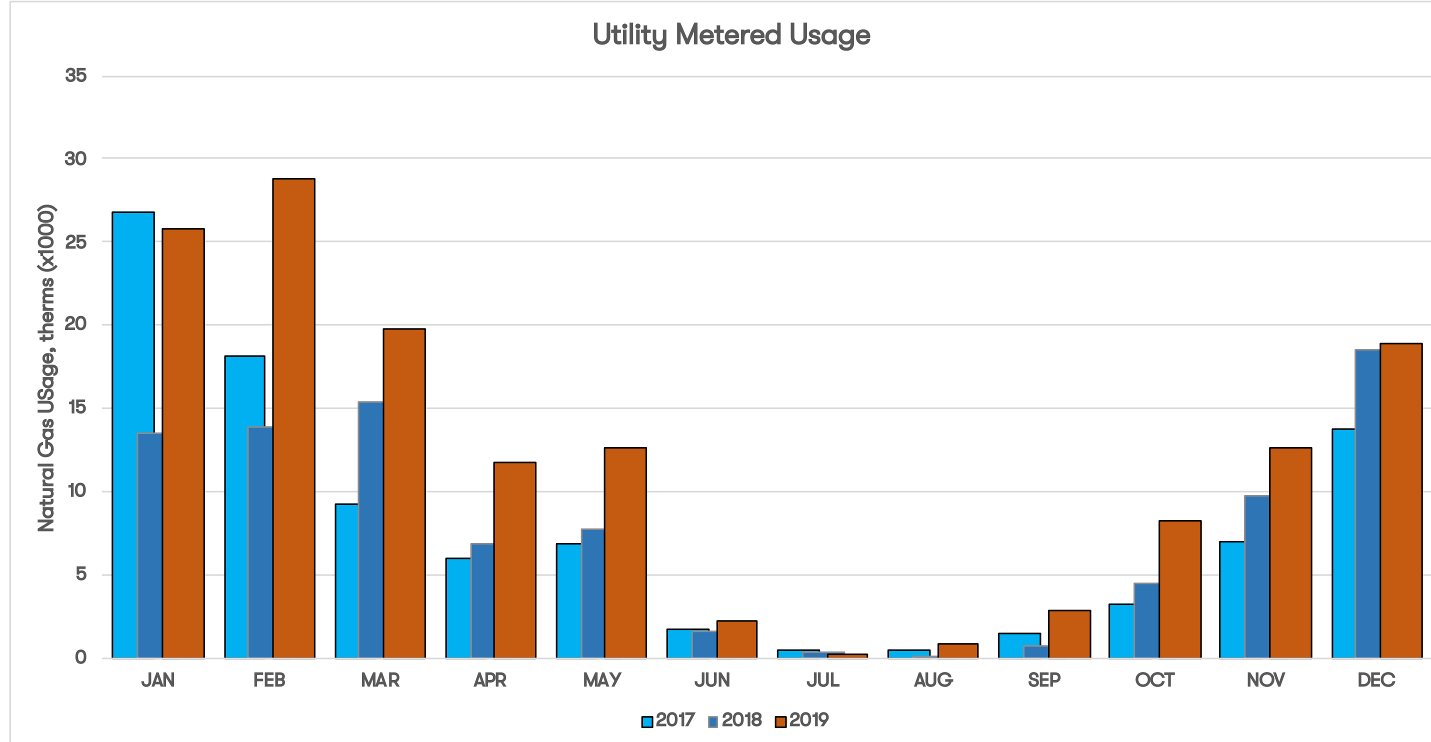


FIGURE 4 – MONTHLY NATURAL GAS USAGE IN THERMS/DAY

Table 3 – Most Recent 12 Months Billing History

Month	Days	Therm	Therms/Day	Cost
JAN	31	25,832	833	$19,004.58
FEB	28	28,762	1,027	$19,307.59
MAR	31	19,754	637	$14,824.58
APR	30	11,819	394	$8,120.60
MAY	31	12,626	407	$7,957.63
JUN	30	2,327	78	$1,941.08
JUL	31	317	10	$454.94
AUG	31	933	30	$826.21
SEP	30	2,939	98	$2,271.80
OCT	31	8,332	269	$5,939.48
NOV	30	12,617	421	$8,593.07
DEC	31	18,924	610	$13,793.43
TOTAL:	**365**	**145,182**		**$103,034.99**

Normalized	$0.7097	$/therm
	398	therm/day
	$282.29	$/day

Annualized	$0.7097	$/therm
	145,182	therm/year
	$103,034.99	$/year

Energy Use Intensity

The Energy Usage Intensity, EUI, is expressed as energy per square foot per year. It is calculated by dividing the total energy consumed by the building in one year (measured in kBtu) by the total gross floor area of the buildings.

For CHC, the energy usage is from electricity and natural gas. The annualized usage is converted to kBtu and divided by the total building area to determine the campus's EUI. Table 4 lists the energy consumption, EUI for each energy source, and overall site EUI.

Table 4 – EUI Calculation

Category	Usage/Year	kBtu	Site EUI, kBtu/SF
Natural Gas (therm)	145,182	14,518,200	39.2
Electricity (kWh)	4,164,915	14,210,690	40.1
	TOTAL:	28,728,890	79.3

Table 5 – Estimated EUI for Each Building

Building #	Building Name	Building SF	Energy Star Property Type	Estimated EUI, kBtu/SF
1	M&O	11,304	Non-Refrigerated Warehouse	23.7
2	CDC	9,010	Pre-school/Daycare	67.8
3	CHL	9,900	College/University	88.2
4	CTB	9,970	College/University	88.2
5	WEST	6,800	College/University	88.2
6	CCR	46,000	College/University	88.2
7	SSB	5,575	Office	55.3
8	LRC	59,100	Library	74.9
9	PAC	29,851	Entertainment	58.8
10	CNTL 1	30,621	College/University	88.2
11	CNTL 2	17,238	College/University	88.2
12	CYN	34,016	College/University	88.2
13	ARTS	9,842	College/University	88.2
14	EAST 1	5,760	College/University	88.2
15	EAST 2	4,320	Retail Store	108.2
16	PSAH	46,937	College/University	88.2
17	GYM*	27,250	Recreation/Athletic Centers	0.0
18	NRTH	10,334	College/University	88.2
19	KHA	15,911	Recreation/Athletic Centers	53.1

***Building is not in use / unoccupied**

Building Heat Map

Past Usage Trends

The annual electrical consumption from 2010 to 2019 is represented in Figure 5. CHC observed increased usage from 2013 to 2016. There was a significant reduction in energy usage in 2017 followed by an increase in 2018 and then a decrease 2019. The usage data was sourced from SBCCD's Energy Dashboard.

The annual natural gas consumption from 2011 to 2019 is represented in Figure 6. CHC observed steady usage decrease from 2011 to 2014 followed by increased usage until 2016. From 2016 to 2018, there was a steady decrease in usage. There was a significant increase in energy usage in 2019 to near 2011 levels. The usage data was sourced from SBCCD's Energy Dashboard.

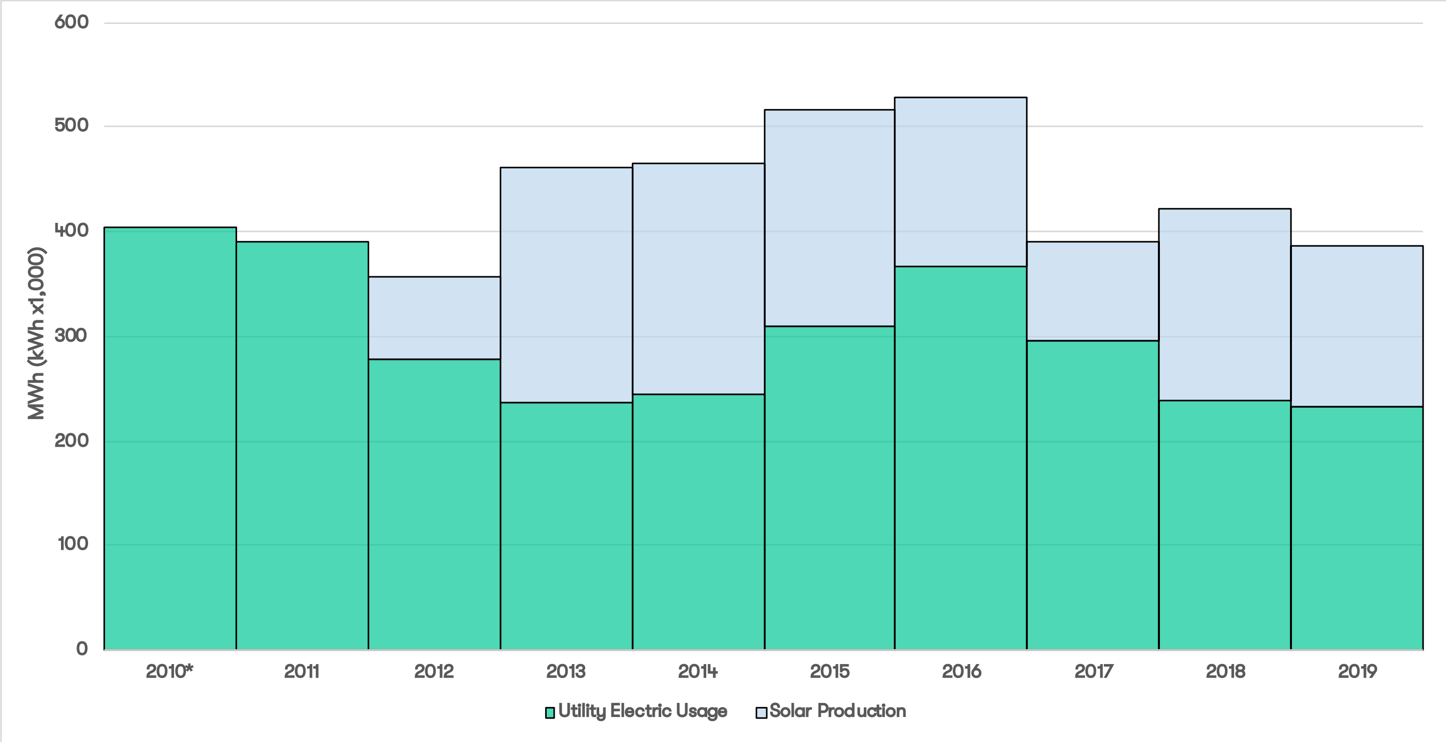


FIGURE 5 – ANNUAL UTILITY ELECTRIC USAGE
* USAGE FOR JANUARY 2010 THROUGH JUNE 2010 ARE ESTIMATED

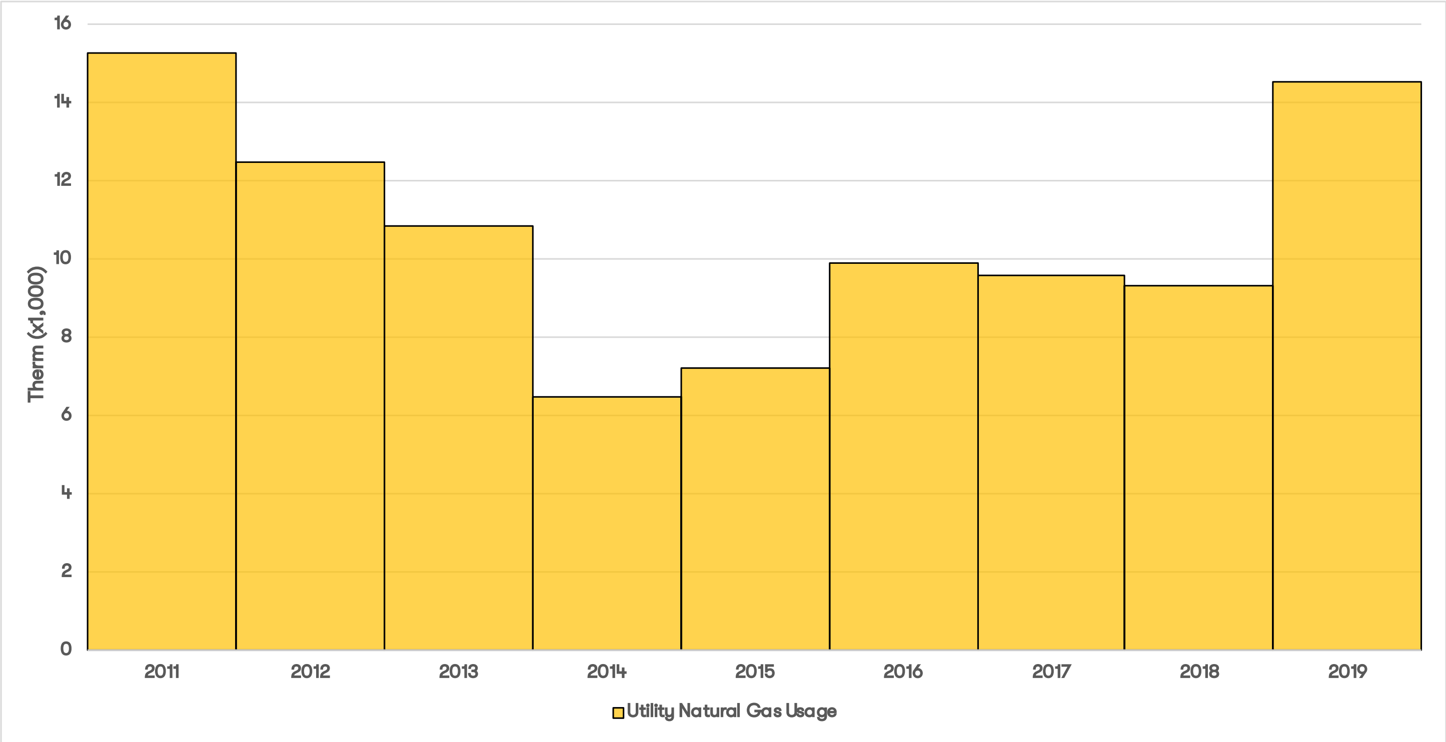


FIGURE 6 – ANNUAL UTILITY NATURAL GAS USAGE

BUILDING SYSTEMS AND ENERGY CONSUMPTION

The following is a high-level description of the existing lighting and HVAC systems currently serving each of the major buildings on campus. A high-level calculation of these buildings was developed to analyze existing EUIs and determine the overall reduction in energy that can be accomplished with system upgrades and improvements.

Maintenance and Operations (Building #1)

OVERVIEW:

The Maintenance and Operation (M&O) building is a one-story maintenance shop building and has 6,400 ft2 floor area. The primary occupants are maintenance staff. The building is mainly for maintenance, tools, custodians, and offices spaces. The building is forty-five years old.

EXISTING CONDITIONS:

HVAC:

There are two Rheem rooftop DX/gas heating packaged units (2x3.5 tons, EER=8.7, SEER=10) that serve the condition spaces. The packaged units are controlled by programmable thermostats. The building also has eight Reznor gas unit heaters (2x150 MBH and 6x125 MBH) for various maintenance bays, warehouse, and equipment rooms.

LIGHTING:

The M&O building is primarily illuminated with low-bay suspended 2'x'4 fixtures, 2'x2' recessed troffer fixtures, and 6" recessed can fixtures. The low-bay fixtures are equipped with 32W fluorescent T8 lamps and electronic ballasts. The 2'x2' recessed troffer fixtures are equipped with 17W fluorescent T8 lamps and electronic ballasts. The recessed can fixtures are equipped with CFLs. Room fixtures are controlled with wall switches and occupancy sensors.

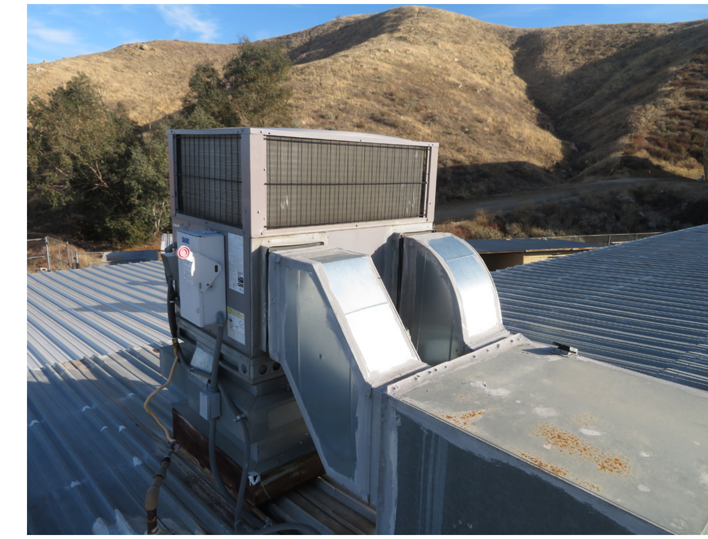
PLUMBING:

Domestic hot water (DHW) is heated by one 32 MBH, 30 gallons gas water heater.

PLUG LOADS:

There is office equipment such monitors, computers, and copier/printers. There are air compressors for tools and tire inflation.

MAINTENANCE & OPERATIONS BUILDING



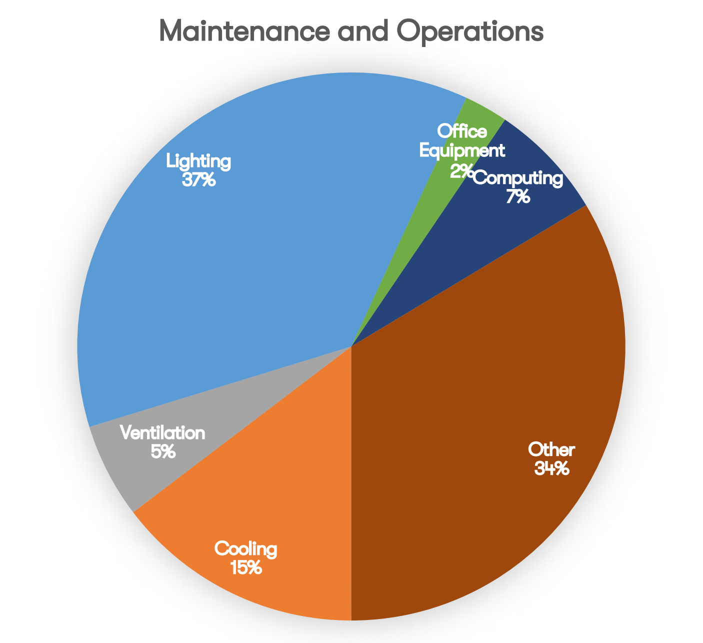
PACKAGED ROOFTOP UNIT

LOW BAY LINEAR FLUORESCENT LIGHT FIXTURES

LOW BAY LINEAR FLUORESCENT LIGHT FIXTURES

ENERGY CONSUMPTION:

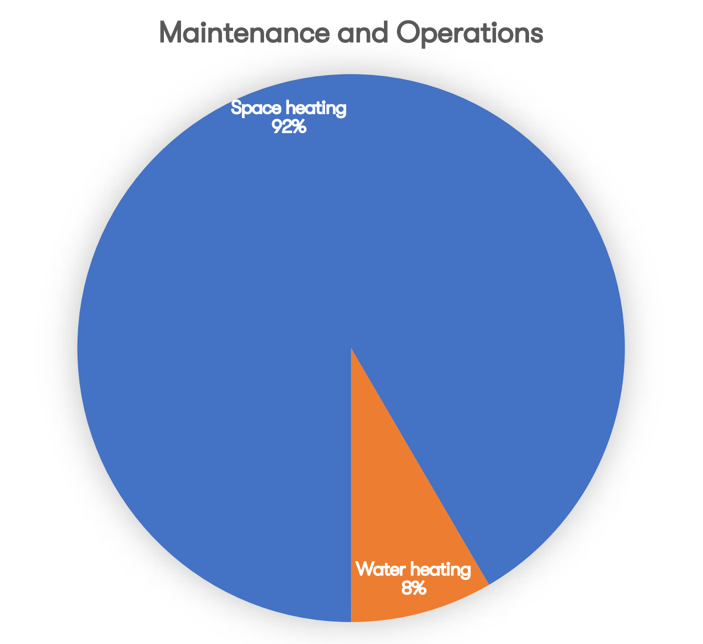
The energy consumption for the building is mainly plug loads, lighting, and the HVAC systems. This building was occupied during the field survey.



Maintenance and Operations		
CATEGORY	KWH	PERCENTAGE
SPACE HEATING	0	0%
COOLING	5,701	15%
VENTILATION	2,180	6%
WATER HEATING	0	0%
LIGHTING	14,253	37%
COOKING	0	0%
REFRIGERATION	0	0%
OFFICE EQUIPMENT	1,006	3%
COMPUTING	2,683	7%
OTHER	13,080	34%
TOTAL:	38,903	100%

HVAC Equipment Inventory

Unit Tag	Qty	Make/Model	CFM	Cooling, MBH	Heating, MBH	Type
AC-1, AC-2	2	RHEEM	1,400	42.0	80.0	RTU, DX/GAS
UH-1, UH-2	2	RENZOR	2,160	N/A	150.0	HEATER, GAS
UH-3 TO UH-8	6	RENZOR	1,545	N/A	125.0	HEATER, GAS



Maintenance and Operations		
CATEGORY	THERMS	PERCENTAGE
SPACE HEATING	1,242	92%
WATER HEATING	114	8%
COOKING	0	0%
OTHER	0	0%
TOTAL:	1,356	100%

Lighting Equipment Inventory

Fixture Description	Fixture Type	Quantity	Wattage
2'X4' RECESSED & SUSPENDED	FLUORESCENT, 2L F32T8	56	59.0
2'X2' RECESSED TROFFER	FLUORESCENT, 2L F17T8	20	33.0
RECESSED CAN DOWNLIGHT	FLUORESCENT, 2L CFL	10	34.0

Child Development Center

OVERVIEW:

The Child Development Center (CDC) is comprised of two separate one-story buildings. One building is 3,450 ft2 and the other building is 2,450 ft2 floor area. The primary occupants are infant toddlers, and staff. The buildings are mainly classrooms, toddler rooms, and play area for children. The building is twenty years old.

EXISTING CONDITIONS:

HVAC:

The 3,450 ft2 building is served by three rooftop dx/gas heating packaged units (1x7.5 ton, 2x5 ton, EER/SEER=11/13). The 2,450 ft2 building is served by two rooftop dx/gas heating packaged units (1x6 ton, 2x5 ton, EER/SEER=11/13).

LIGHTING:

The lighting fixtures within the CDC buildings are primarily equipped with 32W fluorescent T8 lamps and electronic ballasts. Other fixtures also include compact fluorescent lamps and halogen. The building has a variety of fixtures including recessed troffers and recessed can downlights. Room fixtures are controlled with wall switches and occupancy sensors.

PLUMBING:

Domestic hot water is heated by two 34 MBH, 40 gallons gas water heater, one for each building.

PLUG LOADS:

There is office equipment such monitors, computers, and copier/printers.

PROCESS LOADS:

The building includes a wood shop with various power tools and vacuum dust collector, a ceramics studio with a kiln, and an air compressor for pneumatic tools.

CHILD DEVELOPMENT CENTER BUILDING

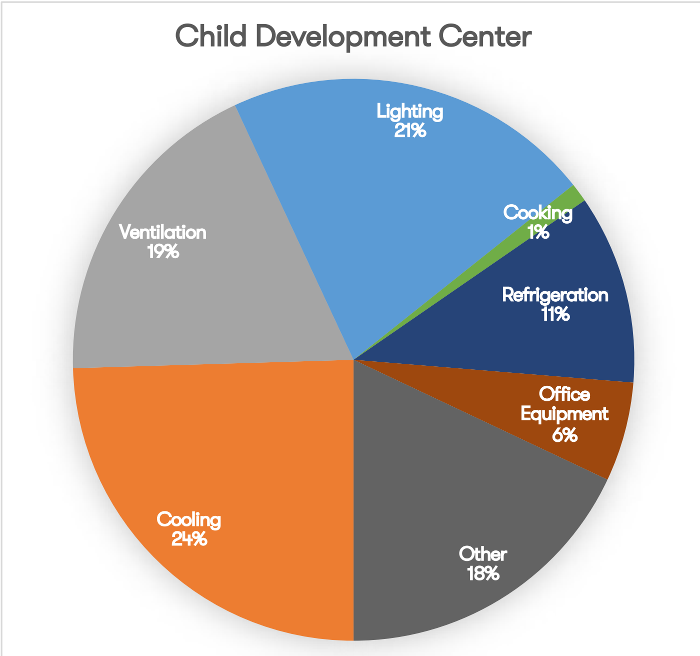
PACKAGED ROOFTOP UNIT

TYPICAL 2'X4' RECESSED TROFFER FIXTURE

TYPICAL CEILING MOUNTED OCCUPANCY SENSOR

ENERGY CONSUMPTION:

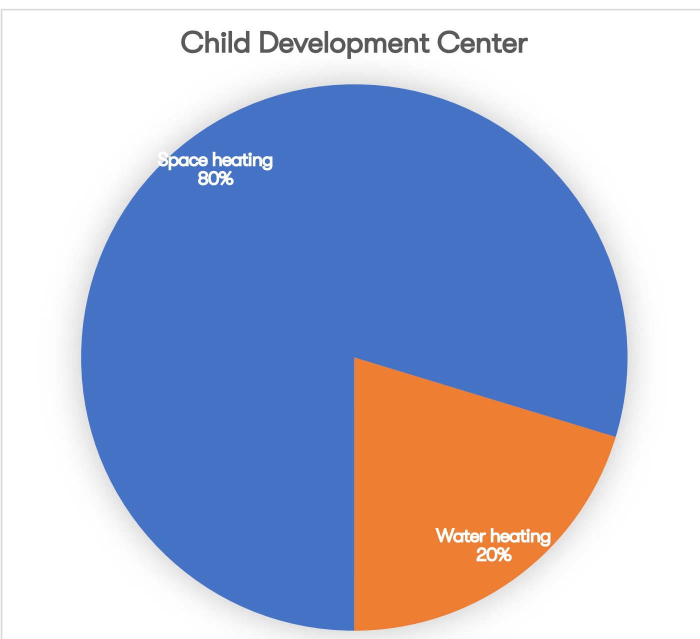
The energy consumption for the building is mainly plug loads, lighting, and the HVAC systems. This building was occupied during the field survey.



Child Development Center		
CATEGORY	KWH	PERCENTAGE
SPACE HEATING	0	0%
COOLING	21,707	25%
VENTILATION	16,401	19%
WATER HEATING	0	0%
LIGHTING	18,813	21%
COOKING	965	1%
REFRIGERATION	9,648	11%
OFFICE EQUIPMENT	5,065	6%
COMPUTING	0	0%
OTHER	15,919	18%
TOTAL:	88,517	100%

HVAC Equipment Inventory

Unit Tag	Qty	Make/Model	CFM	Cooling, MBH	Heating, MBH	Type
N/A	1	BARD	1,000	30.0	30.0	WALL MOUNT HEAT PUMP
N/A	1	BDP 581B060	2,000	60.0	59.0	RTU, DX/GAS
N/A	1	BDP 581B060	2,000	60.0	59.0	RTU, DX/GAS
N/A	1	BDP 581B090	3,000	90.0	59.0	RTU, DX/GAS
N/A	1	BDP 581B060	2,000	60.0	59.0	RTU, DX/GAS
N/A	1	BDP 581B072	2,400	72.0	59.0	RTU, DX/GAS



Child Development Center		
CATEGORY	THERMS	PERCENTAGE
SPACE HEATING	2,459	80%
WATER HEATING	626	20%
COOKING	0	0%
OTHER	0	0%
TOTAL:	3,086	100%

Lighting Equipment Inventory

Fixture Description	Fixture Type	Quantity	Wattage
2'X4' RECESSED TROFFER	FLUORESCENT, 2L F32T8	40	62.0
2'X4' RECESSED TROFFER	FLUORESCENT, 3L F32T8	12	89.0
RECESSED CAN DOWNLIGHT	FLUORESCENT, 2L CFL	10	34.0

Crafton Hall

OVERVIEW:

The Crafton Hall (CHL) building is a two-story building and has 8,560 ft2 floor area. The primary occupants are students and faculty. The building includes offices, auditorium, and kitchen spaces. The building is fifty years old.

EXISTING CONDITIONS:

HVAC:

Building has one multizone unit with a variable speed fan and one split system heat pump. The multizone unit is served by the campus chilled water and heating hot water loop. The split system serves office space. The rest of the building is served by the multizone zone unit.

LIGHTING:

The building lighting are primarily equipped with 32W fluorescent T8 lamps and electronic ballasts. The auditorium has high-bay fixtures equipped with linear fluorescent F32T8 lamps. Room fixtures are controlled with wall switches and occupancy sensors. The building exterior perimeter has LED fixtures.

PLUMBING:

Domestic hot water is heated by one 100 MBH, 100 gallons gas water heater with circulation pump.

PLUG LOADS:

There is office equipment such monitors, computers, and copier/printers. There are refrigerated vending machines. The building has small data closets for the networking equipment.

PROCESS LOADS

The kitchen has stoves, ovens, kitchen exhaust hoods, refrigerators, and freezers. The cafeteria has hot-food display cases, reach-in refrigerated beverage cases, kitchen exhaust hoods, and refrigerated merchandise cases.

CRAFTON HALL BUILDNG

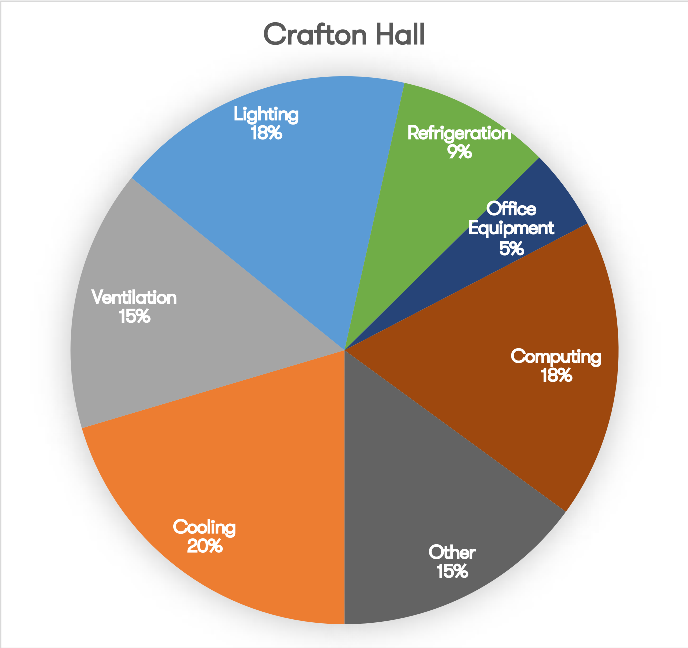
MULTIZONE AIR HANDLER

INTERIOR LIGHTING FIXTURE AND OFFICE FAN COIL UNIT

EXTERIOR PERIMTER LED FIXTURE

ENERGY CONSUMPTION:

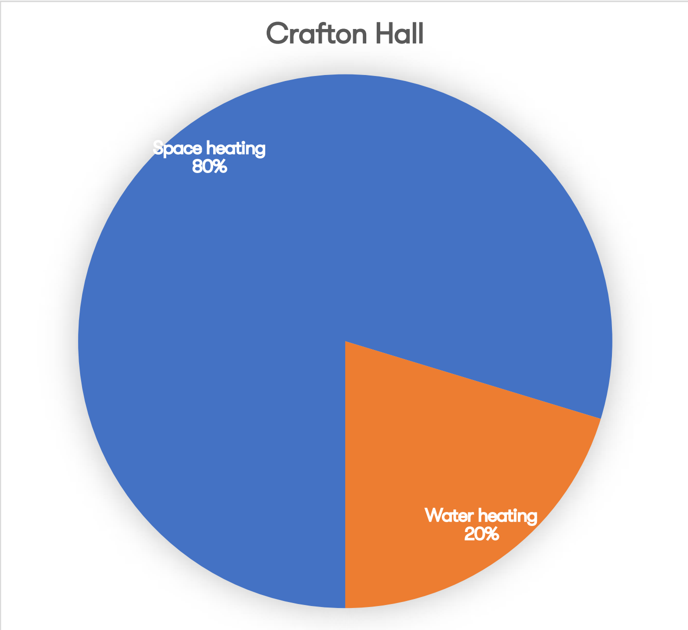
The energy consumption for the building is mainly plug loads, lighting, and the HVAC systems. This building was unoccupied during the field survey. The area surveyed was limited since the facility keys did not grant access certain areas.



Crafton Hall		
CATEGORY	KWH	PERCENTAGE
SPACE HEATING	0	0%
COOLING	25,822	20%
VENTILATION	19,510	15%
WATER HEATING	0	0%
LIGHTING	22,379	18%
COOKING	0	0%
REFRIGERATION	11,477	9%
OFFICE EQUIPMENT	6,025	5%
COMPUTING	22,379	18%
OTHER	18,936	15%
TOTAL:	126,529	100%

HVAC Equipment Inventory

Unit Tag	Qty	Make/Model	CFM	Cooling, MBH	Heating, MBH	Type
M2-C	1	MCQUAY LM 150	24,360	1116.6	1078.0	MULTIZONE CHW, HHW
N/A	1	MITSUBISHI	800	24.0	24.0	DX SPLIT SYSTEM



Crafton Hall		
CATEGORY	THERMS	PERCENTAGE
SPACE HEATING	12,078	80%
WATER HEATING	3,076	20%
COOKING	0	0%
OTHER	0	0%
TOTAL:	15,155	100%

Lighting Equipment Inventory

Fixture Description	Fixture Type	Quantity	Wattage
2'X4' RECESSED TROFFER	FLUORESCENT, 3L F32T8	20	89.0
HIGH-BAY	FLUORESCENT, 3L F32T8	27	89.0

Clock Tower Building

OVERVIEW:

The Clock Tower Building (CTB) is a three-story building and has 9,970 ft2 floor area. The primary occupants are students and faculty. Space types are primarily offices and classrooms. Building is fifty years old. The mechanical and electrical systems were renovated circa 2014..

EXISTING CONDITIONS:

HVAC:

The building has two air handling units (AHUs), AHU-1 and AHU-2, with variable speed fans. AHU-1 serves the west wing of the building and the other serving the east wing. The AHUs are served by the campus chilled water loop. The AHU-2 for the east wing also includes pre-heat coils served by heating hot water loop. Conditioned air is distributed to variable air volume (VAV) boxes with hot-water reheat coils. There are three DX fan coils serving elevator and IDF rooms. The HVAC systems are controlled through direct-digital controls down to the zone level.

LIGHTING:

The lighting fixtures within CTB were recently retrofitted to LEDs. The building is predominately illuminated with lensed 2'x2' recessed troffers and suspended 4' direct/indirect fixtures. The recessed troffers fixtures are 39W LED fixtures. The suspended 4' direct/indirect fixtures are 41W LED fixtures. Other fixture types also include LED recessed can downlights, 4' LED strip lights, and round surface-mounted downlights. Room fixtures are controlled with wall switches, occupancy sensors, and dimming controls in some cases.

PLUMBING:

Domestic hot water is heated by 155 MBH, 89 gallons gas water heater with domestic hot water circulation pump located in Boiler Room.

PLUG LOADS:

There is office equipment such monitors, computers, and copier/printers. The building has small data closets for the networking equipment.


CLOCK TOWER BUILDING

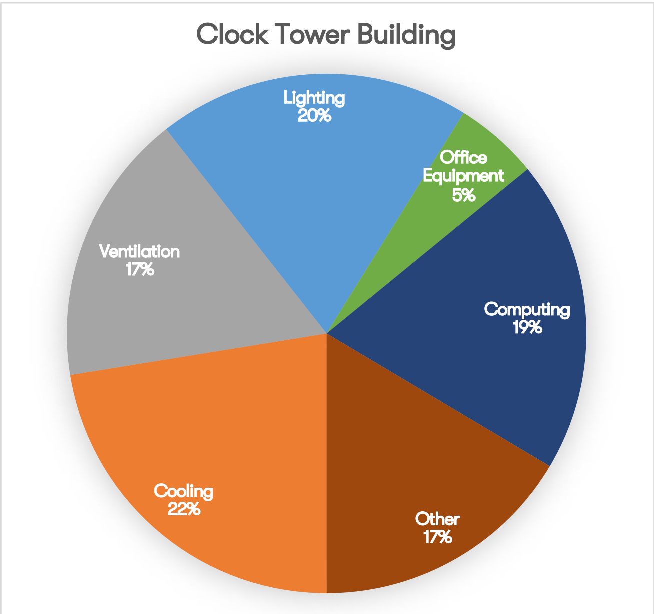

AIR HANDLER UNIT 1


TYPICAL LIGHTING LAYOUT FOR CLASSROOM


TYPICAL LIGHTING DIMMING CONTROLS FOR CLASSROOM

ENERGY CONSUMPTION:

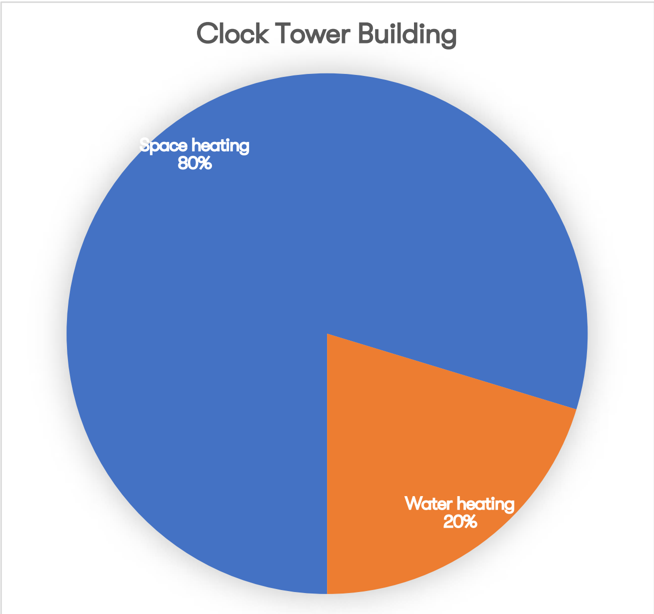
The energy consumption for the building is mainly plug loads, lighting, and the HVAC systems. This building was unoccupied during the field survey.



Clock Tower Building		
CATEGORY	KWH	PERCENTAGE
SPACE HEATING	0	0%
COOLING	28,599	22%
VENTILATION	21,608	17%
WATER HEATING	0	0%
LIGHTING	24,786	19%
COOKING	0	0%
REFRIGERATION	0	0%
OFFICE EQUIPMENT	6,673	5%
COMPUTING	24,786	19%
OTHER	20,972	16%
TOTAL:	127,424	100%

HVAC Equipment Inventory

Unit Tag	Qty	Make/Model	CFM	Cooling, MBH	Heating, MBH	Type
AHU-1	1	ENERGY LABS C11057	5,100	153.0	N/A	CHW
AHU-2	1	ENERGY LABS C9142	7,400	205.0	N/A	CHW
N/A	3	DAIKIN	1,000	30.0	N/A	DX SPLIT SYSTEM



Clock Tower Building		
CATEGORY	THERMS	PERCENTAGE
SPACE HEATING	3,540	80%
WATER HEATING	902	20%
COOKING	0	0%
OTHER	0	0%
TOTAL:	4,442	100%

Lighting Equipment Inventory

Fixture Description	Fixture Type	Quantity	Wattage
2'X2' RECESSED TROFFER	LED	50	39.0
4'X8' DIRECT/INDIRECT PENDENT	LED	2	41.0
RECESSED CAN DOWNLIGHT	LED	22	18.0
4' STRIP LIGHT	LED	3	47.0
RECESSED CAN DOWNLIGHT	LED	10	11.0
RECESSED CAN DOWNLIGHT DOUBLE	LED	16	22.0
SEMI-RECESSED DOWNLIGHT	LED	9	28.0
ROUND SURFACE MOUNTED	LED	8	37.0

West Complex

OVERVIEW:

The West Complex (WEST) building is a two-story building and has 6,800 ft2 floor area. The primary occupants are students and faculty. The building is primarily classrooms. The building is fifty years old.

EXISTING CONDITIONS:

HVAC:

The WEST building has one heating/cooling multizone with variable speed fan and economizer. Heating hot water and chilled water is provided to the unit from Central Plant. Total installed cooling capacity for the building is calculated as 29 tons (235 ft2/ton). Total installed heating capacity for the building is estimated at 130 MBH.

LIGHTING:

The building lighting are primarily equipped with 4' T8 LED lamps and electronic ballasts. Other fixtures also include compact fluorescent lamps, halogen, and metal halide. The building has a variety of fixtures including recessed troffers, suspended vapor tight fixtures, and recessed can downlights. Room fixtures are controlled with wall switches and occupancy sensors.

PLUMBING:

Domestic hot water is heated by a gas-fired water heater with storage tank. The water heater rating was unable to be verified.

PLUG LOADS:

There is office equipment such monitors, computers, and copier/printers. The building has small data closets for the networking equipment.


WEST COMPLEX BUILDING

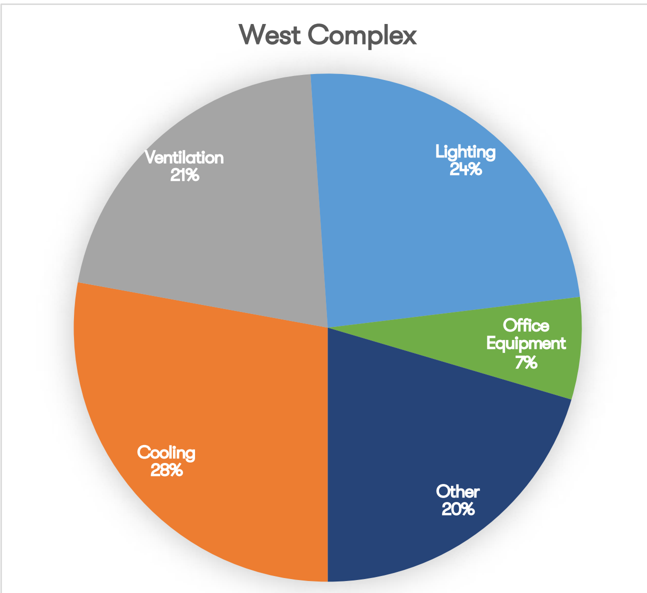

AIR HANDLER UNIT


TYPICAL LIGHTING LAYOUT FOR CLASSROOM


TYPICAL LIGHTING SWITCH AND TEMPERATURE SENSOR

ENERGY CONSUMPTION:

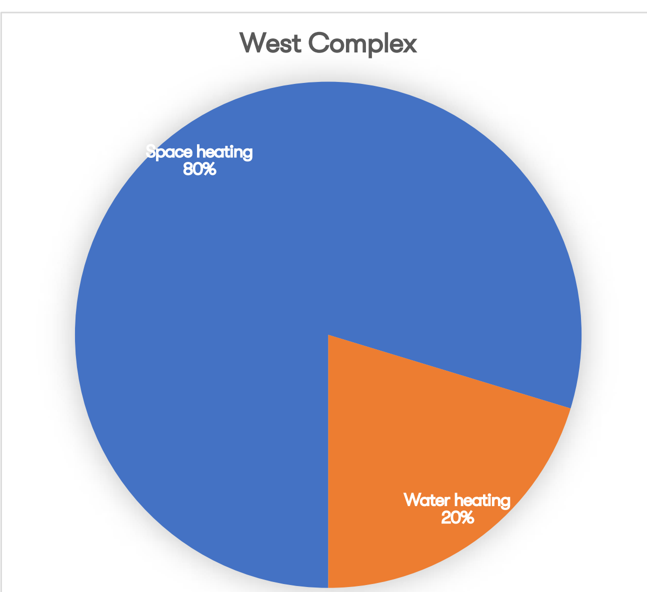
The energy consumption for the building is mainly plug loads, lighting, and the HVAC systems. This building was unoccupied during the field survey.



West Complex		
CATEGORY	KWH	PERCENTAGE
SPACE HEATING	0	0%
COOLING	24,216	28%
VENTILATION	18,297	21%
WATER HEATING	0	0%
LIGHTING	20,987	24%
COOKING	0	0%
REFRIGERATION	0	0%
OFFICE EQUIPMENT	5,650	7%
COMPUTING	0	0%
OTHER	17,758	20%
TOTAL:	86,909	100%

HVAC Equipment Inventory

Unit Tag	Qty	Make/Model	CFM	Cooling, MBH	Heating, MBH	Type
M1-C	1	MCQUAY LML 22-V	9,920	348.0	130.0	MULTIZONE CHW, HHW



West Complex		
CATEGORY	THERMS	PERCENTAGE
SPACE HEATING	2,414	80%
WATER HEATING	615	20%
COOKING	0	0%
OTHER	0	0%
TOTAL:	3,029	100%

Lighting Equipment Inventory

Fixture Description	Fixture Type	Quantity	Wattage
4' SURFACE PRISMATIC	2L LED TUBE	256	36.0
4' WALLWASH	1L LED TUBE	48	12.0

Crafton Center

OVERVIEW:

The Crafton Center (CCR) building is a two-story building and has 43,600 ft2 floor area. The primary occupants are students and faculty. Space types include offices, retail sales floor, meeting/conference rooms, and a commercial kitchen. The building was constructed circa 2013.

EXISTING CONDITIONS:

HVAC:

The building has four custom, Energy Labs air handling units (AHUs) with variable speed fans and 100% economizer capabilities. The AHUs are served by the campus chilled-water loop. One of the AHUs also include pre-heat coils served by the campus heating hot-water loop. Conditioned air is distributed to variable air volume (VAV) boxes with hot-water reheat coils. There are two DX fan coils serving data rooms. The HVAC systems are controlled through direct-digital controls down to the zone level.

LIGHTING:

The building lighting are a combination of linear fluorescent T5, T5HO, and T8 technology; compact fluorescent lamps; and LEDs. The fixture types are predominately lensed 2'x4' and 2'x2' recessed troffers fixtures. The recessed troffers fixtures are 28W and 14W linear fluorescent T5 fixtures, respectively. Room fixtures are controlled with wall switches, occupancy sensors, and dimming controls in some cases.

PLUMBING:

Domestic hot water is heated by 225 MBH tankless gas water heater with a 1/6-hp circulation pump. There are also two 11.08 kW and two dual 8.32 kW point-of-use instantaneous electric water heaters.

PLUG LOADS:

There is office equipment such monitors, computers, and copier/printers. The building has small data closets for the networking equipment.

PROCESS LEADS:

The building includes a small commercial kitchen which is equipped with fume hoods, walk-in refrigerators and freezers, and cooking equipment. The kitchen is adjacent to a convenience store/food sales floor which has reach-in refrigerated cases. There is also electric cart storage and charging.

CRAFTON CENTER BUILDING

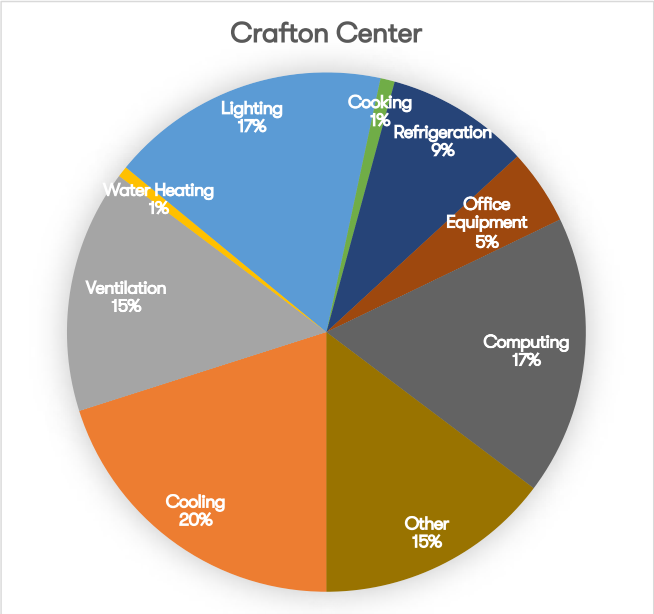
AIR HANDLER UNIT

BOOKSTORE LIGHTING LAYOUT

TYPICAL COMMON AREA AND CORRIDOR LIGHTING LAYOUT

ENERGY CONSUMPTION:

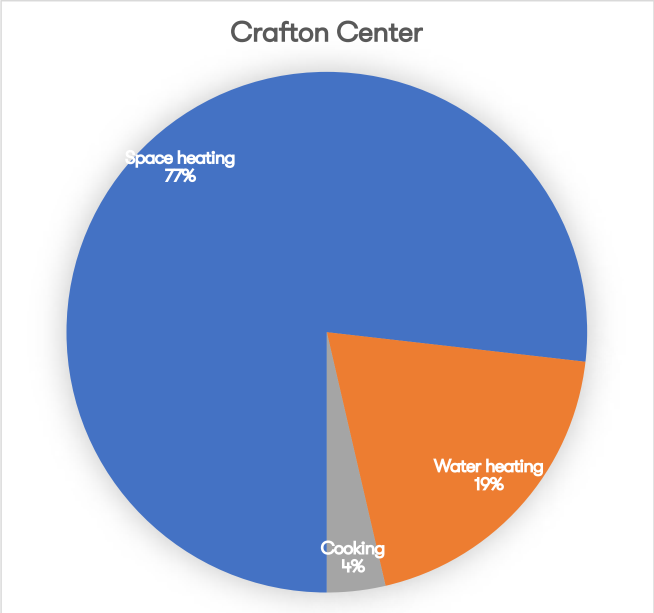
The energy consumption for the building is mainly plug loads, lighting, kitchen exhaust hoods, walk-in refrigerators and freezers, and the HVAC systems. Based on the field survey, the kitchen hoods and make-up air units were operating even though the space was unoccupied. This building was sparsely occupied during the field survey.



Crafton Center		
CATEGORY	KWH	PERCENTAGE
SPACE HEATING	0	0%
COOLING	118,107	20%
VENTILATION	89,237	15%
WATER HEATING	3,937	1%
LIGHTING	102,360	17%
COOKING	5,249	1%
REFRIGERATION	52,492	9%
OFFICE EQUIPMENT	27,558	5%
COMPUTING	102,360	17%
OTHER	86,612	15%
TOTAL:	587,912	100%

HVAC Equipment Inventory

Unit Tag	Qty	Make/Model	CFM	Cooling, MBH	Heating, MBH	Type
AHU-1	1	ENERGY LABS	10,000	337.0	N/A	CHW
AHU-2	1	ENERGY LABS	12,000	457.0	N/A	CHW
AHU-3	1	ENERGY LABS	8,000	326.0	268.0	CHW, HHW
AHU-4	1	ENERGY LABS	5,000	171.0	N/A	CHW
FC-1, 2 / CU-1, 2	2	CARRIER 40QN / 38HDF036	900	34.1	N/A	DX FAN COIL



Crafton Center		
CATEGORY	THERMS	PERCENTAGE
SPACE HEATING	15,741	77%
WATER HEATING	4,010	20%
COOKING	743	4%
OTHER	0	0%
TOTAL:	20,494	100%

Lighting Equipment Inventory

Fixture Description	Fixture Type	Quantity	Wattage
2'X4' RECESSED TROFFER	FLUORESCENT, 2L F28T5	94	60.0
2'X2' RECESSED TROFFER	FLUORESCENT, 2L F14T5	112	30.0
6" RECESSED CAN DOWNLIGHT	LED	133	18.0
36" RECESSED ROUND DOWNLIGHT	LED	10	150.0
4' DIRECT INDIRECT PENDANT	FLUORESCENT, 2L F28T5	83	60.0
4' RECESSED SLOT	FLUORESCENT, 1L F28T5	29	29.0
5'X4' LIGHT FIXTURE	FLUORESCENT, 1L F80T5HO	16	85.0
8' DIRECT INDIRECT PENDANT	FLUORESCENT, 1L F54T5HO	68	140.0
4' STRIP LIGHT	FLUORESCENT, 2L F28T5	12	60.0
36" DIRECT ROUND PENDANT	FLUORESCENT, 6L F24T5	17	170.0
36" DIRECT ROUND PENDANT	FLUORESCENT, 4L F24T5	8	160.0
4' WRAPAROUND	FLUORESCENT, 2L F32T8	9	60.0
TRACK LIGHTING, LOW VOLTAGE	LED	18	50.0

Student Support Building

OVERVIEW:

The Student Support Building (SSB) is a two-story building and has 5,575 ft2 floor area. The primary occupants are students and faculty. Building contains mainly office and administration spaces. The building is twenty-two years old. The mechanical and electrical systems are original to the building.

EXISTING CONDITIONS:

HVAC:

The building is served by five 4-pipe fan coils. The chilled water cool coils are controlled by two-way control valves. Building is supplied with chilled water from Central Plant. The heating hot water coils of fan coils are controlled by three-way control valves. Buildings is supplied with heating hot water from Central Plant. Outside air is provided to fan coils through roof outside air intakes.

LIGHTING:

The building lighting are primarily equipped with 32W fluorescent T8 lamps and electronic ballasts. Other fixtures also include compact fluorescent lamps and halogen. The building has a variety of fixtures including recessed troffers and recessed can downlights. Room fixtures are controlled with wall switches and occupancy sensors.

PLUMBING:

Domestic hot water is heated by 6kW, 10 gallons electric water heater with domestic hot water circulation pump.

PLUG LOADS:

There is office equipment such monitors, computers, and copier/printers. The building has small data closets for the networking equipment.

STUDENT SUPPORT BUILDING

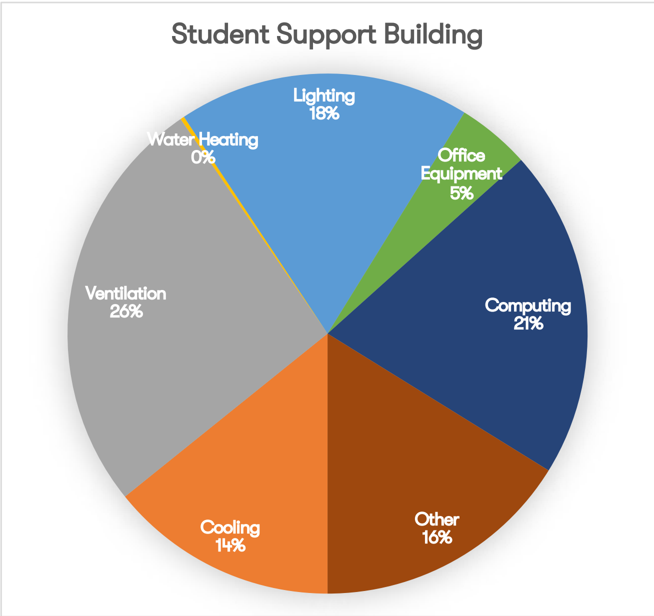

FAN COIL UNIT WITHIN ELECTRICAL ROOM


TYPICAL 2'X4' RECESSED TROFFER LIGHTING LAYOUT


EXTERIOR CORRIDOR SURFACE MOUNTED FIXTURES

ENERGY CONSUMPTION:

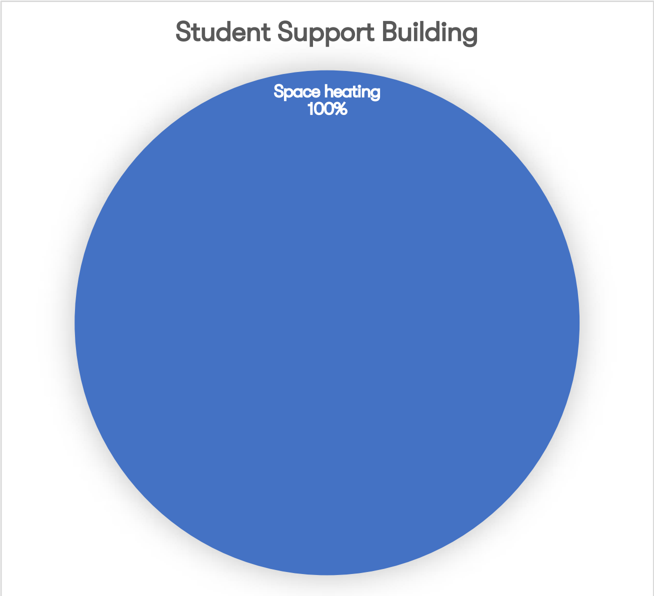
The energy consumption for the building is mainly plug loads, lighting, and the HVAC systems. This building was unoccupied during the field survey.



Student Support Building		
CATEGORY	KWH	PERCENTAGE
SPACE HEATING	0	0%
COOLING	6,356	14%
VENTILATION	11,726	26%
WATER HEATING	110	0%
LIGHTING	8,110	18%
COOKING	0	0%
REFRIGERATION	0	0%
OFFICE EQUIPMENT	2,027	5%
COMPUTING	9,151	20%
OTHER	7,233	16%
TOTAL:	44,712	100%

HVAC Equipment Inventory

Unit Tag	Qty	Make/Model	CFM	Cooling, MBH	Heating, MBH	Type
FC-01	1	CARRIER 42-BH/16	1,540	46.2	24.1	4-PIPE FAN COIL
FC-02	1	CARRIER 42-BH/20	1,710	51.3	37.3	4-PIPE FAN COIL
FC-03	1	CARRIER 42-BH/16	1,630	48.9	17.6	4-PIPE FAN COIL
FC-04	1	CARRIER 42-BH/12	1,530	45.9	31.2	4-PIPE FAN COIL
FC-05	1	CARRIER 42-BH/12	1,360	40.8	29.2	4-PIPE FAN COIL



Student Support Building		
CATEGORY	THERMS	PERCENTAGE
SPACE HEATING	1,559	100%
WATER HEATING	0	0%
COOKING	0	0%
OTHER	0	0%
TOTAL:	1,559	100%

Lighting Equipment Inventory

Fixture Description	Fixture Type	Quantity	Wattage
2'X4' RECESSED TROFFER	FLUORESCENT, 3L F32T8	64	93.0
RECESSED CAN DOWNLIGHT	FLUORESCENT, 2L CFL	25	30.0

Learning Resource Center

OVERVIEW:

The Learning Resource Center (LRC) is a three-story building and has 54,461 ft2 floor area. The primary occupants are students and faculty. The building includes offices, classrooms, meeting rooms, auditorium, library, and large corridors and lobbies. The building was constructed circa 2010. The mechanical and electrical systems are original to the building.

EXISTING CONDITIONS:

HVAC:

The building has two AHUs with variable speed fans with one serving the east side of the building and the other serving the west side. The AHUs have a capacity of 35,600 CFM and 45,000 CFM, respectively. Chilled water is supplied to the AHUs from the Central Plant. Conditioned air is distributed to variable air volume (VAV) boxes with hot-water reheat coils. The reheat coils are served by the building's natural gas boiler. There are two dual-source computer room air conditioning (CRAC) units serving computer data center. There are six DX fan coils serving the elevator room, IDF rooms, and electrical rooms. There are five chilled-water fan coils serving the auditorium, multi-purpose, pantry/storage, and gallery.

LIGHTING:

The building lighting are primarily equipped with 17W or 32W fluorescent T8 lamps and electronic ballasts. Other fixtures also include compact fluorescent lamps, halogen, and metal halide. The building has a variety of fixtures including recessed troffers, suspended direct/indirect fixtures, recessed can downlights, and decorative pendent fixtures. Room fixtures are controlled with wall switches, occupancy sensors, and dimming control in some cases.

PLUMBING:

Domestic hot water is heated by 150 MBH tankless gas water heater with a 1/25-hp circulation pump. There are also four 5.45 kW and two 9.0 kW point-of-use instantaneous electric water heaters.

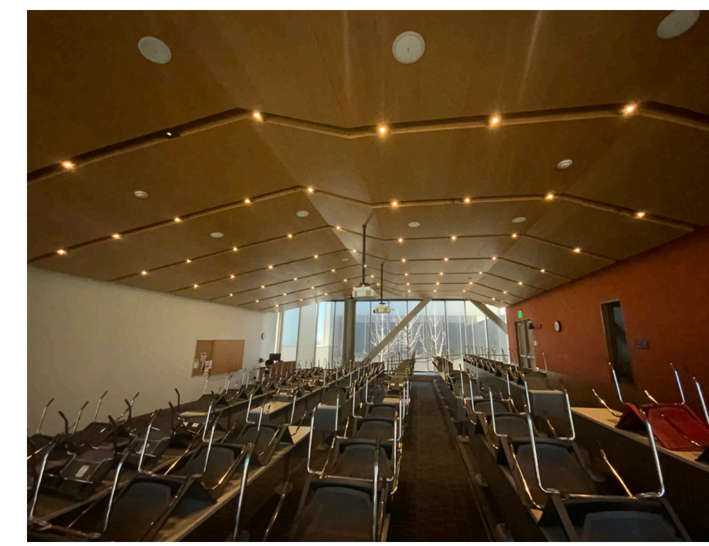
PLUG LOADS:

There is office equipment such monitors, computers, and copier/printers. The building has small data closets for the networking equipment.

LEARNING RESOURCE CENTER BUILDING

AIR HANDLING UNIT

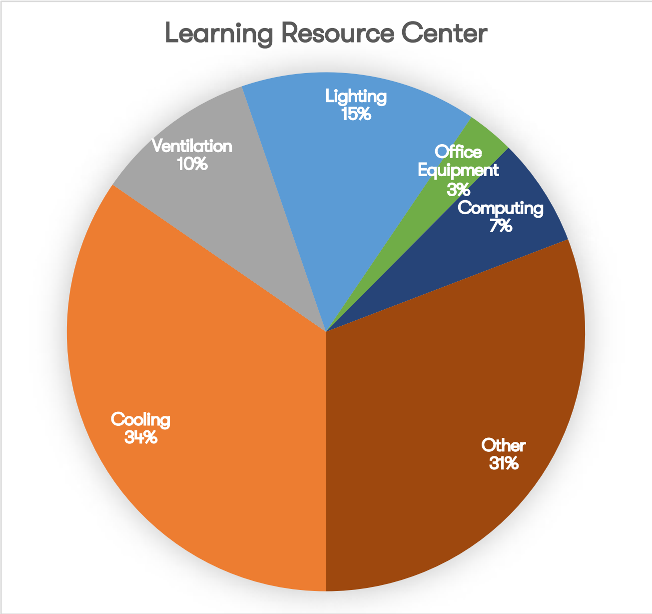
TYPICAL BOOKSTACK 4' SUSPENDED LIGHTING LAYOUT



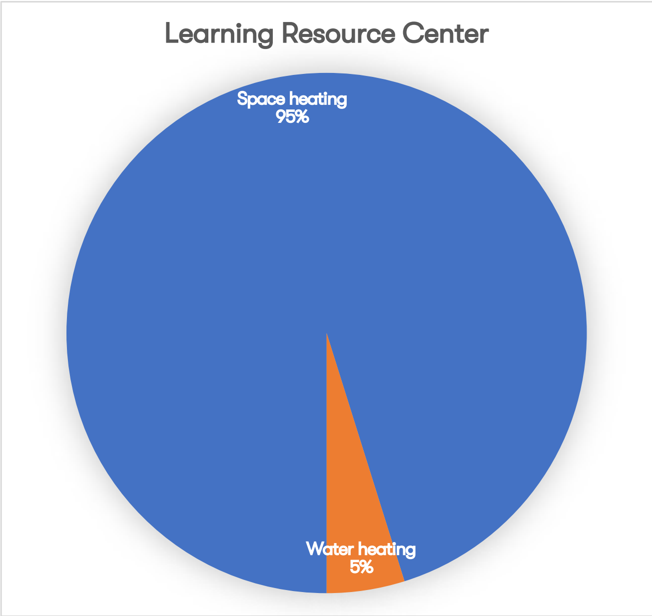
AUDITORIUM LIGHTING LAYOUT

ENERGY CONSUMPTION:

The energy consumption for the building is mainly plug loads, lighting, and the HVAC systems. This building was unoccupied during the field survey.



Learning Resource Center		
CATEGORY	KWH	PERCENTAGE
SPACE HEATING	0	0%
COOLING	221,969	35%
VENTILATION	64,967	10%
WATER HEATING	0	0%
LIGHTING	94,743	15%
COOKING	0	0%
REFRIGERATION	0	0%
OFFICE EQUIPMENT	18,949	3%
COMPUTING	43,311	7%
OTHER	197,607	31%
TOTAL:	641,546	100%



Learning Resource Center		
CATEGORY	THERMS	PERCENTAGE
SPACE HEATING	21,281	95%
WATER HEATING	1,082	5%
COOKING	0	0%
OTHER	0	0%
TOTAL:	22,363	100%

HVAC Equipment Inventory

Unit Tag	Qty	Make/Model	CFM	Cooling, MBH	Heating, MBH	Type
AHU-1	1	TRANE TCCA068	35,600	1360.0	N/A	CHW
AHU-2	1	TRANE TCCA080	45,000	1690.0	N/A	CHW
CU-1-1, CU-1-3	2	LIEBERT CDF510-A	14,250	360.0	N/A	CRAC, DX
CU-1-2, CU-1-4	2	LIEBERT CDF510-A	14,250	360.0	N/A	CRAC, DX
CU-1-1, 2	2	TRANE 2TTB3036	1,200	36.0	N/A	DX SPLIT SYSTEM
CU-2-1, 2, 3, 4, 5	5	TRANE 2TTB3036	1,200	36.0	N/A	DX SPLIT SYSTEM
FC-2-3, 5, 6, 8	4	90 HBAW-6	3,000	141.0	221.0	4-PIPE FAN COIL
FC-2-4	1	24 HBAW-6	800	34.4	57.0	4-PIPE FAN COIL
FC-2-7	1	36 HBAW-6	1,200	51.5	84.0	4-PIPE FAN COIL

Lighting Equipment Inventory

Fixture Description	Fixture Type	Quantity	Wattage
ADJUSTABLE LOW-VOLTAGE SPOT	50MR16	56	53.0
ADJUSTABLE LOW-VOLTAGE SPOT	50MR16	72	53.0
PENDANT DOWNLIGHT	FLUORESCENT, 1L FP54/030	16	45.0
SUSPENDED INDIRECT	FLUORESCENT, 1L FP54/030	836	14.0
SUSPENDED INDIRECT	FLUORESCENT, 1L FP54/030	3	60.0
SUSPENDED INDIRECT	FLUORESCENT, 1L FP54/030	416	8.0
SUSPENDED INDIRECT	FLUORESCENT, 1L FP54/030	60	15.0
RECESSED CAN DOWNLIGHT	FLUORESCENT, 1L CF32	74	35.0
RECESSED CAN DOWNLIGHT	FLUORESCENT, 1L CF32	16	35.0
RECESSED CONTINUOUS	FLUORESCENT, 1L CF9	67	9.0
RECESSED LINEAR	FLUORESCENT, 2L F28T5	67	60.0
RECESSED LINEAR	FLUORESCENT, 2L F28T5	20	60.0
RECESSED LINEAR WALL WASH	FLUORESCENT, 2L F54T5	5	60.0
RECESSED LINEAR WALL WASH	FLUORESCENT, 2L F54T5	10	60.0
2'X4' RECESSED DIRECT INDIRECT	FLUORESCENT, 3L F28T5	29	90.0
2'X2' RECESSED DIRECT INDIRECT	FLUORESCENT, 3L F14T5	90	46.0
RECESSED WALL WASH	FLUORESCENT, 1L FP24	24	26.0
RECESSED WALL WASH	FLUORESCENT, 1L FP24	23	26.0
MH DOWNLIGHT	1L CMH20	12	25.0
MH RECESSED	3L CMH20	8	150.0
MH DOWNLIGHT	1L CMH20	12	25.0
RECESSED HALOGEN	1L CMH20	2	150.0
SUSPENDED SPOTLIGHT	FLUORESCENT, 2L F32T8	25	70.0
SURFACE MOUNT	FLUORESCENT, 1L F28T5	39	8.0
CONTINUOUS	FLUORESCENT, 1L CF8	12	8.0
CONTINUOUS DOWNLIGHT	FLUORESCENT, 1L CF8	291	8.0

Performing Arts Center

OVERVIEW:

The Performing Arts Center (PAC) is a three-story building and has 29,850 ft2 floor area. The primary occupants are students and faculty. The building is used for auditorium with stage, workshop and exhibition spaces. Building is forty-five years old. The structure is cast in place concrete.

EXISTING CONDITIONS:

HVAC:

The building has two multizone air handling units with variable speed fans on the second floor of the building. The units are 26,000 CFM with 20-hp and 23,000 CFM with 15-hp motors with economizing capabilities. Both units are served by the campus heating-hot water loop and chilled-water loop.

LIGHTING:

The building lighting are primarily equipped with 17W or 32W fluorescent T8 lamps and electronic ballasts. Fixtures also include compact fluorescent lamps, halogen, and metal halide. The building has a variety of fixtures including recessed troffers, suspended direct/indirect fixtures, recessed can downlights, and decorative pendent fixtures. Room fixtures are controlled with wall switches, occupancy sensors, and dimming control in some cases.

PLUMBING:

Domestic hot water is heated by one 12kW, 50 gallons electric water heater with circulation pump. There are two sump pumps with 7.5 Hp motor each for sewer service in the basement.

PLUG LOADS:

There is office equipment such monitors, computers, and copier/printers. There are also various equipment associated with theatre/stage production. The building has small data closets for the networking equipment.

PERFORMING ARTS CENTER BUILDING

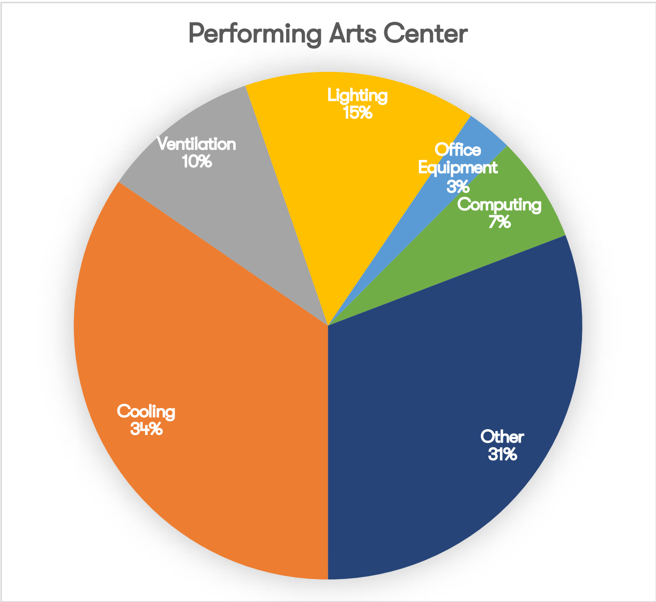
MULTI-ZONE AIR HANDLING UNIT

GENERAL LIGHTING LAYOUT OF ORCHESTRA PRACTICE ROOM

GENERAL FOYER LIGHTING LAYOUT

ENERGY CONSUMPTION:

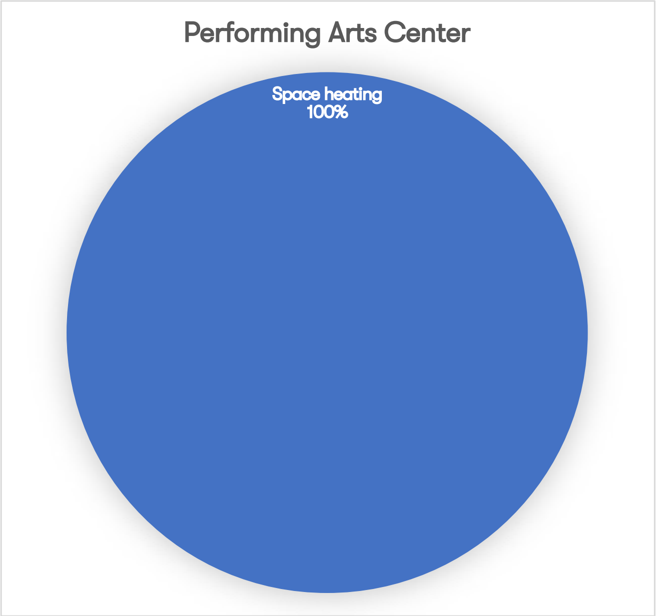
The energy consumption for the building is mainly plug loads, lighting, and the HVAC systems. The theatrical lights also have significant consumption. This building was sparsely occupied during the field survey.



Performing Arts Center		
CATEGORY	KWH	PERCENTAGE
SPACE HEATING	0	0%
COOLING	88,001	35%
VENTILATION	25,756	10%
WATER HEATING	0	0%
LIGHTING	37,561	15%
COOKING	0	0%
REFRIGERATION	0	0%
OFFICE EQUIPMENT	7,512	3%
COMPUTING	17,171	7%
OTHER	78,342	31%
TOTAL:	254,344	100%

HVAC Equipment Inventory

Unit Tag	Qty	Make/Model	CFM	Cooling, MBH	Heating, MBH	Type
MZ-1	1	TRANE NO. 50	26,000	775.0	600.0	MULTIZONE CHW, HHW
MZ-2	1	TRANE NO. 50	23,000	685.0	540.0	MULTIZONE CHW, HHW
RF-1	1	TRANE MODEL Q SIZE 44	20,800	N/A	N/A	RETURN FAN
RF-2	1	TRANE MODEL Q SIZE 44	19,000	N/A	N/A	RETURN FAN



Performing Arts Center		
CATEGORY	THERMS	PERCENTAGE
SPACE HEATING	8,866	100%
WATER HEATING	0	0%
COOKING	0	0%
OTHER	0	0%
TOTAL:	8,866	100%

Lighting Equipment Inventory

Fixture Description	Fixture Type	Quantity	Wattage
WALL MOUNT DOWNLIGHT	FLUORESCENT, 2L CFL	11	
SURFACE MOUNT DOWNLIGHT	FLUORESCENT, 1L CFL	7	
WALL MOUNT DOWNLIGHT	FLUORESCENT, 1L CFL	6	
1'X1 RECESSED SQUARE	HALOGEN 300W	61	
1'X1 RECESSED SQUARE	HALOGEN 150W	41	
RECESSED SQUARE WALL WASH	HALOGEN 150W	55	
SURFACE OR PENDANT DOWNLIGHT	HALOGEN 300W	9	
RECESSED STEPLIGHT	FLUORESCENT, 1L CFL	20	
1'X4' SURFACE MOUNT	FLUORESCENT, 2L F32T8	8	
2'X4' RECESSED TROFFER	FLUORESCENT, 3L F32T8	118	
8' HIGH-BAY INDUSTRIAL SUSPENDED	FLUORESCENT, 3L F96T8	18	
4' SURFACE MOUNT INDUSTRIAL	FLUORESCENT, 2L F32T8	30	
4' SURFACE MOUNT ACRYLIC DIFFUSER	FLUORESCENT, 2L F32T8	18	

Central Complex 1

OVERVIEW:

The Central Complex 1 (CNTL 1) building is a three-story building and has 24,569 ft2 of conditioned floor area. The primary occupants are students and faculty. Space types include offices, classrooms, auditorium lecture halls, and biology labs spaces. The building also includes the campus central plant and supplies chilled water and heating hot water to the other buildings on campus. The building is approximately fifty years old. The mechanical and electrical systems were renovated circa 2014.

EXISTING CONDITIONS:

HVAC:

The building has six air handling units (AHUs) with variable speed fans located throughout various mechanical rooms. The AHUs are served by the campus chilled water loop. Two of the AHUs also include pre-heat coils served by the heating hot water loop. Conditioned air is distributed to variable air volume (VAV) boxes with hot-water reheat coils. There are seven DX fan coils serving electrical, data, and server rooms. The building also houses the campus central plant with chiller room, boiler room, and cooling tower room. The HVAC systems are controlled through direct-digital controls down to the zone level.

LIGHTING:

The building lighting were retrofitted to LEDs as part of the renovations. The building is predominately illuminated with lensed 2'x4' recessed troffers fixtures. The recessed troffers fixtures are 45W or 66W LED fixtures. Room fixtures are controlled with wall switches, occupancy sensors, and dimming controls in some cases.

PLUMBING:

Domestic hot water is heated by one 4.5kW, 58 gallons electric water heater with domestic hot water circulation pump and two 3.5kW, 30 gallons electric water heaters with domestic hot water circulation pumps.

PLUG LOADS:

There is office equipment such monitors, computers, and copier/printers. The building has small data closets for the networking equipment.

CENTRAL COMPLEX 1 BUILDING

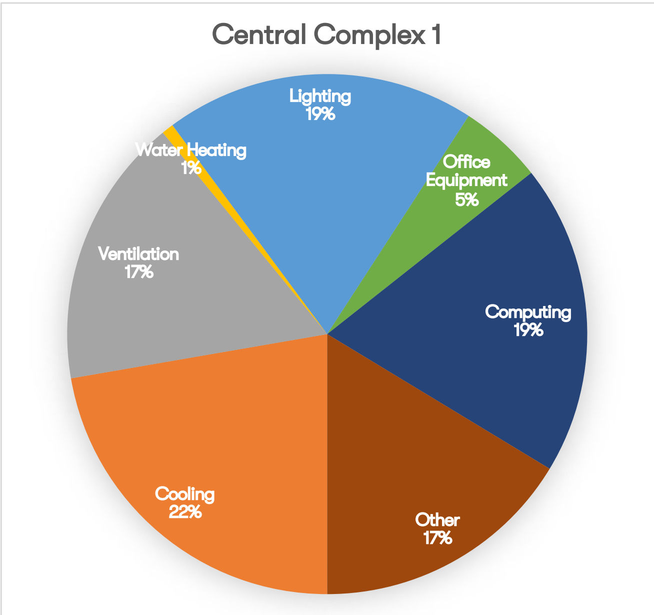
CENTRAL PLANT CHILLERS

TYPICAL AIR HANDLER UNIT WITH CHILLED WATER CONNECTION

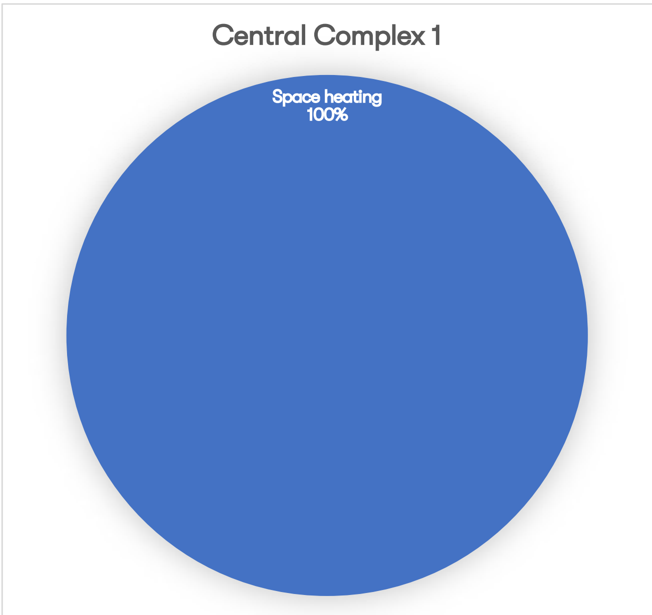
TYPICAL CLASSROOM LIGHTING LAYOUT

ENERGY CONSUMPTION:

The energy consumption for the building is mainly plug loads, lighting, building-specific HVAC systems, and the central plant which serves other buildings on campus. Based on the field survey, some of the unoccupied spaces are being conditioned. Additionally, both AHU-3 and AHU-4 fans were observed to be operating at 100%. This building was sparsely occupied during the field survey.



Central Complex 1		
CATEGORY	KWH	PERCENTAGE
SPACE HEATING	0	0%
COOLING	87,184	22%
VENTILATION	65,872	17%
WATER HEATING	2,906	1%
LIGHTING	75,559	19%
COOKING	0	0%
REFRIGERATION	0	0%
OFFICE EQUIPMENT	20,343	5%
COMPUTING	75,559	19%
OTHER	63,935	16%
TOTAL:	391,358	100%



Central Complex 1		
CATEGORY	THERMS	PERCENTAGE
SPACE HEATING	13,642	100%
WATER HEATING	0	0%
COOKING	0	0%
OTHER	0	0%
TOTAL:	13,642	100%

HVAC Equipment Inventory

Unit Tag	Qty	Make/Model	CFM	Cooling, MBH	Heating, MBH	Type
AHU-1	1	ALLIANCE	3,500	133.0	N/A	CHW
AHU-2	1	ALLIANCE	5,040	215.0	N/A	CHW
AHU-3	1	ALLIANCE	9,300	339.0	N/A	CHW
AHU-4	1	ALLIANCE	9,800	410.0	N/A	CHW
AHU-5	1	ALLIANCE	5,650	186.0	N/A	CHW
AHU-6	1	ALLIANCE	3,850	127.0	N/A	CHW
FC-1, 2, 5 / CU-1, 2, 5	3	CARRIER 40GV024 / 38GVC024	580	24.0	N/A	DX FAN COIL
FC-3 / CU-3	1	CARRIER 40GV012 / 38GVC012	340	12.0	N/A	DX FAN COIL
FC-4, 6, 7 / CU-4, 6, 7	3	CARRIER 40GV009 / 38GVC009	330	9.0	N/A	DX FAN COIL
HP-1	1	CARRIER RAV-SP1180	400	18.0	19.0	SPLIT SYSTEM HEAT PUMP

Lighting Equipment Inventory

Fixture Description	Fixture Type	Quantity	Wattage
2'X4' RECESSED TROFFER	LED STANDARD OUTPUT	104	45.0
2'X4' RECESSED TROFFER	LED MEDIUM OUTPUT	43	66.0
2'X2' RECESSED TROFFER	LED HIGH OUTPUT	29	45.0
6" DOWNLIGHT	LED	56	18.0
6" DOWNLIGHT WET LISTED	LED	26	18.0
4' STRIP, 1L	LED	11	25.0
4' STRIP, 1L	LED	12	47.0
24" PENDANT DOWNLIGHT	LED	3	30.0
36" PENDANT DOWNLIGHT	LED	3	94.0
48" PENDANT DOWNLIGHT	LED	3	156.0
48" LINEAR CHANNEL	LED	10	28.0
24" LINEAR CHANNEL	LED	39	14.0
48" LINEAR CHANNEL	LED	13	28.0
36" RECESSED LIGHT	LED	4	94.0
RECESSED STEP	LED	28	5.0
2'X4' RECESSED GYP	LED	6	68.0

Central Complex 2

OVERVIEW:

The Central Complex 2 (CNTL 2) building is a two-story building and has 17,250 ft2 floor area. The primary occupants are students and faculty. The space types include physic and chemistry labs, lecture halls, and office spaces. The building is approximately forty-five years old. The mechanical and electrical systems were renovated circa 2014.

EXISTING CONDITIONS:

HVAC:

The building has two multizone units with variable speed fans. The two units are served by the campus heating-hot water loop and chilled-water water loop. Each unit has economizer capabilities. One of the units is 9,600 CFM with 10-hp supply fan motor on the VFD. Another is 7,360 CFM with 7.5-hp supply fan motor on VFD. Both units are served by one in-line exhaust fan with VFD.

LIGHTING:

The lighting fixtures within the CNTL 2 building are primarily equipped with 2'x4' recessed troffer LED fixtures. Other fixtures also include compact and linear fluorescent lamps and halogen. The building has a variety of fixtures including suspended, wrap around, and recessed can downlights. Room fixtures are controlled with wall switches and occupancy sensors.

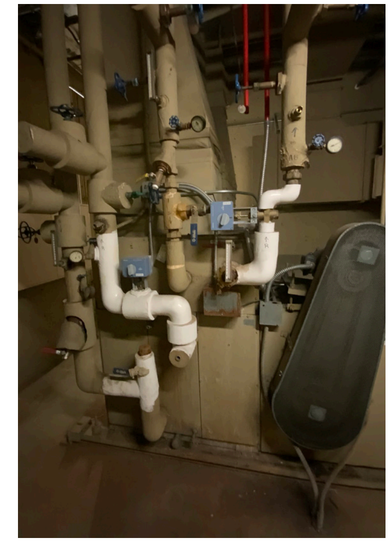
PLUMBING:

Domestic hot water is heated by one 4.5kW, 50 gallons electric water heater with domestic hot water circulation pump.

PLUG LOADS:

There is office equipment such monitors, computers, and copier/printers. The building has small data closets for the networking equipment.

LIBRARY



TYPICAL AIR HANDLER UNIT

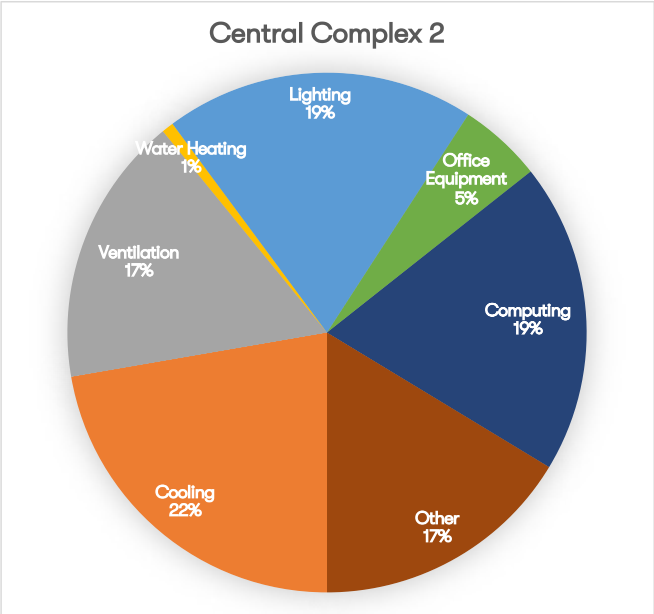
MULTIZONE DAMPERS

EXHAUST FANS

TYPICAL CLASSROOM LIGHTING LAYOUT

ENERGY CONSUMPTION:

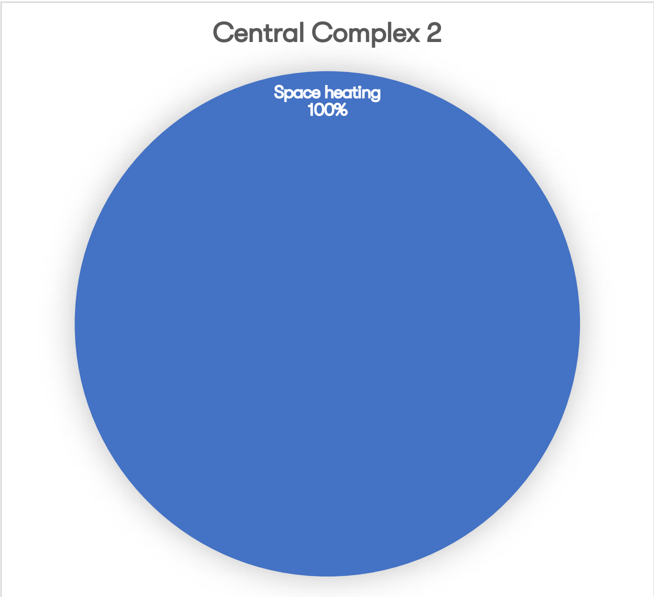
The energy consumption for the building is mainly plug loads, lighting, and the HVAC systems. This building was unoccupied during the field survey.



Central Complex 2		
CATEGORY	KWH	PERCENTAGE
SPACE HEATING	0	0%
COOLING	49,080	22%
VENTILATION	37,083	17%
WATER HEATING	1,636	1%
LIGHTING	42,536	19%
COOKING	0	0%
REFRIGERATION	0	0%
OFFICE EQUIPMENT	11,452	5%
COMPUTING	42,536	19%
OTHER	35,992	16%
TOTAL:	220,314	100%

HVAC Equipment Inventory

Unit Tag	Qty	Make/Model	CFM	Cooling, MBH	Heating, MBH	Type
MZ-1	1	MCQUAY LML217CH	9,600	288.0	3456.0	MULTIZONE CHW, HHW
MZ-2	1	MCQUAY	7,360	220.8	2649.6	MULTIZONE CHW, HHW
EF-1-2M	1	BARRY BLOWER	3,200	N/A	N/A	EXHAUST FAN
EF-2-2M	1	BARRY BLOWER	3,200	N/A	N/A	EXHAUST FAN



Central Complex 2		
CATEGORY	THERMS	PERCENTAGE
SPACE HEATING	7,680	100%
WATER HEATING	0	0%
COOKING	0	0%
OTHER	0	0%
TOTAL:	7,680	100%

Lighting Equipment Inventory

Fixture Description	Fixture Type	Quantity	Wattage
2'X4' RECESSED TROFFER	LED RETROFIT KIT	135	89.0
RECESSED CAN DOWNLIGHT	FLUORESCENT, 1L CFL42W	16	44.0
RECESSED CAN DOWNLIGHT	FLUORESCENT, 1L CFL26W	6	28.0
4' SURFACE MOUNT	FLUORESCENT, 2L F32T8	34	59.0
RECESSED STEP LIGHT	FLUORESCENT, 1L CFL13W	14	59.0
WALL MOUNT DOWNLIGHT	FLUORESCENT, 1L CFL13W	20	15.0
4' STRIP LIGHT	FLUORESCENT, 1L F32T8	14	31.0
CEILING MOUNT DOWNLIGHT	HALOGEN	17	50.0

Canyon Hall

OVERVIEW:

The Canyon Hall (CYN) building is comprised of two separate two-story buildings, one lecture/office wing and one laboratory/classroom wing with a total building area of 34,016 ft2. The primary occupants are students and faculty. The lecture/office wing building has two large lecture halls on the first floor and office space on the second floor. The laboratory/classroom wing is primarily laboratory classroom space with stockrooms and support areas. The building was constructed circa 2013.

EXISTING CONDITIONS:

HVAC:

The CYN building is served by two AHUs, one for each building. The lecture/office wing AHU is a 9,000 CFM air handler with variable speed fans and is connected to the campus chilled-water loop. The conditioned air is distributed to variable air volume boxes with hot-water reheat coils. The laboratory/classroom wing AHU is a with 45,000 CFM, 100% outside air unit with variable speed fan. The AHU is connected to the campus chilled-water loop and heating-hot water system. The conditioned air is distributed to supply air valves that are equipped with hot-water reheat coils. Additionally, there are two DX fan coils for IDF rooms within the laboratory wing.

There are three high-plume exhaust fans each with a 25-hp variable speed fan serving the laboratory fume hood exhaust system. The high-plume exhaust fans are connected to the exhaust air valves for the fume hoods and the general exhaust air valves.

LIGHTING:

The building lighting are primarily equipped with 28W fluorescent T8 lamps and electronic ballasts. Other fixtures also include compact fluorescent lamps and LEDs. The building has a variety of fixtures including recessed troffers, wall-mounted up/down cylinder fixtures, and recessed can downlights. Room fixtures are controlled with wall switches, occupancy sensors, and dimming control in some cases.

PLUMBING:

Domestic hot water is heated by 299 MBH, 70 gallons gas water heater with a 1/6-hp circulation pump. There are also one 18 kW point-of-use instantaneous electric water heaters.

PLUG LOADS:

There is office equipment such monitors, computers, and copier/printers. There are significant plug logs within the laboratory wing. The laboratory has low-temperature freezers, ovens, and laboratory equipment. There are vacuum pumps and water deionization equipment serving the laboratory needs. The building has small data closets for the networking equipment.

CANYON HALL BUILDING

TYPICAL AIR HANDLER UNIT WITH CHILLED WATER CONNECTION

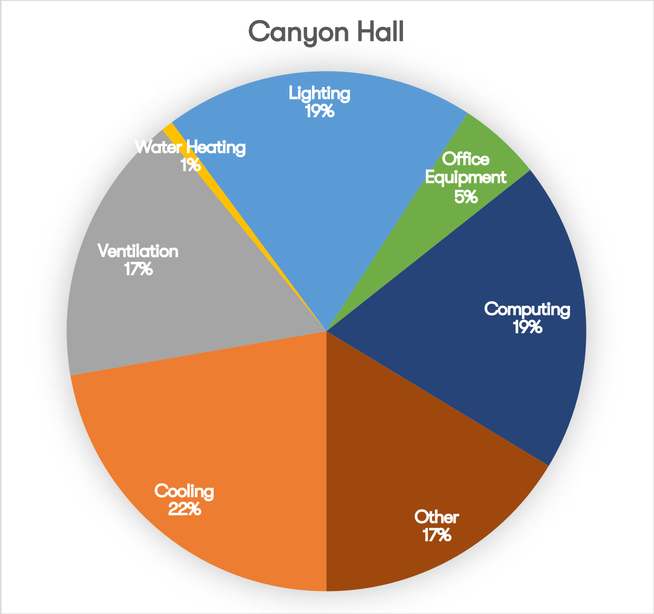
TYPICAL FUME HOOD

TYPICAL CLASSROOM LIGHTING LAYOUT

COLD STORAGE REFRIGERATORS

ENERGY CONSUMPTION:

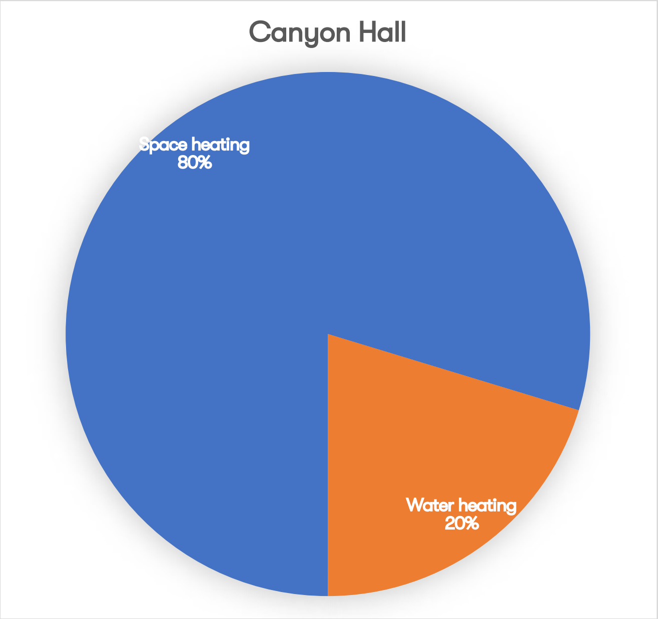
The energy consumption for the building is mainly plug loads, lighting, the walk-in refrigerators and freezers, reach-in refrigerated cases, electric cart charging, and the HVAC systems. This building was unoccupied during the field survey.



Canyon Hall		
CATEGORY	KWH	PERCENTAGE
SPACE HEATING	0	0%
COOLING	96,850	22%
VENTILATION	73,175	17%
WATER HEATING	3,228	1%
LIGHTING	83,937	19%
COOKING	0	0%
REFRIGERATION	0	0%
OFFICE EQUIPMENT	22,598	5%
COMPUTING	83,937	19%
OTHER	71,023	16%
TOTAL:	434,748	100%

HVAC Equipment Inventory

Unit Tag	Qty	Make/Model	CFM	Cooling, MBH	Heating, MBH	Type
AHU-101	1	ENERGY LABS C6668	9,000	329.0	N/A	CHW
AHU-102	1	ENERGY LABS C128150	45,000	2719.0	1457.0	CHW, HHW
EF-101, 102, 103	3	ENERGY LABS C48270	24,000	N/A	N/A	HIGH-PLUME EXHAUST
EF-104, 105	2	GREENHECK CUE-080-VG	200	N/A	N/A	EXHAUST FAN
EF-106	1	GREENHECK CUBE-161HP-10	1,700	N/A	N/A	EXHAUST FAN
FC-101, 102	2	DAIKIN	570	22.0	N/A	DX SPLIT SYSTEM



Canyon Hall		
CATEGORY	THERMS	PERCENTAGE
SPACE HEATING	12,078	80%
WATER HEATING	3,076	20%
COOKING	0	0%
OTHER	0	0%
TOTAL:	15,155	100%

Lighting Equipment Inventory

Fixture Description	Fixture Type	Quantity	Wattage
2'X4' RECESSED TROFFER	FLUORESCENT, 3L F32T8	194	84.0
2'X4' RECESSED TROFFER	FLUORESCENT, 2L F32T8	7	53.0
2'X4' RECESSED TROFFER	FLUORESCENT, 1L F32T8	12	29.0
RECESSED CAN DOWNLIGHT	FLUORESCENT, 2L CFL32W	57	76.0
RECESSED CAN DOWNLIGHT	FLUORESCENT, 2L CFL32W	26	46.0
RECESSED CAN DOWNLIGHT	FLUORESCENT, 2L CFL26W	20	52.0
RECESSED CAN DOWNLIGHT	FLUORESCENT, 1L CFL42W	26	46.0
RECESSED CAN DOWNLIGHT	FLUORESCENT, 1L CFL26W	12	28.0

Visual Arts

OVERVIEW:

The Visual Arts (ARTS) building is a one-story building and has 9,850 ft2 floor area. The primary occupants are students and faculty. Space types are mainly art laboratory and studio spaces. The building is forty-five years old.

EXISTING CONDITIONS:

HVAC:

The building is served by two multizone units with variable speed fans and economizer capabilities. The heating hot water and chilled water to multizone units are provided from Central Plant.

LIGHTING:

The building lighting are primarily equipped with 32W fluorescent T8 lamps and electronic ballasts. Other fixtures also include compact fluorescent lamps and halogen. The building has a variety of fixtures including recessed troffers and recessed can downlights. Room fixtures are controlled with wall switches and occupancy sensors.

PLUMBING:

Domestic hot water (DHW) is heated by one 6kW, 50 gallons electric water heater with circulation pump.

PLUG LOADS:

There is office equipment such monitors, computers, and copier/printers.

ARTS BUILDING

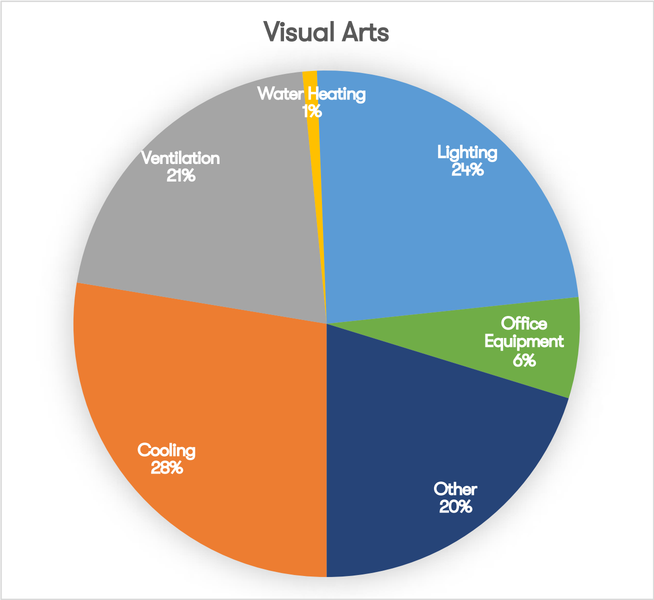

CHILLED WATER CONNECTIONS TO AIR HANDLING UNITS


TYPICAL CLASSROOM LIGHTING LAYOUT


TYPICAL WALL MOUNTED EXTERIOR LIGHTING FIXTURE

ENERGY CONSUMPTION:

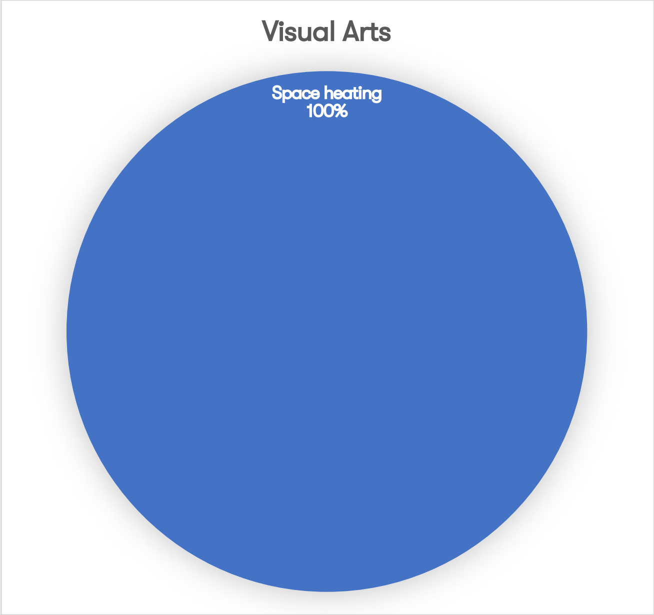
The energy consumption for the building is mainly plug loads, lighting, and HVAC systems. Based on the field survey, some of the unoccupied spaces are being conditioned. This building was unoccupied during the field survey.



Visual Arts		
CATEGORY	KWH	PERCENTAGE
SPACE HEATING	0	0%
COOLING	34,727	28%
VENTILATION	26,238	21%
WATER HEATING	1,158	1%
LIGHTING	30,096	24%
COOKING	0	0%
REFRIGERATION	0	0%
OFFICE EQUIPMENT	8,103	6%
COMPUTING	0	0%
OTHER	25,466	20%
TOTAL:	125,788	100%

HVAC Equipment Inventory

Unit Tag	Qty	Make/Model	CFM	Cooling, MBH	Heating, MBH	Type
MZ-1	1	AIR FAN LPM 25B	8,000	293.0	400.0	MULTIZONE CHW, HHW
MZ-2	1	AIR FAN LPM 15B	6,000	168.0	300.0	MULTIZONE CHW, HHW



Visual Arts		
CATEGORY	THERMS	PERCENTAGE
SPACE HEATING	4,385	100%
WATER HEATING	0	0%
COOKING	0	0%
OTHER	0	0%
TOTAL:	4,385	100%

Lighting Equipment Inventory

Fixture Description	Fixture Type	Quantity	Wattage
2'X4' RECESSED TROFFER	FLUORESCENT, 3L F32T8	172	89.0
4'X4' RECESSED TROFFER	FLUORESCENT, 6L F32T8	6	171.0
4' SURFACE MOUNT	FLUORESCENT, 2L F32T8	6	59.0
2' RECESSED TROFFER	FLUORESCENT, 2L F17T8	9	34.0
1' SURFACE MOUNT	FLUORESCENT, 1L CFL42W	8	44.0

East Complex 1

OVERVIEW:

The East Complex 1 (EAST 1) building is one story building and has 4,350 ft2 floor area. The primary occupants are students and faculty. The space type is primarily classroom. Building is less than twenty years old.

EXISTING CONDITIONS:

HVAC:

There are six Carrier rooftop DX/gas heating packaged units (2x5 tons, 1x4 tons, 3x3 tons, SEER=10). serving the building. The units are controlled by programmable thermostats.

LIGHTING:

The lighting fixtures within the EAST 1 building are primarily equipped with 2'x4'recessed troffer LED fixtures. Room fixtures are controlled with wall switches and occupancy sensors.

PLUMBING:

There are no domestic water heaters or water fixtures that server the building.

PLUG LOADS:

There is office equipment such monitors, computers, and copier/printers.

EAST COMPLEX 2 BUILDING

TYPICAL PACKAGED ROOFTOP HEAT PUMP

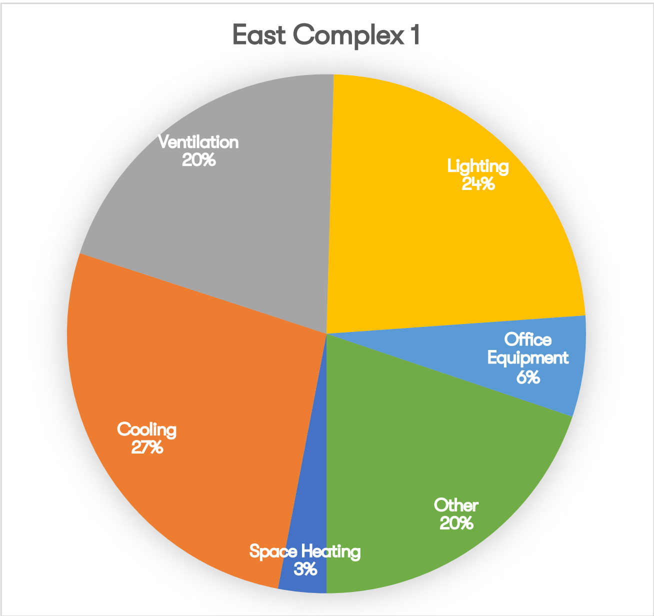
GENERAL ROOF LAYOUT

TYPICAL LIGHTING LAYOUT

TYPICAL LIGHTING FIXTURE WITH F32T8 LAMPS

ENERGY CONSUMPTION:

The energy consumption for the building is mainly plug loads, lighting, and the HVAC systems. This building was unoccupied during the field survey.



East Complex 1		
CATEGORY	KWH	PERCENTAGE
SPACE HEATING	2,211	3%
COOLING	19,896	27%
VENTILATION	15,033	20%
WATER HEATING	0	0%
LIGHTING	17,244	23%
COOKING	0	0%
REFRIGERATION	0	0%
OFFICE EQUIPMENT	4,643	6%
COMPUTING	0	0%
OTHER	14,591	20%
TOTAL:	73,617	100%

HVAC Equipment Inventory

Unit Tag	Qty	Make/Model	CFM	Cooling, MBH	Heating, MBH	Type
N/A	1	CARRIER 48GSN060	2,000	60.0	70.0	RTU, DX/GAS
N/A	1	CARRIER 48GSN060	2,000	60.0	70.0	RTU, DX/GAS
N/A	1	CARRIER 48GSN048	1,600	48.0	70.0	RTU, DX/GAS
N/A	1	CARRIER 48GSN042	1,400	42.0	47.0	RTU, DX/GAS
N/A	1	CARRIER 48GSN042	1,400	42.0	47.0	RTU, DX/GAS
N/A	1	CARRIER 48GSN042	1,400	42.0	47.0	RTU, DX/GAS

Lighting Equipment Inventory

Fixture Description	Fixture Type	Quantity	Wattage
2'X4' RECESSED TROFFER	LED	130	114.0

Observatory

OVERVIEW:

The East Complex 2 (EAST 2) building is one story building and has 5,750 ft2 floor area. The primary occupants are students and faculty. Space types include a sales floor for books, stock room, clerical space, and offices. Building is less than twenty years old.

EXISTING CONDITIONS:

HVAC:

There are six Carrier rooftop DX/gas heating packaged units (4x5 tons, 1x4 tons, 1x3.5 tons, SEER=10) serving the bookstore. The units are controlled by programmable thermostats.

LIGHTING:

The lighting fixtures within the EAST 2 building are primarily equipped with 32W fluorescent T8 lamps and electronic ballasts. Room fixtures are controlled with wall switches and occupancy sensors.

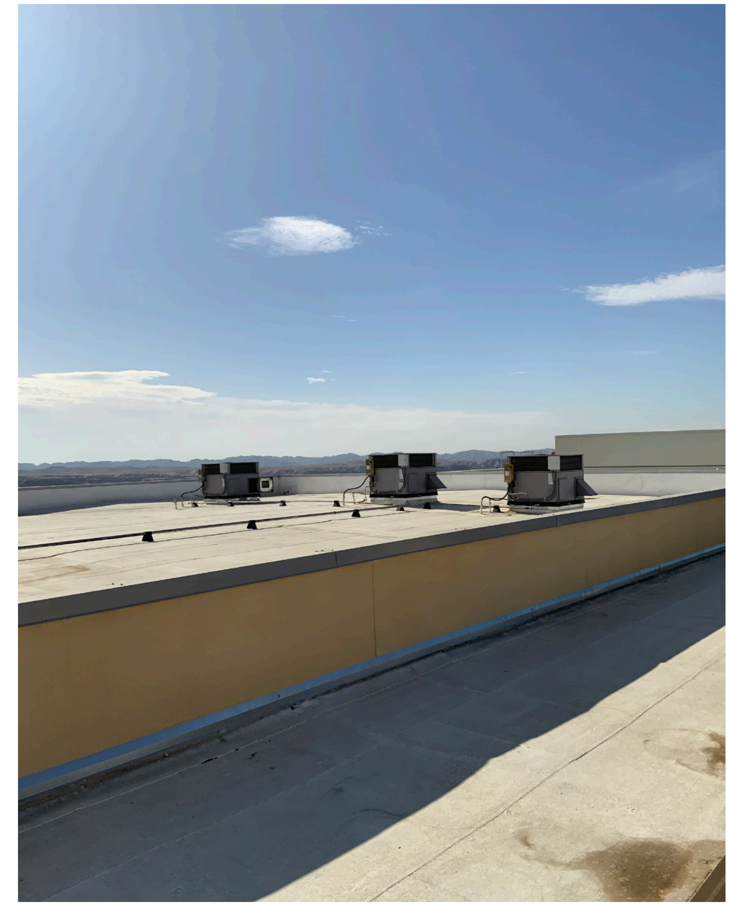
PLUMBING:

Domestic hot water (DHW) is heated by one 1.5kW, 6 gallons electric water heater.

PLUG LOADS:

There is office equipment such monitors, computers, and copier/printers.

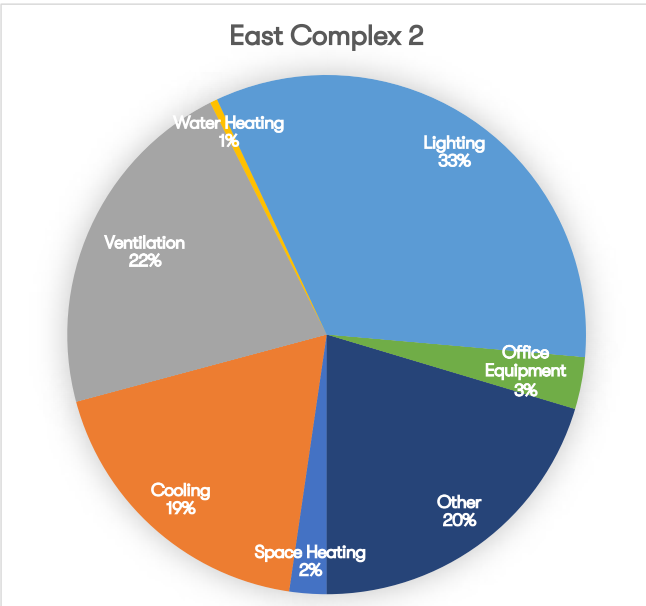
GENERAL LIGHTING LAYOUT



PACKAGED ROOFTOP HEAT PUMPS

ENERGY CONSUMPTION:

The energy consumption for the building is mainly plug loads, lighting, and the HVAC systems. This building was unoccupied during the field survey.



East Complex 2		
CATEGORY	KWH	PERCENTAGE
SPACE HEATING	1,569	2%
COOLING	12,553	19%
VENTILATION	14,750	22%
WATER HEATING	314	0%
LIGHTING	22,596	33%
COOKING	0	0%
REFRIGERATION	0	0%
OFFICE EQUIPMENT	2,197	3%
COMPUTING	0	0%
OTHER	13,809	20%
TOTAL:	67,788	100%

HVAC Equipment Inventory

Unit Tag	Qty	Make/Model	CFM	Cooling, MBH	Heating, MBH	Type
N/A	1	CARRIER 48GSN060	2,000	60.0	70.0	RTU, DX/GAS
N/A	1	CARRIER 48GSN060	2,000	60.0	70.0	RTU, DX/GAS
N/A	1	CARRIER 48GSN048	1,600	48.0	70.0	RTU, DX/GAS
N/A	1	CARRIER 48GSN042	1,400	42.0	47.0	RTU, DX/GAS
N/A	1	CARRIER 48GSN042	1,400	42.0	47.0	RTU, DX/GAS
N/A	1	CARRIER 48GSN042	1,400	42.0	47.0	RTU, DX/GAS

Lighting Equipment Inventory

Fixture Description	Fixture Type	Quantity	Wattage
2'X4' RECESSED TROFFER	FLUORESCENT, 3L F32T8	75	89.0

Public Safety & Allied Health

OVERVIEW:

The Public Safety & Allied Health (PSAH) building is a two-story building and has 30,800 ft2 floor area. The primary occupants are students and faculty. The space types include offices, classrooms, and large vehicle garage/bay. The building was constructed in circa 2013.

EXISTING CONDITIONS:

HVAC:

The PSAH building is served by two AHUs, one for each floor. The first floor AHU is a 12,875 CFM air handler with variable speed fans and is connected to the campus chilled-water loop. The second floor AHU is a 10,700 CFM air handler with variable speed fans and is connected to the campus chilled-water loop. Both AHUs have economizer capabilities. The conditioned air is distributed to variable air volume boxes with hot-water reheat coils. Additionally, there are four DX fan coils for IDF rooms within the laboratory wing. There are four gas-fired radiant heaters serving the large vehicle garage/bay.

LIGHTING:

The lighting fixtures within PSAH building were a combination of linear fluorescent T5 technology, compact fluorescent lamps, and LEDs. The fixture types are predominately lensed 1’x4’ recessed troffers fixtures equipped with 28W linear fluorescent T5 lamps. The offices are illuminated with 2’x2’ recessed troffer fixtures equipped with 14W linear fluorescent T5 lamps. The large vehicle garage/bay is illuminated with high-bay pendant mounted fixtures equipped with compact fluorescent lamps. Room fixtures are controlled with wall switches, occupancy sensors, and dimming controls in some cases.

PLUMBING:

Domestic hot water is heated by 380 MBH tankless gas water. There are also one 4.5 kW and one 9.0 kW point-of-use instantaneous electric water heaters.

PLUG LOADS:

There is office equipment such monitors, computers, and copier/printers. There is a breakroom that includes refrigerators and microwaves. The building has small data closets for the networking equipment.

PUBLIC SAFETY AND ALLIED HEALTH BUILDING

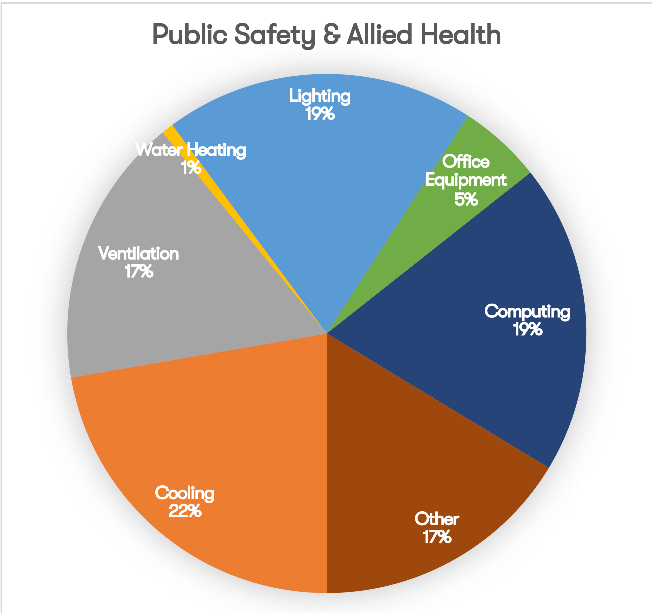

AIR HANDLER UNITS WITH CHILLED WATER CONNECTIONS


TYPICAL CLASSROOM LIGHTING LAYOUT


FIRETRUCK SERVICE BAY HIGH-BAY LIGHTING LAYOUT

ENERGY CONSUMPTION:

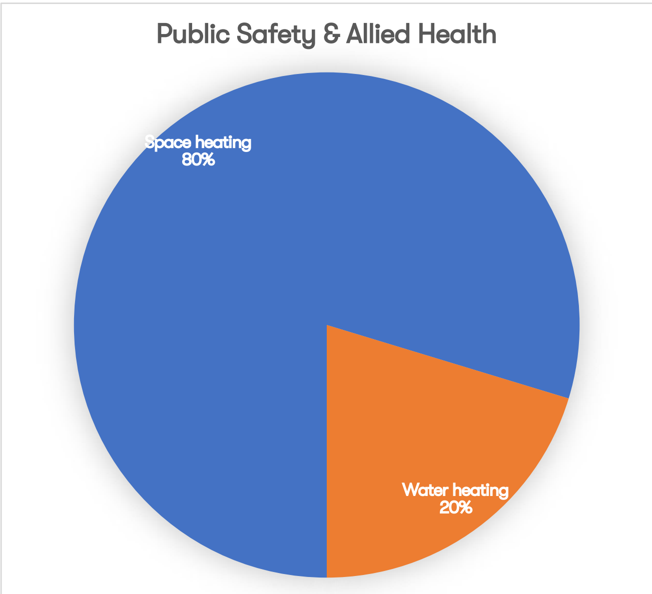
The energy consumption for the building is mainly plug loads, lighting, and the HVAC systems. This building was sparsely occupied during the field survey.



Public Safety & Allied Health		
CATEGORY	KWH	PERCENTAGE
SPACE HEATING	0	0%
COOLING	96,850	22%
VENTILATION	73,175	17%
WATER HEATING	3,228	1%
LIGHTING	83,937	19%
COOKING	0	0%
REFRIGERATION	0	0%
OFFICE EQUIPMENT	22,598	5%
COMPUTING	83,937	19%
OTHER	71,023	16%
TOTAL:	434,748	100%

HVAC Equipment Inventory

Unit Tag	Qty	Make/Model	CFM	Cooling, MBH	Heating, MBH	Type
AHU-1	1	ENERGY LABS	12,875	399.0	N/A	CHW
AHU-2	1	ENERGY LABS	10,700	396.0	N/A	CHW
FC-1 / CU-1	1	CARRIER 40QA / 38HDR	1,200	44.4	N/A	DX FAN COIL
FC-2, 3 / CU-2, 3	2	CARRIER 40QN / 38HDF	900	34.1	N/A	DX FAN COIL
FC-4 / CU-4	1	CARRIER 40QN / 38HDF	645	16.6	N/A	DX FAN COIL
RH-1, 2, 3	3	SPACE-RAY LTU 125	N/A	N/A	125.0	RADIANT HEATER, GAS



Public Safety & Allied Health		
CATEGORY	THERMS	PERCENTAGE
SPACE HEATING	16,666	80%
WATER HEATING	4,245	20%
COOKING	0	0%
OTHER	0	0%
TOTAL:	20,911	100%

Lighting Equipment Inventory

Fixture Description	Fixture Type	Quantity	Wattage
FLUORESCENT FIXTURE	FLUORESCENT, 1L F28T5	35	30.0
4' RECESSED	FLUORESCENT, 1L F28T5	31	30.0
6' RECESSED DOWNLIGHT	LED	12	39.0
UNDERCABINET LIGHT	LED	3	30.0
OPEN HIGH BAY	FLUORESCENT, 1L CFL42W	16	198.0
PENDANT LOW-PROFILE STRIP	FLUORESCENT, 2L F32T8	8	62.0
4' DIRECT SUSPENDED	FLUORESCENT, 1L F28T5	2	30.0
4' SUSPENDED	FLUORESCENT, 2L F32T8	4	62.0
2'X2' RECESSED TROFFER	FLUORESCENT, 2L F14T5	35	34.0
FLUORESCENT FIXTURE	FLUORESCENT, 2L F32T8	16	62.0
6' RECESSED DOWNLIGHT	LED	23	27.0
SUSPENDED STAR SHAPE	FLUORESCENT, 3L F28T5	16	72.0
1'X4' RECESSED TOFFER	FLUORESCENT, 2L F28T5	129	62.0
2'X2' RECESSED TROFFER	FLUORESCENT, 2L F14T5	56	47.0
FLUORESCENT FIXTURE	FLUORESCENT, 2L F14T5	4	34.0

Gymnasium

OVERVIEW:

The Gymnasium (GYM) building is a two-story building and has 27,900 ft2 floor area. Its usage is gym spaces. Building is forty- five years old. This building does not appear to be in use anymore and is scheduled to be demolished.

EXISTING CONDITIONS:

HVAC:

Gymnasium building has six heating hot water/chilled water air handlings units. Four of them are constant flow 9,000 CFM, 3HP supply fan units with economizer. One of the air handling units is constant flow 3,000 CFM, 1HP supply fan, and one is constant flow 1,460 CFM with 1.5 HP supply fan.

There are four heating hot water/chilled water fan coils in men's and women's locker rooms and three heating hot water/chilled water fan coils in the basement.

LIGHTING:

The lighting fixtures within the GYM building are primarily equipped with 32W fluorescent T8 lamps and electronic ballasts. Other fixtures also include compact fluorescent lamps and halogen. The building has a variety of fixtures including recessed troffers and recessed can downlights. Room fixtures are controlled with wall switches and occupancy sensors.

PLUMBING:

Domestic hot water (DHW) is heated by Patterson-Kelly Compact 400 packaged water heater served by hydronic boiler.

PLUG LOADS:

There is office equipment such monitors, computers, and copier/printers. The building has small data closets for the networking equipment.

ENERGY CONSUMPTION:

The energy consumption for the building is mainly plug loads, lighting, and the HVAC systems. However, the building is not occupied and building systems are expected to be offline. This building was unoccupied during the field survey.

GYMNASIUM BUILDING

HVAC Equipment Inventory

Unit Tag	Qty	Make/Model	CFM	Cooling, MBH	Heating, MBH	Type
AHU-1	1		9,000			CHW, HHW
AHU-2	1		9,000			CHW, HHW
AHU-3	1		9,000			CHW, HHW
AHU-4	1		9,000			CHW, HHW
AHU-5	1		3,000			CHW, HHW
AHU-6	1		1,460			CHW, HHW

North Complex

OVERVIEW:

The North Complex (NRTH) is comprised of two one-story buildings. These buildings are modular classroom buildings and has a total of 8,300 ft2 floor area. The primary occupants are students and faculty. The space types classroom laboratories, restrooms, and laboratory support spaces. Building is ten years old.

EXISTING CONDITIONS:

HVAC:

There are wall-mounted packaged BARD heat pumps (4x3.5 tons, EER=8.7, SEER=10) that serve the classroom spaces. There are five split-split heat pumps that serve the support spaces. There are three high-plume exhaust fans that serve the fume hoods within the laboratories. The fume hoods were not in use and the high-plume exhaust fans were off.

LIGHTING:

The lighting fixtures within the NRTH building are primarily equipped with 32W fluorescent T8 lamps and electronic ballasts. The building has a variety of fixtures including recessed troffers and surface mounted wraps with lens. Room fixtures are controlled with wall switches and occupancy sensors.

PLUMBING:

Domestic hot water is heated point-of-use instantaneous electric water heaters. The water heater ratings were unable to be verified.

PLUG LOADS:

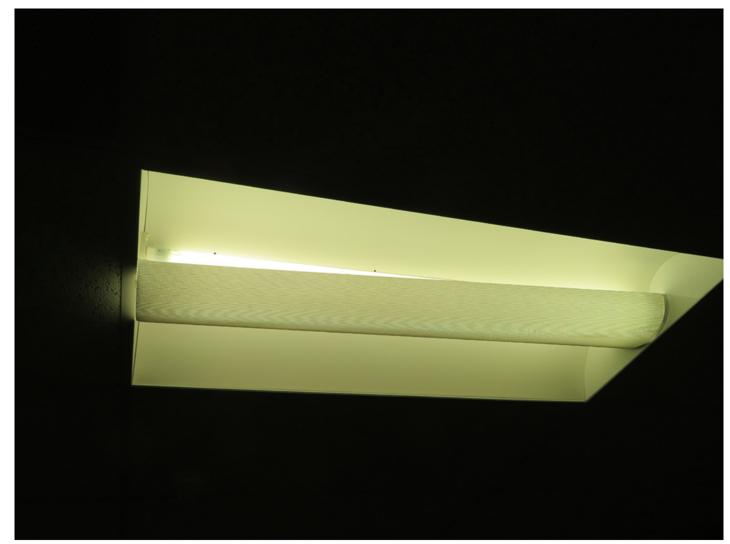
There is office equipment such monitors, computers, and copier/printers. The building has small data closets for the networking equipment.

NORTH COMPLEX BUILDING

TYPICAL WALL-MOUNTED HEAT PUMP

TYPICAL SPLIT SYSTEM CONDENSING UNIT

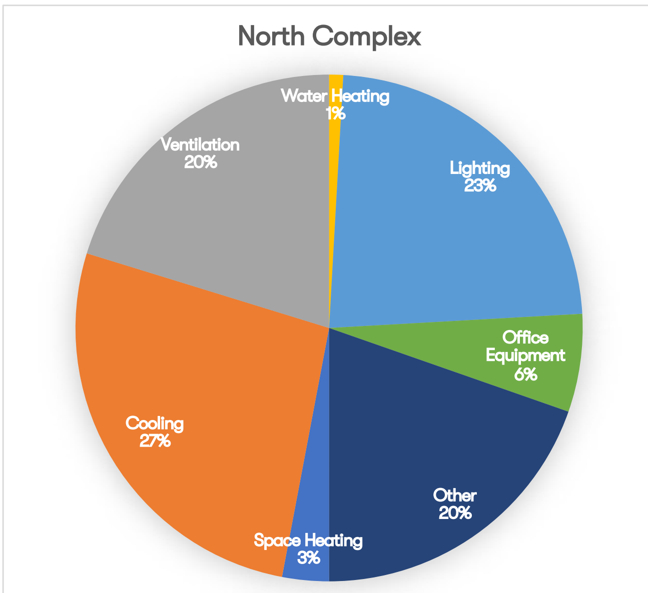
TYPICAL CLASSROOM LIGHTING LAYOUT



TYPICAL LIGHTING FIXTURE WITH F32T8 LAMP

ENERGY CONSUMPTION:

The energy consumption for the building is mainly plug loads, lighting, and the HVAC systems. This building was unoccupied during the field survey.



North Complex		
CATEGORY	KWH	PERCENTAGE
SPACE HEATING	3,931	3%
COOLING	35,377	27%
VENTILATION	26,730	20%
WATER HEATING	1,179	1%
LIGHTING	30,660	23%
COOKING	0	0%
REFRIGERATION	0	0%
OFFICE EQUIPMENT	8,255	6%
COMPUTING	0	0%
OTHER	25,943	20%
TOTAL:	132,076	100%

HVAC Equipment Inventory

Unit Tag	Qty	Make/Model	CFM	Cooling, MBH	Heating, MBH	Type
N/A	4	BARD	1,400	42.0	30.0	WALL MOUNT HEAT PUMP
N/A	3	MITSUBISHI	800	24.0	30.0	SPLIT SYSTEM HEAT PUMP
EF	3	TBD		N/A	N/A	HIGH-PLUME EXHAUST

Lighting Equipment Inventory

Fixture Description	Fixture Type	Quantity	Wattage
2'X4' RECESSED TROFFER	FLUORESCENT, 3L F32T8	112	91.0
1'X4' RECESSED TROFFER / SURFACE	FLUORESCENT, 2L F32T8	12	60.0

Kinesiology, Health Education & Aquatics Complex

OVERVIEW:

The Kinesiology, Health Education & Aquatics Complex (KHA) is comprised of three separate one-story buildings and has 7,500 ft2 floor area. The primary occupants are students, pool visitors, and faculty. The buildings include a fitness center, dance studio, yoga studio, locker rooms, offices, and a mechanical room for the pool pump. The building was constructed circa 2013.

EXISTING CONDITIONS:

HVAC:

There are three rooftop dx/gas heating packaged units (1x11 tons, 1x5.5 tons, 1x7 tons, SEER=14) serving the fitness center, dance studio, and yoga studio. The units are controlled by programmable thermostats. There is one DX fan coil serving the IDF room. There is one split system heat pump serving the office and restroom space.

LIGHTING:

The lighting fixtures within the KHA building are primarily low-bay fixtures equipped with compact fluorescent lamps and electronic ballasts. Other fixtures also include linear fluorescent T5 lamps and LEDs. The building has a variety of fixtures including low-bay pendant fixtures, 2'x4' recessed troffers, wall-mounted cylindrical downlights, and recessed can downlights. Room fixtures are controlled with wall switches, occupancy sensors, and dimming control in some cases.

The outdoor pool is light with high-mast high-intensity discharge fixtures.

PLUMBING:

Domestic hot water is heated by 190 MBH tankless water heater with a 1/8-hp circulation pump.

PLUG LOADS:

There is office equipment such monitors, computers, and copier/printers. The fitness enter also includes exercise equipment such as treadmills.

PROCESS LOADS:

There is a constant-speed 40-hp pool pump and filtration system serving the recreational outdoor pool. The pool water is primarily heated with the solar thermal water heating system located on hills next to adjacent parking lot with two natural gas boilers as back up.

TYPICAL PACKAGED ROOFTOP UNIT

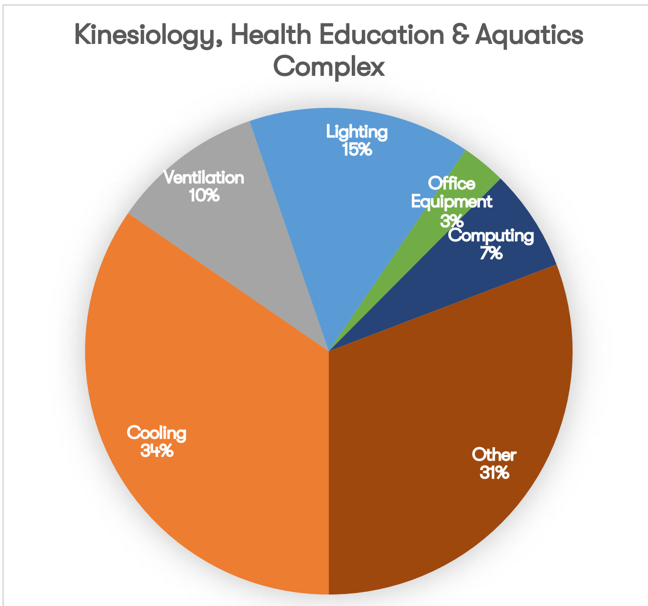
POOL PUMP

TYPICAL FITNESS CENTER LIGHTING LAYOUT

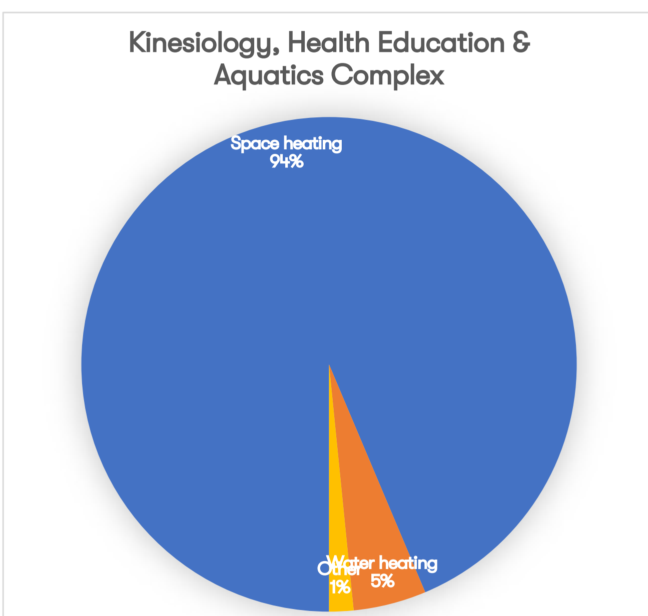
TYPICAL CYLINDRICAL LED LIGHT FIXTURE

ENERGY CONSUMPTION:

The energy consumption for the building is mainly pool pump, lighting, and the HVAC systems. A portion of the pool water heating is offset by the solar thermal water heating system. This building was occupied with pool visitors during the field survey.



Kinesiology, Health Education & Aquatics Complex		
CATEGORY	KWH	PERCENTAGE
SPACE HEATING	0	0%
COOLING	42,399	35%
VENTILATION	12,409	10%
WATER HEATING	0	0%
LIGHTING	18,097	15%
COOKING	0	0%
REFRIGERATION	0	0%
OFFICE EQUIPMENT	3,619	3%
COMPUTING	8,273	7%
OTHER	37,745	31%
TOTAL:	122,543	100%



Kinesiology, Health Education & Aquatics Complex		
CATEGORY	THERMS	PERCENTAGE
SPACE HEATING	4,000	94%
WATER HEATING	203	5%
COOKING	0	0%
OTHER	68	2%
TOTAL:	4,272	100%

HVAC Equipment Inventory

Unit Tag	Qty	Make/Model	CFM	Cooling, MBH	Heating, MBH	Type
EVA-1	1	RENZOR	2,000	N/A	120.0	MAKE-UP AIR, GAS
EVA-2	1	RENZOR	2,000	N/A	120.0	MAKE-UP AIR, GAS
AC-1	1	TRANE YHC060	2,000	60.0	58.8	RTU, DX/GAS
FC-1, HP-1	1	CARRIER FX4C / 38QRR	2,000	60.0	60.0	DX FAN COIL
FC-2, HP-2	1	MITSUBISHI MSZ-Z09NA	230	9.0	10.9	DX FAN COIL
FC-3, HP-3	1	CARRIER FX4C / 38QRR	800	24.0	24.0	DX FAN COIL
EF-1, 2, 3, 4, 5, 6, 7, 8	8	COOK 60 ACE	300	N/A	N/A	EXHAUST FAN
RTU-1	1	AAON RN-013-8	3,000	135.5	156.0	RTU, DX/GAS
RTU-2	1	AAON RN-007-8	1,500	65.0	72.9	RTU, DX/GAS
RTU-3	1	AAON RN-008-8	2,700	86.0	120.0	RTU, DX/GAS
FC-1 / CU-1	1	CARRIER 40QNC018 / 38HDF	645	16.6	N/A	DX SPLIT SYSTEM
HP-1 / CU-2	1	CARRIER FV4CN / 25HNB39	825	31.9	35.3	SPLITY SYSTEM HEAT PUMP

Lighting Equipment Inventory

Fixture Description	Fixture Type	Quantity	Wattage
RECESSED CAN DOWNLIGHT	FLUORESCENT, 1L CFL26W	18	28.0
RECESSED SHOWER DOWNLIGHT	FLUORESCENT, 1L CFL8W	96	9.0
2'X2' RECESSED DIRECT / INDIRECT	FLUORESCENT, 3L F17T8	16	46.0
1'X2' RECESSED DIRECT / INDIRECT	FLUORESCENT, 1L F17T8	10	16.0
2'X4' RECESSED DIRECT / INDIRECT	FLUORESCENT, 3L F32T8	4	90.0
CONTINUOUS UPLIGHT	FLUORESCENT, 1L F32T8	30	9.0
SUSPENDED STRIP	FLUORESCENT, 2L F32T8	15	65.0
SUSPENDED STRIP	FLUORESCENT, 1L F32T8	4	31.0
4' SURFACE MOUNTED	FLUORESCENT, 1L F32T8	3	31.0
LINEAR INDIRECT WALL MOUNT	FLUORESCENT, 1L CFL8W	243	9.0
6" DOWNLIGHT	LED	5	39.0
6" SHOWER DOWNLIGHT	LED	1	39.0
LOW-BAY DOWNLIGHT	FLUORESCENT, 2L CFL42W	58	94.0
2'X4' RECESSED TROFFER	LED	6	40.0
4' STRIP LIGHT	FLUORESCENT, 1L F28T5	2	30.0
4' PERIMETER COVE LIGHT	LED	2	23.0

ENERGY CONSERVATION MEASURES AND STRATEGIES

Based on the field surveys, P2S identified energy conservation measure (ECM) and strategies to implement. The follow tables summarize the ECM savings, cost, and payback for the campus.

Table 7 – Building Cost Summary Table

Building	Installed Cost ($)
ARTS	$25,254
CCR	$9,492
CDC	$45,872
CNTL 1	$50,932
CNTL 2	$25,764
CTB	$9,064
CYN	$9,312
EAST 1 & 2	$78,080
EXTERIOR	$147,700
LRC	$23,408
M&O	$13,216
NRTH	$5,376
PAC	$74,813
PSAH	$9,089
SSB	$13,055
VARIOUS	$70,000
WEST	$15,346
GRAND TOTAL	$625,772

Table 6 – Summary Table

ECM #	ECM Description	Energy Savings, kWh/yr	Demand Savings, kW	THERM SAVINGS, THERMS/YR	CONSTRUCTION COST	INCENTIVES / REBATE, $	COST SAVINGS, $	SIMPLE PAYBACK, YRS
1	Interior Lighting Upgrade	111,817	32	0	$64,544	$9,196	$15,800	3.5
2	Exterior Lighting Upgrade	90,009	6	0	$147,700	$0	$13,006	11.4
3	Controls, RCx, and MBCx	147,609	0	1,760	$105,771	$20,408	$14,740	5.8
4	Fan Wheel Retrofit	48,105	2	0	$63,000	$0	$4,397	14.3
5	Plug Load Control	93,820	0	0	$70,000	$0	$8,575	8.2
6	Tankless DHW Heaters	48,347	0	-1,650	$35,612	$0	$3,248	11.0
7	Premium Efficiency Motors	7,250	0	0	$13,144	$0	$1,053	12.5
8	RTU Upgrade	23,629	0	0	$126,000	$1,860	$2,160	57.5
TOTALS:		570,585	40	110	$625,772	$31,464	$62,978	9.4

The following is a list of ECMs to promote energy efficiency at the campuses.

ECM 01 Interior Lighting Upgrade

The interior lighting fixtures for SBVC and CHC predominately utilize 4' 32W fluorescent T8 lamps and electronic ballasts. Additionally, other lighting technology utilized on both campuses include compact fluorescent lamps, 2' 17W fluorescent T8 lamps and electronic ballasts, high-intensity discharge lamps, and 3' 21W fluorescent T5 lamps and electronic ballasts. These fixtures are recommended to be retrofitted with LED technology. There are several options available that range in cost, savings, and complexity. Three options for LED upgrades are described below. P2S recommends Option 1 as an overall approach because of the relatively lower cost, comparatively similar savings, and is the least complex of the three options. Lighting retrofits for each building should be considered on a case-by-case basis to ensure the best solution is implemented. In addition to saving energy, occupant comfort and ease of maintenance should be considered. In some cases, Option 2 or 3 may be the best solution. A LED lighting retrofit may encompass a combination of all three options. Buildings and interior spaces already utilizing LED technology are not included in the recommendation.

ECM 01 OPTION 1

P2S recommends re-lamping the linear fluorescent, compact fluorescent, and high-intensity discharge lamps with equivalent LED lamps. The 4' 32W fluorescent T8 lamps is recommended to be replaced with 4' LED type A lamps. LED type A lamps, also known as LED plug-and-play lamps, operate on the existing electronic ballast within the fixture. Re-lamping with LED type A lamps does not require modifications to the lighting fixture. Re-lamping is applicable to a wide range of fixture types on each campus which includes 2'x4' recessed troffers, suspended direct/indirect fixtures, wall- or ceiling-mounted fixtures, and cove lighting. Similarly, the compact fluorescent lamps, 2' 17W fluorescent T8 lamps, and the 3' 21W fluorescent T5 lamps are recommended to be re-lamped with equivalent LED type A lamps. Re-lamping does not trigger Title 24 code which would mandate a series of lighting controls also be implemented if they were not already installed.

The high-intensity discharge lamps are also recommended to be re-lamped with equivalent LED lamps. Re-lamping the fixtures would require removing the ballast and wiring the socket to line voltage. Such modifications to the fixture would trigger Title 24 code. However, Title 24 grants an exception if less than 10% of the fixtures serving an enclosed space of the fixtures are modified (Title 24-2019 Part 6 section 141.1.(b).2.I). The maximum fixture threshold may not be applicable to spaces such as the Valley College Bookstore and Campus Center.

The proposed LED lamps should be Energy Star qualified and/or DesignLights Consortium (DLC) certified to ensure installed products meet quality assurance standards. Utility incentive programs also require that LED products meet these standards in order to be eligible for rebates and incentives.

Special consideration should be made for ballast compatibility. Most LED type A lamps are designed to operate on electronic ballasts offered by major manufacturers. Ballast compatibility sheets are published by LED lamp manufacturers and should be referenced before LED lamps are installed. If necessary, ballasts should be replaced if they have failed or incompatible with the proposed LED type A lamps. Replacing the ballast is considered an alteration by Title 24 code and trigger code requirements. However, Title 24 grants an exception if less than 10% of the fixtures serving an enclosed space of the fixtures are modified (Title 24-2019 Part 6 section 141.1.(b).2.I).

ECM 01 OPTION 2

In the scenario that re-lamping with LED type A lamps is not a feasible solution, P2S recommends installing LED type B lamps, also known as LED ballast-bypass or direct-wire lamps, which would require removal of the ballast and rewiring of the lamp sockets (shunted to non-shunted) to line voltage. The lamp sockets may also need to be replaced before LED lamps are installed. Option 2 is applicable to the 4' 32W fluorescent T8 lamps, 2' 17W fluorescent T8 lamps, and the 3' 21W fluorescent T5 lamps.

Removal of the ballast triggers Title 24 code which would mandate a series of lighting controls also be implemented if they were not already installed. Per Title 24-2019 Part 6 section 130.1, the lighting control requirements are:

- Manual Area Controls: Each area enclosed by ceiling-height partitions shall provide lighting controls that allow the lighting in that area to be manually turned on and off. This level of control is already implemented in the majority of Valley College and Crafton Hills College spaces.

- Multi-Level Lighting Controls: The general lighting of any enclosed area 100 square feet or larger with a connected lighting load that exceeds 0.5 watts per square foot shall provide multilevel lighting controls that allow the level of lighting to be adjusted up and down. This level of control requires dimming capabilities of the installed lights. This level of control is implemented in a small number of spaces for both campuses.
- Shut-Off Controls: All installed indoor lighting shall be equipped with controls able to automatically reduce lighting power when the space is typically unoccupied. This level of control is already implemented in the majority of Valley College and Crafton Hills College spaces.
- Automatic Daylighting Controls: Lighting in the vicinity of daylit areas (skylights and windows) shall provide controls that automatically adjust the power of the installed lighting up and down to keep the total light level stable as the amount of incoming daylight changes. This level of control is not typical for either campuses.

Option 2 is only recommended if Option 1 is not feasible and if Title 24 is not triggered. Majority of spaces for both Valley College and Crafton Hills College already meet two of the four levels of lighting control. However, implementing the multi-level lighting controls (dimming) and automatic daylighting controls (daylight harvesting) can be cost prohibitive.

ECM 01 OPTION 3

In the scenario that a whole fixture replacement is preferable, P2S recommends upgrading the existing fluorescent and high-intensity discharge fixtures with equivalent LED fixtures. The proposed upgrade will trigger Title 24 unless an exception s met. Crafton Hills College has a few buildings that have already been retrofitted with LED fixtures, specifically building CTB and CNTL 1.

For specific fixture types, P2S recommends the following LED fixture retrofits:

- Retrofit the 2'x4' and 2'x2' recessed troffer with 2'x4' and 2'x2' LED retrofit kits, respectively.
- Replace the 4' and 8' suspended direct/indirect fluorescent fixtures with 4' and 8' suspended LED fixtures, respectively.
- Replace the 6" and 8" recessed can fixtures equipped with compact fluorescent lamps with 6" and 8" recessed integrated LED kit, respectively.
- Replace the low-bay, pendant-mounted 175W metal halide fixtures with low-bay LED fixtures.

ECM 02 Exterior Lighting Upgrade

P2S recommends the exterior high-intensity discharge (HID) and compact fluorescent fixtures be retrofitted with equivalent LED fixtures. Where applicable, the HID and compact fluorescent lamps (CFLs) can be re-lamped with equivalent LED lamps rather than fully replaced for cost-savings purposes. This recommendation is primarily targeted at Crafton Hills College. The exterior lighting at Valley College is primarily already LED.

Additionally, new LED fixtures should be equipped with motion sensor and dimming capabilities. When the space is occupied, the LED fixture should operate between 90-100% light output. When the space is vacated, the LED fixture can dim down to 40%-60% brightness. LED fixture manufacturers typically include options for integrated motion sensors and dimming capabilities which saves on field installation cost. The controls and light output settings will need to be programmed and commission in the field to ensure proper operation.

P2S recommends following standards defined in latest versions of Illuminating Engineering Society of North America's (IESNA) RP-33 Lighting for Exterior Environments and RP-20 Lighting For Parking Facilities.

Special consideration should be made for high-mast lighting for the Valley College Athletics Complex stadium and the Crafton Hills College Aquatic Center pool. These high-mast fixtures are specially designed to meet standards and regulations defined in ANSI /IES RP-6-20: Recommended Practice - Lighting Sports and Recreational Areas. Retrofitting the lights to LED will require a redesign of the light distribution. P2S assumes the existing high-mast poles can be reused without being relocated and no additional poles are need when retrofitting to LED fixtures.

ECM 03 Controls, RCx, and MBCx Measures

These recommendations are based on a high-level survey of the HVAC controls. An in-depth study is required to validate the feasibility of these recommendations. Where feasible, P2S recommends implementing HVAC controls such as demand control ventilation (DCV), static pressure reset on multizone systems, exhaust fan setbacks, and occupancy-sensor based heating/cooling setbacks on both SBVC and CHC campuses.

Additionally, P2S recommends evaluating and re-scheduling HVAC operating schedules to align with the occupancy schedules. Currently, both campuses are hosting classes online and most buildings are unoccupied. However, several buildings are being conditioned and not in setback mode.

P2S also recommends implementing monitoring-based commissioning for various buildings that were observed to be over pressurized. An air balancing test may be required to evaluate the supply, return, and exhaust airflow within the building.

This measure was presented in the Alternative Energy Concept Plan (January 2010) for CHC developed by P2S. The calculations and cost estimates were re-evaluated to reflect current information.

Table 8 – List of Buildings Recommended for Controls, RCx, and MBCx

CHC
ART
CCR
CNTL 1
CNTL 2
CTB
PAC
PSAH
WEST

ECM 04 Fan Wheel Retrofit

This EEM evaluates the feasibility of installing an efficient fan wheel on the existing air handler sized for the proper airflow in the building. Existing fans wheels were installed with AHU during original construction over 30 years ago. Air-foil blades on fan wheels can provide 15 % efficiency gains compared to forward curved fans.

This EEM has labor element involved in it. If campus decides to replace all the air handlers, this measure should be included, and the paybacks will get even shorter because the shop costs of installing fan wheels will be much less than field retrofit.

This measure was presented in the Alternative Energy Concept Plan (January 2010) developed by P2S. The calculations and cost estimates were re-evaluated to current standards and pricing.

Table 9 – List of Buildings Recommended for Fan Wheel Retrofit

CHC
PAC
WEST
ART

ECM 05 Plug Load Control

P2S recommends implementing controls and software programming to reduce plug load across both campuses. The largest plug load observed during site visits was computers in the classrooms (computer labs) and offices. Watt-stoppers power strips can be installed to ensure plug-loads are turned off and not idling drawing power.

Additionally, P2S recommends that all the computers have Power Management Software, which turns the computer off or on sleep mode when it is inactive for more predetermined time. Settings of Power Management cannot be changed by users and can be changed by network administrators. Though the computers were observed to be off during the site visit, most likely due to the shelter-at-home orders, an automatic power-off schedule can be implemented when campus resumes normal operation to reduce plug-load energy consumption.

This measure was presented in the Alternative Energy Concept Plan (January 2010) developed by P2S. The calculations and cost estimates were re-evaluated to current standards and pricing.

ECM 06 Tankless DHW Heaters

P2S recommends converting the existing electric and gas water heaters to high efficiency tankless water heaters in various buildings at both campuses. Domestic hot water needs are currently met by electric and gas heaters and are an expensive way of providing domestic water heating in facilities as compared to the tankless water heaters. Tankless water heaters are cheaper to operate, and their service life is more than twice that of a tank-based system. On an operational basis, tankless water heaters heat water much more efficient than the traditional tank-based water heaters. The standard measure of energy efficiency for water heaters is a metric called the Energy Factor or "EF". EFs for tank-based natural gas water heaters are usually in the low 60s, while EFs for natural gas fueled tankless water heaters are usually in the mid 80s. Therefore, when doing the basic job of heating cold water to hot water, tankless water heaters are about 20 to 25 percent more efficient than tank-based systems. In addition, traditional tank- based systems consume energy in their "stand-by" mode, i.e. when they are maintaining the temperature of an already heated but idle tank of hot water. Energy used during stand-by mode can range from 15 to 30 percent of the total energy that a tank-based system uses. Taken together, these two sources of operational efficiency result in tankless water heaters being 20 to 40 percent more economical to operate.

This measure was presented in the Alternative Energy Concept Plan (January 2010) developed by P2S. The calculations and cost estimates were re-evaluated to current standards and pricing.

ECM 07 Premium Efficiency Motors

P2S recommends replacing the standard efficiency motors in various buildings to premium efficiency motors. Both Valley College and Crafton Hills College have over 100 motors in the buildings being analyzed. It is recommended that campuses maintain the inventory of motors with the appropriate data, such as using a DOE (Department of Energy) tool called MotorMaster+.

We observed that many building with large motors (HP>3) had been retrofitted with premium efficiency motors. Premium efficiency motors are a right replacement for any motor that operates more than 1000 hours/yr. Both campuses should mandate the use of premium efficiency motors for all future retrofits and new buildings.

If the air handlers are replaced, the installation costs will have further savings for not retrofitting the motors in field.

This measure was presented in the Alternative Energy Concept Plan (January 2010) developed by P2S. The calculations and cost estimates were re-evaluated to current standards and pricing.

ECM 08 RTU Upgrade

P2S recommends replacing the RTUs (Roof top Units) with new energy efficient RTUs when the equipment reaches the end of its useful life. Typical lifespan of an RTU is 15 to 20 years depending on routine maintenance and operating conditions.

Current RTUs on both campuses have a SEER (Seasonally adjusted Energy efficiency Ratio) rating of ranging between 10 and 11 and the units ranges from 3 to 6 tons. RTUs available on the market have SEER ratings of 21 and upwards. Current California energy code standards requires a minimum SEER rating of 14.0 or above for equipment less 65,000 Btu/hr in cooling capacity (Table C-3 of the Non-Residential Compliance Manual / NCM Appendices A-D).

This measure was presented in the Alternative Energy Concept Plan (January 2010) developed by P2S. The calculations and cost estimates were re-evaluated to current standards and pricing.

ECM 09 Thermal Energy Storage

P2S recommends the installation of a new 8000 Ton-Hrs TES (Thermal Energy Storage) at CHC campus, using existing chillers. The EEM includes the installation of TES with instruments, controls and civil construction costs, with provision for commissioning. By installing TES, CHC will be able to shift the demand charges from peak and mid-peak consumption to zero charges of off-peak consumption. Chillers operate more efficiently at lower condenser temperatures. The chillers are expected to operate at 0.5 kW/ton at night, which will save energy (kWh/Yr), when compared to day operations similar to existing operations.

Chilled water will be stored in approximately 720,000 gallons of storage tank and chillers, cooling towers, cooling tower circulation pumps will be turned off during peak hours in summer. TES has most cost savings from load shifting then from increased efficiency of night operations. This measure is applicable to CHC campus only.

This measure was presented in the Alternative Energy Concept Plan (January 2010) for CHC developed by P2S. The calculations and cost estimates were re-evaluated to reflect current information.

DESIGN RECOMMENDATIONS

Gymnasium

The Gymnasium building on the CHC campus is schedule for demolition and replacement. The new Gymnasium building is scheduled for construction in near future. P2S recommends a goal of 15% better than current Title 24 performance. These measures should also apply to future new buildings and major renovations on campus.

HVAC SYSTEMS

- Use of Heat Recovery Chiller
- Displacement Ventilation as applicable
- Radiant Systems
- Select and install high-efficiency systems such as premium efficiency motors
- Implementing variable speed drives on fans and pumps
- Implementing various HVAC control strategies such as:
  - Demand control ventilation
  - Duct static pressure reset
  - Supply air temperature rest
  - HVAC occupancy sensors ad temperature setpoint setback
- Utilizing a third-party commissioning agent to ensure all systems are properly operating and optimized to match the design intent.

LIGHTING SYSTEMS

- Install LED fixtures with dimming capabilities
- Implementing vacancy sensors where occupants must actively turn on lights and a vacancy sensor will automatically shut them off.
- Daylight harvesting for lights located near windows and skylights
- Task turning lights to appropriate levels
- Building Envelope:
- Increased insulation
- Utilize high energy performance windows to mitigate heat gains and solar transmittance.

DOMESTIC HOT WATER

- Install a tankless water heater for domestic hot water usage
- Utilize heat recovery to preheat water

BUILDING ENVELOPE

- Optimize overall wall and roof insulation
- Utilize high energy performance windows to mitigate heat gains and solar transmittance.

DOMESTIC HOT WATER

- Install a tankless water heater for domestic hot water usage
- Utilize heat recovery to preheat water

SAVINGS-BY-DESIGN

Utility incentives are available for new construction through the Savings-By-Design program. This statewide approach offers a multi-faceted program designed to consistently serve the needs of the nonresidential building community throughout California. SBD encourages energy-efficient building design and construction practices. It helps meet California short and long-term energy goals and promotes the efficient use of energy by offering up-front design assistance and financial incentives based on project performance. Incentives are paid to the owner based how much better the building performs compared to a code standard building (Title 24 Part 6).

INCENTIVES, GRANTS, AND PILOT PROGRAMS

Utility incentives and financing are available for eligible energy efficiency upgrades. Both SCE and SCG offer various incentive and financing programs to their customers. Eligible energy efficiency projects receiving an incentive from one program are not eligible to receive incentives from a different program. SCE and SCG defines a loading order of incentives for eligible energy efficiency projects.

Midstream Point of Purchase (MPOP)

Southern California Edison (SCE) offers a discount at the point of purchase for qualified LED products through approved distributors. The discount is offered at a fixtured dollar rate on a per unit basis (i.e. $/fixture or $/lamp). The list of approved distributors are found at SCE's MPOP offerings website: https://www.sceonlineapp.com/MidstreamPOP.aspx

To qualify for MPOP incentive, a product must, at minimum, be ENERGY STAR ® listed or Design Lights Consortium ® qualified and meet program product requirements. All products must be installed in an interior location. Current incentive offerings include LED high/low bay fixture replacements and 4' LED T8 lamp replacement (type A only). Type A lamps are plug-and-play lamps intended to work with the existing ballasts. Ballast compatibility should be checked for type A LED lamps to ensure proper operation. Distributors will identify eligible products when requested.

MPOP and other utility incentive offerings are subject to change without notice and funding is limited to first-come-first served. Current 2021 program details are still being finalized by the utility administrator and the public utilities commission.

The recommendation described in Option 1 would qualify for incentives through the MPOP offerings. Incentive amounts are based on the 2020 program cycle.

Express (Deemed) Solutions Rebate Program

The 2020 Statewide Energy Efficiency Business Rebate Offering provides financial rebates to offset the cost of replacing or upgrading to high-efficiency equipment. Non-residential customers that install eligible, "prescriptive" energy efficiency measures (energy-saving technology) are eligible for a predetermined rebate for each measure installed, if they meet all the other program requirements and funding is available.

Rebates are paid on the prescriptive measures as determined by Southern California Edison (SCE) and Southern California Gas Company (SCG), the local utility administrators. Non-residential customers wishing to receive rebates must submit a project application through the rebate offering process for installation of eligible energy efficiency measure(s). The 2020 enrollment cycle began January 1, 2020 and ends on December 31, 2020. Applications are accepted throughout the program cycle or until SCE's rebate offering funds are exhausted. Check with the utility administrator for specific enrollment periods. Rebates can only be paid for active measures installed within the 2020 program enrollment cycle.

SCE offerings: https://www.sceonlineapp.com/ExpressSolutions.aspx

SCG offerings: https://www.socalgas.com/for-your-business/energy-savings/rebates-and-incentives

Customized Incentive Program

The 2019 Statewide Customized Offering, or the program, provides financial incentives to qualifying non-residential customers for the permanent installation of new high-efficiency equipment or permanent operational improvement of existing equipment and systems. The financial incentive is provided to influence and enable customers to implement energy efficiency projects, or measures that would otherwise not be implemented. The program offerings are not intended for customers who would have installed the measure(s) without the program influence, for negligent or deferred maintenance practice, or as a reward for established practices.

Incentives are paid on the energy savings and permanent peak demand reductions above and beyond a baseline energy performance, which include state-mandated codes, federal-mandated codes, industry-accepted performance standards, or other baseline energy performance standards as determined by the program administrator. Incentives for gas-related energy savings are eligible in Southern California Gas Company natural gas service territory; incentives for electric-related energy savings are eligible in Southern California Edison electric service territory.

SCE offerings: https://www.sceonlineapp.com/CustomizedSolutions.aspx

SCG offerings: https://www.socalgas.com/for-your-business/energy-savings/rebates-and-incentives

BRO (Behavioral, Retro-Commissioning, and Operational)

BRO (Behavioral, Retro-commissioning and Operational, formerly RCx) is a systematic process for investigating an existing building's operations (energy-using systems) and identifying opportunities to improve occupant comfort, save energy, and lower electricity bills. BRO seeks to improve how building equipment and systems function together. Depending on the age of the building, BRO can often resolve problems that have developed throughout the building's life. In all, the BRO program improves a building's operations and maintenance (O&M) procedures to enhance overall building performance.

BRO projects are distinctly different from retrofit projects. Both seek to improve the overall energy efficiency of the facility, retrofits involve replacing inefficient or outdated equipment, while BRO focuses on improving the efficiency of the existing systems and equipment via operational non-routine maintenance or repairs. On BRO projects, the existing system always represents the baseline for determining the savings, whereas with a retrofit, building code or industry standard baselines typically need to be considered.

SCE offerings: https://www.sceonlineapp.com/CustomizedSolutions.aspx

SCG offerings: https://www.socalgas.com/for-your-business/energy-savings/rebates-and-incentives

On-Bill Financing (OBF)

Through the On-Bill Financing (OBF) program, SCE customers may apply for financing for qualifying energy efficiency projects for their business. Qualifying customers would repay the loan in monthly installments, which would be added as a line item on their bill. Customers can fund qualified energy efficiency projects at zero interest with no fees, reducing monthly electricity usage, and receiving financial rebates or incentives for installing qualifying energy efficient equipment. Financing is currently available for Express, Customized Solutions, BRO (RCx or Retro-commissioning), and Midstream Point of Purchase programs.

Loan limits vary by customer segment. Loans are capped at the Service Account (SA) level. Customers with multiple SAs may have loans at each SA up to the maximum amount for their segment. When certain requirements are met, we will bundle or consolidate qualifying loans for customers.

This project example is for a customer in the government segment. The estimated monthly electric cost savings resulting from the project is $667. The Financeable Amount divided by the monthly savings ($90,000 / $667 = 135 months), exceeds the maximum 10-year allowable loan term for this customer segment. Therefore, the Adjusted OBF loan amount will need to be reduced to $80,040 (120 months x $667).

SCE offerings: https://www.sce.com/business/tools/on-bill-financing

SCG offerings: https://www.socalgas.com/for-your-business/energy-savings/zero-percent-financing

OBF Loan Limits and Terms

CUSTOMER SEGMENT	INDIVIDUAL SA	BUNDLED SA	CONSOLIDATED SA	LOAN TERMS
GOVERNMENT & INSTITUTIONAL	MIN: $5,000 MAX: $1,000,000	MIN: $5,000 MAX: $1,000,000	N/A	UP TO 10 YEARS
MULTIFAMILY	MIN: $5,000 MAX: $250,000	N/A	MIN: $5,000 MAX: $250,000	UP TO 10 YEARS
BUSINESS	MIN: $5,000 MAX: $250,000	N/A	MIN: $5,000 MAX: $250,000	UP TO 5 YEARS

Project Example

PROJECT INFORMATION (GOVERNMENT CUSTOMER)	PROJECT VALUES
PROJECT COST	$110,000
REBATE/INCENTIVE AMOUNT	$20,000
FINANCEABLE AMOUNT	$90,000
ESTIMATED ANNUAL ENERGY SAVINGS	66,667 KWH
AVERAGE 12-MONTH ELECTRIC RATE	$0.12
ESTIMATED MONTHLY ELECTRIC COST SAVINGS	$667
MONTHLY DEBT REPAYMENT	$667
MONTHS TO FULLY REPAY LOAN	135 MONTHS (11.25 YEARS)
LOAN EXCEED SEGMENT CAP	120 MONTHS (10.0 YEARS)
ADJUSTED OBF LOAN AMOUNT	$80,040
CUSTOMER CONTRIBUTION / BUY DOWN	$9,960

Savings-By-Design (SBD)

Savings-By-Design (SBD) is California's nonresidential new construction energy efficiency (EE) program, administered statewide and funded by Utility customers through the Public Purpose Programs surcharge that is applied to gas and electric services.

The participating utilities are listed below:

- Pacific Gas and Electric (PG&E)
- Sacramento Municipal Utility District (SMUD)
- San Diego Gas And Electric (SDG&E)
- Southern California Edison (SCE)
- Los Angeles Department of Water and Power (LADWP)

This statewide approach offers a multi-faceted program designed to consistently serve the needs of the nonresidential building community throughout California. SBD encourages energy-efficient building design and construction practices. It helps meet California short and long-term energy goals and promotes the efficient use of energy by offering up-front design assistance and financial incentives based on project performance.

SBD uses the uses a CPUC-modified version of most current version of the California Building Energy Efficiency Standards (Title 24, Part 6) as a reference baseline for; and when appropriate, uses other industry standards to determine reference baselines for comparisons. It encourages and generates project energy savings to perform better than mandated by Title 24. SBD analyses provide detailed technical and financial assistance data that allows Owners and Design Teams to make informed decisions regarding EE features.

SCE offerings: https://www.sceonlineapp.com/SBD.aspx

Southern California Regional Energy Network (SoCalREN)

The SoCalREN offers no-cost support to public agencies from start to finish through energy efficiency projects. The program's free services include high-level technical assistance, objective third-party expertise, access to financing and project staffing for all stages of an energy efficiency project at no cost. SoCalREN Energy Efficiency Project Delivery Program include:

- Energy Consumption Benchmarking
- Technical support, including facility energy audits, identifying energy efficiency improvement measures, and energy efficiency performance specifications
- Project management and other staff support throughout your energy efficiency project
- Analysis of financing options, financial advisory services, and assistance with rebate and incentive applications
- Proposal and construction support, including procurement guidance, performance specification support, construction management support, and third-party objective review

https://socalren.com/

ANALYSIS

ECM 01 Interior Lighting Upgrade

This ECM analyzes the Option 1 of the recommended lighting upgrade. Option 1 recommends re-lamping the linear fluorescent, with equivalent LED Type A lamps. LED type A lamps, also known as LED plug-and-play lamps, operate on the existing electronic ballast within the fixture. Re-lamping with LED type A lamps does not require modifications to the lighting fixture. The analysis focuses on energy and cost savings associated with re-lamping the linear fluorescent T8 and T5 lamps. Other lamp types are excluded from the analysis.

The baseline consumption is based on field surveys and information obtained from the Campus. According to the CHC, there have been campus wide projects in 2004 to replace all the fluorescent lights with T8 and T5 of lamps and ballast which were current at the time. Additionally, the field survey confirmed recent renovations to upgrade interior fixtures to LED in several buildings. Buildings with LED fixtures are excluded from the calculations. The analysis focuses on buildings that still utilize the T8 and T5 lamps and ballasts. Although most campus buildings operate from 4:00 AM till midnight for teaching and custodian usage, it is assumed that lights are used for 12 hours from Monday thru Thursday and 10 hours on Friday for 50 weeks, which is 2900 hours of annual usage. Actual operating hours may be as high as 4000 hours/year for interior lighting. The inputs and assumptions made for this ECM are listed in table 10.

Table 10 – Inputs and Assumptions

#	Parameter	Value	Comments
1	Cost of electricity ($/kWh)	$0.0914	CHC UTILITY BILLS
2	Cost of electricity ($/kWh)	$0.1413	SBVC UTILITY BILLS
3	Rebate ($/Lamp), 4' T8 only	$4.00	SCE MPOP
5	ANNUAL OPERATING HOURS	2900	HRS/YR

Table 11 – Estimate of Savings, Costs, Rebates and Payback for Option 1 for SBVC

Existing Conditions							Post-Retrofit Conditions											
Building	Type	Fixture	Fixture Qty	Watts per fixture	Total kW	kWh/Yr (E)	Replacement Fixture	Option	New Watts/ fixture	Total kW	kW Demand Reduction	Operating Hours	kWh/yr (N)	kWh saved (kWh)/yr	Annual Cost Savings ($)	Total Installed Cost ($)	Rebate	Simple Payback (Yrs)
EAST 1 & 2	Fluor	4 lamps/fixture x 4' lamps	130	114.0	14.8	42,978	LED	1	58.0	7.5	5.0	2,900	21,866	21,112	$2,983	$7,280	$2,080	1.7
SSB	Fluor	3 lamps/fixture x 4' lamps	60	89.0	5.3	15,486	LED	1	43.5	2.6	1.7	2,900	7,569	7,917	$1,119	$2,880	$720	1.9
M&O	Fluor	2 lamps/fixture x 4' lamps	56	59.0	3.3	9,582	LED	1	29.0	1.6	1.1	2,900	4,710	4,872	$688	$2,016	$448	2.3
CDC	Fluor	2 lamps/fixture x 4' lamps	52	59.0	3.1	8,897	LED	1	29.0	1.5	1.0	2,900	4,373	4,524	$639	$1,872	$416	2.3
CCR	Fluor	2 lamps/fixture x 4' lamps T5	80	60.0	4.8	13,920	LED	1	32.0	2.6	1.7	2,900	7,424	6,496	$918	$2,720	$-	3.0
CCR	Fluor	2 lamps/fixture x 2' lamps T5	70	30.0	2.1	6,090	LED	1	24.0	1.7	1.1	2,900	4,872	1,218	$172	$2,240	$-	13.0
LRC	Fluor	1 lamps/fixture x 2' lamps T5	836	14.0	11.7	33,942	LED	1	12.0	10.0	6.7	2,900	29,093	4,849	$685	$23,408	$-	34.2
CYN	Fluor	3 lamps/fixture x 4' lamps	194	89.0	17.3	50,071	LED	1	43.5	8.4	5.6	2,900	24,473	25,598	$3,617	$9,312	$2,328	1.9
ARTS	Fluor	3 lamps/fixture x 4' lamps	155	89.0	13.8	40,006	LED	1	43.5	6.7	4.5	2,900	19,553	20,452	$2,890	$7,440	$1,860	1.9
NRTH	Fluor	3 lamps/fixture x 4' lamps	112	89.0	10.0	28,907	LED	1	43.5	4.9	3.2	2,900	14,129	14,778	$2,088	$5,376	$1,344	1.9
TOTALS:						249,879					31.7			111,817	$15,800	$64,544	$9,196	3.5

ECM 02 Exterior Lighting Upgrade

This ECM analyzes the recommendation for an exterior lighting upgrade. The analysis excludes SBVC campus because the exterior lighting has already been retrofitted to LED. Additionally, the high-mast lighting for the SBVC stadium and CHC aquatics center are excluded. High mast lighting for sports field and stadium requires special consideration and beyond the scope of this analysis.

The baseline consumption is based on the high-level field survey. The fixture types and quantities are estimated from site observations and should be verified with a detailed audit or inventory list from M&O. Operating hours for the exterior lights are assumed to be 12 hours per night, typically 6pm to 6am daily. The annual operating hours is estimated to be 4380 hours/year. The inputs and assumptions made for this ECM are listed in the table 12.

Table 12 – Inputs and Assumptions

#	Parameter	Value	COMMENTS
1	Cost of electricity ($/kWh)	$0.1445	CHC utility bills (no solar)
2	Rebate ($/kWh)	$0.00	
3	Annual Operating Hours	4380	Hrs/Yr

Table 13 – Estimate of Savings, Costs, Rebates and Payback

Existing Conditions								Post-Retrofit Conditions											
Building	Type	Fixture	Fixture Qty	Watts per fixture	TOTAL KW	kWh/Yr (E)	Replacement Fixture	Option	New Watts/ fixture	Total kW	kW Demand Reduction	Operating Hours	kWh/yr (N)	kWh saved (kWh)/yr	Annual Cost Savings ($)	Total Installed Cost ($)	Rebate	Simple Payback (Yrs)
Walkways	MH	MH150 Post Top	40	190	7.6	33,288	LED	1	53	2.1	1.4	4,380	9,286	24,002	$3,468	$67,000	$-	19.3
Campus Wide	MH	MH250 Flood	20	295	5.9	25,842	LED	1	80	1.6	1.1	4,380	7,008	18,834	$2,722	$17,000	$-	6.2
Campus Wide	MH	MH100 FLOOD	30	128	3.8	16,819	LED	1	29	0.9	0.6	4,380	3,811	13,009	$1,880	$14,700	$-	7.8
PARKING LOTS	MH	MH250 PARKING LOT POLE	40	295	11.8	51,684	LED	1	100	4.0	2.7	4,380	17,520	34,164	$4,937	$49,000	$-	9.9
TOTALS:			130			127,633					5.7		37,624	90,009	$13,006	$147,700	$-	11.4

ECM 03 Controls, RCx, and MBCx Measures

There are several potential HVAC controls and monitoring-based commissioning opportunities available at both San Bernardino Valley College and Crafton Hills College. This ECM identifies potential measures for each campus that can lead to savings after the sub-meters for electricity and gas are installed for each building.

The figure below demonstrates the benefits of implementing energy submetering and continued MBCx efforts. These recommendations are based on a cursory survey of the HVAC controls. An in-depth study is required to validate the feasibility of these recommendations.

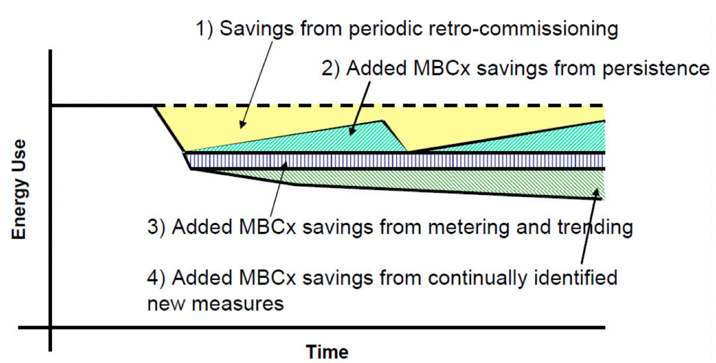


FIGURE 5 – TYPES OF MONITORING-BASED COMMISSIONING AND ASSOCIATED SAVINGS TREND
SOURCE: BROWN, K. MONITORING-BASED COMMISSIONING: 2008 UPDATE. APRIL 22, 2008

INPUTS AND ASSUMPTIONS

The following inputs and assumptions are were made to estimate the savings for the measures identified under this ECM.

Table 14 – Inputs and Assumptions

#	Parameter	Value	UNITS	COMMENTS
1	Cost of Electricity	$0.0914	$/KWH	From utility bills, CHC
2	Cost of Electricity	$0.1413	$/KWH	From utility bills, SBVC
3	Cost of Natural Gas	$0.7097	$/THERM	CHC, Energy Dashboard
4	COST OF NATURAL GAS	$0.8755	$/THERM	SBVC, Energy Dashboard
5	ELECTRICITY REBATE	$0.06	$/KWH	CCC-IOU Incentive Rate
6	GAS REBATE	$1.00	$/THERM	CCC-IOU Incentive Rate
7	DEMAND CONTROL VENTILATION	5% / 5%	PERCENT	Cooling / Fan Energy Savings
8	STATIC PRESSURE RESET	5% / 10%	PERCENT	Cooling / Fan Energy Savings
9	OCC SENSOR BASED HEATING/COOLING SETBACKS	3%	PERCENT	Overall Energy Savings
10	EXHAUST FAN SETBACK	3% / 3%	PERCENT	Fan / Heating Energy Savings

DEMAND CONTROL VENTILATION

Demand control ventilation (DCV) reduces heating, cooling and fan costs by managing CO2 in the occupied paces of the buildings. Capital costs are additional CO2 sensors in each space where demand ventilation is recommended, typically meeting/conference rooms, classrooms, offices, and breakrooms. Brandemuehl, M., & Braun, J. (1999) reports as much as 20% savings in electric cooling energy. For a conservative estimate, P2S used 5% to calculate the potential savings. Real-world savings are expected to be higher for laboratory buildings.

OCCUPANCY SENSORS BASED HEATING/ COOLING SETBACKS

Currently only lighting loads are relayed with occupancy sensor. This measure proposes that occupancy sensor be integrated into the thermostats or room temperature sensors to setback the temperature setpoints when the space is unoccupied. Conference rooms, meeting rooms, not-in-session classes are examples of spaces that can reduce the heating/cooling load and ventilation requirements for the buildings recommended for retrofit under this ECM. Per U.S. Department of Energy PNNL-22072 Table 12 , there is an overall 5.3% savings from the total energy use for implementing occupancy-based controls using common occupancy sensors for spaces with existing occupancy sensors for lights. For a conservative estimate, P2S used 3% to calculate the potential savings.

STATIC PRESSURE RESET

Air flows vary significantly during a day depending on occupancy and thermal load. Not all zones are used all the times, which creates variance in air flow needs in zones. Several buildings already have VFD (Variable Frequency Drive) installed to modulate the air handler fans. Additional savings can be achieved by implementing a static pressure reset algorithm. Per PIER Energy-Efficient Air-Handling Controls (2003), energy savings are reported to be 26.3% for fans and 17.4% for cooling systems. For a conservative estimate, P2S used 10% for fan energy savings and 5% for cooling energy to calculate the potential savings.

EXHAUST FAN SETBACKS

Exhaust fans are proposed to be setback with demand ventilation algorithm during occupied hours with inputs from all occupancies of the building, proposed under occupancy sensor-based setbacks. Exhaust fans of restrooms also need to be operated on demand with delay timer shut off mechanism. The exhaust fans would operate similarly to lights that are controlled with occupancy sensors. Per U.S. Department of Energy PNNL-22072 Table 119 , there is 5.6% (base case 9.77 kBtu/SF to improved case I 9.22 kBtu/SF) savings from lighting energy use for implementing occupancy-based controls using common occupancy sensors for spaces with without occupancy sensors for lights. Applying the same control scheme to exhaust fans, the exhaust fan operation is expected to also be reduced by 5.6%. For a conservative estimate, P2S used 3% for fan energy and space heating energy to calculate the potential savings.

Table 15 – Unit Cost Estimates for Capital Cost

#	Post Sub-Metering MBCx Measure	Cost Element	MATERIAL COST	LABOR COST	CONTINGENCY	TOTAL COST	NOTES
1	Demand Control Ventilation	CO2 Sensors	$250	$300	$220	$770	INTEGRATE THE CO2 SENSOR INPUTS WITH OCC SENSORS
2	Static Pressure Reset	Duct Static Pressure Sensor	$262	$650	$365	$1,277	RS MEANS 23 09 53 10 3084
3	Occ Sensor Based Heating/Cooling Setbacks	DDC Inputs	$215	$250	$186	$651	FOR ON/OFF MAINTAINED CONTACTS,
4	EXHAUST FAN SETBACK	OS SENSORS	$215	$550	$306	$1,071	RS MEANS 26 09 13 10 0100

Table 16 – Estimate of Savings, Costs, Rebates and Payback

	Sq. Ft	Total Building kWh/Yr	Total Building Therms/Yr	Post Sub-Metering MBCx Measure	Cooling (19.65%), Ventilation (14.85%), kWh/yr	Space Heating (72.85%), therms/year	Savings, kWh/yr	Savings, Therms/yr	Cost Savings	CCC-IOU Rebates	Qty	Estimated Capital Costs	Simple Payback, Years	Notes
CNTL 1	30,600	440,053	15,340	DEMAND CONTROL VENTILATION	151,818	11,175	7,591	559	$1,090	$0	20	$15,400	14.13	20 CO2 SENSORS
				STATIC PRESSURE RESET			10,858	0	$992	$1,629	4	$5,107	3.50	
				EXHAUST FAN SETBACK			1,960	335	$417	$797	2	$2,142	3.23	
				OCC SENSOR BASED HEATING/COOLING SETBACKS			13,202	0	$1,207	$1,980	20	$13,020	9.15	
CCR	43,600	626,257	21,830	STATIC PRESSURE RESET	216,059	15,903	15,453	0	$1,412	$2,318	1	$1,277	IMMEDIATE	
				OCC SENSOR BASED HEATING/COOLING SETBACKS			18,788	0	$1,717	$2,818	5	$3,255	0.25	
CTB	8,300	118,704	4,138	STATIC PRESSURE RESET	40,953	3,014	2,929	0	$268	$439	2	$2,554	7.90	
				OCC SENSOR BASED HEATING/COOLING SETBACKS			3,561	0	$325	$534	10	$6,510	18.36	
WEST	6,800	97,722	3,406	STATIC PRESSURE RESET	33,714	2,482	2,411	0	$220	$362	1	$1,277	4.15	
				OCC SENSOR BASED HEATING/COOLING SETBACKS			2,932	0	$268	$440	7	$4,557	15.37	
ART	9,800	141,439	4,930	OCC SENSOR BASED HEATING/COOLING SETBACKS	48,796	3,592	4,243	0	$388	$636	2	$1,302	1.72	
PSAH	30,800	442,424	15,422	STATIC PRESSURE RESET	152,636	11,235	10,917	0	$998	$1,638	1	$1,277	IMMEDIATE	
				OCC SENSOR BASED HEATING/COOLING SETBACKS			13,273	0	$1,213	$1,991	12	$7,812	4.80	
PAC	29,900	285,992	9,969	STATIC PRESSURE RESET	98,667	7,263	7,057	0	$645	$1,059	2	$2,554	2.32	
				DEMAND CONTROL VENTILATION			4,933	363	$708	$0	12	$9,240	13.04	12 CO2 SENSORS
				OCC SENSOR BASED HEATING/COOLING SETBACKS			8,580	0	$784	$1,287	12	$7,812	8.32	
CNTL 2	17,200	247,726	8,635	DEMAND CONTROL VENTILATION	85,466	6,291	4,273	315	$614	$0	12	$9,240	15.06	12 CO2 SENSORS
				STATIC PRESSURE RESET			6,113	0	$559	$917	2	$2,554	2.93	
				EXHAUST FAN SETBACK			1,104	189	$235	$449	1	$1,071	2.65	
				OCC SENSOR BASED HEATING/COOLING SETBACKS			7,432	0	$679	$1,115	12	$7,812	9.86	
TOTALS							147,609	1,760	$14,740	$20,408		$105,771	5.79	

CONCLUSION

The measures outlined above will require measurement and verification to establish an accurate baseline, which is currently beyond the scope of this report. SCE (Southern California Edison) can support in the baseline measurements that can be used to compute the savings that estimated within this ECM. Typical paybacks for these measures are from 2-10 years from multiple resources including PIER (Public Interest Energy Research). All the measures are recommended for further evaluation.

ECM 04 Fan Wheel Retrofit

This ECM analyzes the multi-zone VAV Air Handling Units located throughout the Crafton Hills College campus. An opportunity to reduce energy consumption by replacing the existing fan wheels with a new fan wheels with improved energy efficiency. The air handlers for San Bernardino Valley College buildings are have been recently upgraded and excluded from the analysis.

All the buildings evaluated utilize fans which were installed during the original design and construction. Most of the original installations occurred approximately 45 years ago. Developments in impeller design over the years have increased the fan efficiency from 50% up to 65% and even higher in some cases of larger air handling unit) capacities

ASSUMPTIONS:

Assumptions made in performing the calculations are summarized in the table below.

50% of annual operating hours (3,600 hrs) are assumed as cooling hours and the remaining 50% are heating hours.

SAVING CALCULATIONS:

COMMENTS & CONCLUSIONS

Fan efficiency improvement results in reduced fan motor consumption and reduced cooling load.

Savings are calculated using an estimated fan efficiency of 50% as the baseline and calculating the proposed BHP and annual kW-hrs using a proposed fan efficiency of 65% by installing a new fan wheel. The calculations are performed assuming that the existing fan is operating at 90% of the nominal motor horsepower since recorded operating brake-horsepower values were not available for this analysis. To maintain an apples-to-apples comparison, both the existing and proposed cases were evaluated at an operating load of 90%. Increased efficiency reduces thermal heat load from fan inefficiencies and reduces cooling loads, which are also calculated in table above. A payback based on the sum of the fan motor energy use and chiller energy savings has been evaluated versus the capital costs including installation and labor.

The opportunity to replace of the fan wheels to results in a significant energy and cost savings. This ECM can be used as justification to replace 40+ years old air handling units.

Table 17 – Inputs and Assumptions

#	Parameter	Value	COMMENTS
1	Blended cost of electricity ($/kWh)	$0.0914	FROM UTILITY BILLS
2	kW/Ton for Central Chiller	0.60	ASSUMPTION, TO BE VERIFIED
3	Annual Operation (Hrs)	3,600	HRS/YR, TO BE VALIDATED
4	H-EXISTING FAN	50%	ASSUMPTION, TO BE VERIFIED
5	H-PROPOSED FAN WHEEL	65%	REASONABLE ASSUMPTION
6	REBATE ($/KWH)	$0.00	
7	1 KW = 3412.14 BTU/H	3412.14	CONVERSION FACTOR
8	VFD OUTPUT	90%	REASONABLE ASSUMPTION

Table 18 – Inputs and Assumptions

Bldg #	Bldg Name	AHU#	FAN CFM	EXISTING SUPPLY FAN HP (50% EFFICIENT)	PROPOSED FAN WHEEL MOTOR BHP (65% EFFICIENT)	LOAD FACTOR/ VFD OUTPUT	EXISTING ANNUAL ENERGY USE (KW-HRS/ YR) - FAN MOTOR	PROPOSED ANNUAL ENERGY USE (KW-HRS/YR) - FAN MOTOR	FAN MOTOR ANNUAL ENERGY USE SAVINGS (KW-HRS/ YR)	REDUCED COOLING LOAD (BTUH)	REDUCED CHILLER LOAD (TONS)	ASSUMED KW/TON OF CENTRAL PLANT	REDUCED CHILLER LOAD (KW)	CHILLER ENERGY SAVINGS (KW-HRS/ YR)	SUM OF FAN MOTOR ENERGY AND CHILLER ENERGY SAVINGS (KW-HRS/YEAR)	OPERATIONAL COST SAVINGS ($/YR)	ONE-TIME REBATE SAVINGS ($)	CAPITAL COSTS ($)	SIMPLE PAYBACK, W/O REBATE (YRS)	SIMPLE PAYBACK, W/ REBATE (YRS)
9	PAC	MZ-1	26,000	20	15.38	90%	48,341	37,185	11,156	11,748	0.98	0.6	0.59	2,115	13,270	$1,213	$0	$11,000	9.07	9.07
9	PAC	RF-1	20,800	7.5	5.77	90%	18,128	13,944	4,183	4,406	0.37	0.6	0.22	793	4,976	$455	$0	$10,500	23.09	23.09
9	PAC	MZ-2	23,000	15	11.54	90%	36,256	27,889	8,367	8,811	0.73	0.6	0.44	1,586	9,953	$910	$0	$10,500	11.54	11.54
9	PAC	RF-2	19,000	5	3.85	90%	12,085	9,296	2,789	2,937	0.24	0.6	0.15	529	3,318	$303	$0	$9,000	29.68	29.68
5	WEST	M1-C	9,920	7.5	5.77	90%	18,128	13,944	4,183	4,406	0.37	0.6	0.22	793	4,976	$455	$0	$7,500	16.49	16.49
13	ART	MZ-1	8,000	10	7.69	90%	24,170	18,593	5,578	5,874	0.49	0.6	0.29	1,057	6,635	$606	$0	$7,500	12.37	12.37
13	ART	MZ-2	6,000	7.5	5.77	90%	18,128	13,944	4,183	4,406	0.37	0.6	0.22	793	4,976	$455	$0	$7,000	15.39	15.39
TOTALS→													2	7,666	48,105	$4,397	$0	$63,000	14.33	14.33

ECM 05 Plug Load Control

When an electronic device is plugged in, the device increases the building's energy consumption and energy bill. The building's plug load energy consumption can be reduced when actively managed. Plug loads include computer monitors, printers/copiers, phone/tablet chargers, task lights, personal fans and heaters, A/V equipment, and more, all of which can be turned off at night without negative consequences.

In addition to lowering energy consumption from devices themselves, cutting the plug load can reduce air-conditioning loads. Researchers at the Florida Solar Energy Center found that, for every 100-watt reduction in computer energy consumption in an office building, there's a corresponding 28-watt drop in cooling loads. Because large offices are commonly charged higher rates during peak cooling hours, these midday HVAC savings can be especially lucrative.

STANDBY ISN'T SUFFICIENT

As convenient as it is for a computer to go into standby mode and instantly respond when turned back on, it's consuming energy all the time. Any device that uses a remote control or microprocessors – including computers, printers, TVs, etc. – probably falls into this category. The phenomenon has been more widely studied for homes, but the DOE (Department of Energy) says that it's about 5 percent of total electricity use in schools.

THE ROAD TO REDUCTION

There are three ways to reduce plug load energy consumption:

1. Implementing purchasing policies so that only the most efficient products are purchased, such as Energy Star rated appliances and devices.
2. Raising employee awareness about good practices like turning off equipment and establishing policies that prohibit certain kinds of equipment.
3. Installing plug-load controls, such as power strips with occupancy sensors, that will turn things off when not in use.

Supplying hard wired smart power strips to employees to use for their often-forgotten energy users – such as computer speakers and radios – is a low-cost approach to reducing energy. Smart power strips are an easy way to quickly and easily shut off these devices at the end of the day, and can yield additional savings if also used with computers because they eliminate off-mode power draw.

FIGURE 6 - HARD WIRED POWER STRIP WITH OCCUPANCY SENSOR

Since computers are often the major load in office buildings, enabling aggressive power-management settings on all computer equipment will have an immediate impact. All office equipment (PCs, displays, copiers, etc.) should have their power management – or 'sleep' settings – enabled. Also, back up disks during lunchtime or off usage duration, so that all equipment can be switched off at night.

Although encouraging employees to set aggressive power-management settings on their computer equipment is essentially free and may result in greater awareness and less energy waste, there's no guarantee that employees will comply with the power-management policy. If this proves to be ineffective, P2S recommends using low-cost or free (Windows based) network-based power-management software. Unlike individual computer power settings, this software is centrally controlled, helping IT personnel ensure maximum energy savings, and making it less likely that users will disable it. Power management software is available in the native Windows functionality, open source applications, and commercially.

The analysis in the table below is limited to 1,400 computers.

Table 19 – Analysis for Plug Load Reduction

#	Item	Value	UNITS	
1	# of computers	700	Ea	Assumption
2	Electric consumption per computer	894	kWh/Yr	102 Watts/Station
3	Computer Plug Load	625,464	kWh/yr	Baseline
4	Cost of Electricity	$0.0914	$/kWh	Blended Rate from Utility Bill
5	Unit Energy Savings	134.03	kWh/yr	15% Savings per Work Station
6	Total Energy Savings	93,820	kWh/Yr	Total Annual Energy Savings
7	Cost / Ea	$100	$/Ea	
8	Total Cost	$70,000	$	One time cost
9	Savings, $/Ea	$12	$/Ea	
10	Total $ Savings	$8,575	$/Yr	Total Annual $ Savings
11	Rebate, $/Ea	$0	$/Ea	
12	Simple Payback without Rebate	8.16	Years	
13	Simple Payback w/Rebate	8.16	Years	

ECM 06 Tankless Water Heaters

Domestic Hot Water (DHW) is heated by electric and gas heaters with storage tanks in buildings of San Bernardino Valley College and Crafton Hills College. This energy conservation measure (ECM) attempts to replace existing electric water heaters with high efficiency tankless water heaters, with high energy factors.

CAPITAL COST ESTIMATE

Capital cost estimate of replacing existing water heater with gas (tankless) water heater is summarized in table 21 .

Table 20 – Inputs and Assumptions

#	Parameter	Value	UNITS	COMMENTS
1	Cost of Natural Gas	$0.7097	$/Therm	CHC, Energy Dashboard
2	Cost of Electricity	$0.0914	$/kWh	CHC Utility Bills
3	Cost of Natural Gas	$0.8755	$/Therm	SBVC, Energy Dashboard
4	Cost of Electricity	$0.1413	$/kWh	SBVC Utility Bills
5	Gas Rebate	$0.00	$/Therm	CCC-IOU Rebate
6	Electricity Rebate	$0.00	$/kWh	CCC-IOU Rebate
7	DHW Consumption	1.6	GPD/Person	Reasonable assumption
8	Existing Pump Work = New Pump Work		kWh/Yr	
9	Utilization	250	days/yr	Assumption to be validated
10	Occupant/Sq. ft	100		Assumption to be validated
11	Average ΔT, 60° F	60	° F	
12	Baseline Tanked Energy Factor (EF)	0.65		DOE Published data
13	Tankless Energy Factors (EF)	0.9		0.98 EF is recommended

Table 21 – Inputs and Assumptions

#	CBS Description	Unit Cost	QTY	UNITS	ITEM COST	NOTES/COMMENTS
1	Heater	$1,950.00	1	EA	$1,950	
2	Piping	$22.00	30	LF	$660	MEANS 23.1200
3	Insulation	$5.30	30	LF	$159	
4	ELECTRICAL CONDUIT, 1"	$22.00	10	EA	$220	
5	FLUE DUCT	$4.44	25	LF	$111	MEANS 16.5420
6	DUCT ACCESSORIES	$450.00	1	LOT	$450	
7	DEMOLITION	$500.00	1	EA	$500	
8	CONTINGENCY				$1,037	
					$5,087	

ANALYSIS AND SAVINGS CALCULATIONS

The calculations summarized in the table below were performed to establish baseline energy consumption and baseline energy costs. Proposed energy consumption and energy costs were calculated for the same baseline DHW consumption to establish the proposed energy costs with gas tankless water heaters. The difference between the baseline and proposed configurations is reported as savings for energy and energy costs respectively to perform a simple payback analysis.

Table 22 – Analysis for Tankless Water Heaters

Bldg #	Existing Design	Conditioned Area, ft2	Occupants	DHW Consumption, GPD	Baseline Energy Consumption, kWh/yr	Baseline Energy Consumption, Costs	Proposed Energy Consumption, therms/yr	Proposed Energy Consumption Costs	Capital Cost, $	Savings, $	Rebates, $	Simple Payback, Yrs
CNTL 1	4.5 kW w/58 Gallons Storage, 3.5 kW w/30 Gallons Storage, and 3.5 kW Electric w/30 Gallons Storage	30,621	306	490	19,953	$1,823.74	681	$483.31	$15,262.49	$1,340.43	$0.00	11.4
CNTL 2	4.5 kW w/50 Gallons Storage	17,238	172	276	11,233	$1,026.67	383	$272.08	$5,087.50	$754.59	$0.00	6.7
SSB	1.5 kW Electric w/6 Gallon Storage	5,760	58	92	3,753	$343.06	128	$90.91	$5,087.50	$252.14	$0.00	20.2
PAC	12 kW Electric w/50 Gallon Storage	29,851	150	240	9,774	$893.38	334	$236.76	$5,087.50	$656.62	$0.00	7.7
SSB	6 kW Electric w/10 Gallon Storage	5,575	56	89	3,633	$332.04	124	$87.99	$5,087.50	$244.05	$0.00	20.8
Totals		89,045	742	1,187	48,347	$4,418.89	1,650	$1,171.06	$35,612.48	$3,247.83	$0.00	11.0
7	Demolition	$500.00	1	Ea	$500							
8	Contingency				$1,037							
					$5,087							

ECM 07 Premium Efficiency Motors

BACKGROUND & OBSERVATIONS

P2S recommends that SBVC and CHC maintain an inventory of motors with the appropriate data, such as DOE's (Department of Energy) tool called MotorMaster+. Based on the field survey, many buildings for CHC with large motors (HP>1) can be retrofitted with premium efficiency motors. Premium efficiency motors are a right replacement for any motor that operates more than 2000 hours/yr. Motors observed at San Bernardino Valley College were primarily premium efficiency motors and are excluded from the analysis. SBCCD should mandate the use of premium efficiency motors for all future retrofits and new buildings.

ASSUMPTIONS

- The operating hours of the motors being analyzed are conservatively estimated as 3500 hours. No data logging, or M&V is performed to validate this.
- The load factors are based on general observations during the site visits of the conservation study and they are on conservative side.
- Not all motors are studied or evaluated. Motors with power rating greater than 1 HP, and having a significant return is reported here.

COST, SAVINGS, REBATE, AND PAYBACKS

Table 23 summarizes the Costs, Analysis, Payback for the motors recommended for replacement. MotorMaster+ 4.0 was used for cost of replacement and installation. MotorMaster4.0 database has data for standard and premium efficiency motors.

The following Attachments are attached to substantiate the calculations in Table ECM-10-1.

- Attachment ECM-10-9.pdf
- Attachment ECM-10-11pdf
- Attachment ECM-10-13.pdf
- Attachment ECM-10-14.pdf

Table 23 – Cost, Savings, Payback Analysis

EQUIPMENT	BLDG	HRS/ YR	QTY	% LOAD	ENCLOSURE	VOLTAGE	STD	PREMIUM	MEASURE	HP RATING	KWH/YR SAVINGS	COST	REBATE	SAVINGS $/YR	SIMPLE PAYBACK	PAYBACK, W/ REBATE	ATTACHMENT #
SUPPLY FAN, MZ	WEST	3500	1	75%	ODP	460	86.0	91.5	REPLACE MOTOR	7.5	1,025	$2,012		$149	13.5	13.5	10-11
SUPPLY FAN, MZU	ART	3500	1	75%	ODP	460	86.0	91.5	REPLACE MOTOR	7.5	1,025	$2,012		$149	13.5	13.5	10-11
SUPPLY FAN, MZU	PAC	3500	1	75%	ODP	460	89.4	93.4	REPLACE MOTOR	20	1,879	$2,837		$273	10.4	10.4	10-14
RETURN FAN, MZU	PAC	3500	1	75%	ODP	460	86.0	91.5	REPLACE MOTOR	7.5	1,025	$2,012		$149	13.5	13.5	10-11
SUPPLY FAN, MZU	PAC	3500	1	75%	ODP	460	88.8	93.1	REPLACE MOTOR	15	1,515	$2,490		$220	11.3	11.3	10-13
RETURN FAN, MZU	PAC	3500	1	75%	ODP	460	84.3	90.4	REPLACE MOTOR	5	781	$1,781		$113	15.8	15.8	10-9
TOTALS →											7,250	$13,144	$0	$1,053	12.5	12.5	

ECM 08 RTU Upgrade

San Bernardino Valley College and Crafton Hills College have several buildings with roof top units (RTUs) with SEER ratings of 10-11. Cooling capacity of this RTUs varies from 24,000 Btu/h (2 tons) to 480,000 Btu/h (40 Tons). These units can be upgraded to high efficiency units with SEER ratings of 15 or greater.

Table 24 – Inputs and Assumptions

#	Parameter	Value	UNITS	COMMENTS	ITEM COST	NOTES/COMMENTS
1	Cost of Natural Gas	$0.7097	$/THERM	CHC, ENERGY DASHBOARD	$1,950	
2	Cost of Electricity	$0.0914	$/KWH	CHC UTILITY BILLS	$660	MEANS 23.1200
3	Cost of Natural Gas	$0.8755	$/THERM	SBVC, ENERGY DASHBOARD	$159	
4	COST OF ELECTRICITY	$0.1413	$/KWH	SBVC UTILITY BILLS	$220	
5	ANNUAL HEATING HOURS	3,476	HRS/YEAR	CLIMATE CONSULTANT, RIVERSIDE MUNI, CA	$111	MEANS 16.5420
6	ANNUAL COOLING HRS/YR @ FULL CAPACITY	1,681	HRS/YEAR	CLIMATE CONSULTANT, RIVERSIDE MUNI, CA	$450	
7	DATA CENTER COOLING HRS/YR @ FULL CAPACITY	2,500	HRS/YEAR	ASSUMPTION	$500	
8	REBATE RATE	$40	$/TON	SCE HVAC UPSTREAM	$1,037	

Table 25 – Cost, Savings, Payback Analysis

			EXISTING		PROPOSED						
Bldg	Qty	Cooling BTU/h	SEER	OPERATING COST, $/YR	SEER	OPERATING COST, $/YR	COOLING SAVINGS, KWH/YR	COOLING SAVINGS, $/YR	REPLACEMENT COST, $	REBATE, $	SIMPLE PAYBACK, YRS
M&O	2	42,000	11	$586.64	16	$403.31	2,006	$183	$11,200	$140	60.33
CDC	3	60,000	13	$709.12	16	$576.16	1,455	$133	$12,500	$200	92.51
CDC	1	72,000	13	$850.95	16	$691.40	1,746	$160	$13,500	$240	83.11
CDC	1	90,000	13	$1,063.69	16	$864.24	2,182	$199	$18,000	$300	88.75
EAST 1	3	36,000	10	$553.12	16	$345.70	2,269	$207	$10,600	$120	50.53
EAST 1	1	48,000	10	$737.49	16	$460.93	3,026	$277	$12,000	$160	42.81
EAST 1	2	60,000	10	$921.86	16	$576.16	3,782	$346	$12,500	$200	35.58
EAST 2	1	42,000	11	$586.64	16	$403.31	2,006	$183	$11,200	$140	60.33
EAST 2	1	48,000	11	$670.44	16	$460.93	2,292	$210	$12,000	$160	56.51
EAST 2	4	60,000	11	$838.05	16	$576.16	2,865	$262	$12,500	$200	46.97
				$7,518.00		$5,358.31	23,629	$2,160	$126,000	$1,860	57.48

PHASED IMPLEMENTATION AND RECOMMENDATIONS

Interior Lighting

Retrofitting the interior lighting can be completed in phases. One phase should utilize in-house staff to complete the easier retrofits. Within this phase, installation of new LED lamps or fixtures can be scheduled on a per building level at the pace appropriate for in-house staff. The purchase of LED lamps and fixtures can be synchronized with the retrofit schedules.

A second phase would utilize a lighting contractor to retrofit non-typical lights (e.g. high-bay fixtures, decorative/ specialty lighting, hard to access lights, etc.). Maintenance and operations (M&O) staff should document and compile a list of such light fixtures to be retrofitted by a lighting contractor. Within this phase, P2S recommends a comprehensive contract that includes as many non-typical lights within the scope. A comprehensive contract would reduce the complexity from using multiple contractors and could benefit from the economics of scale to reduce cost.

ECM-01 OPTION 1:

Most of the re-lamping can be completed with in-house custodial staff and/or M&O staff. Re-lamping with LED type A (plug-and-play) lamps does not require modification to the electrical components of the existing fixtures. As such, a wide range of fixtures types can be retrofitted with in-house staff. These fixture types include:

- Fixtures with 4' 32W fluorescent T8 lamps replaced with 4' LED type A lamps
- Fixtures with 2' 17W fluorescent T8 lamps replaced with 2' LED type A lamps
- Fixtures with 3' 21W fluorescent T5 lamps replaced with 3' LED type A lamps
- Fixtures with compact fluorescent lamps re-lamped with equivalent LED lamps. Special consideration should be made for the lamp socket type (i.e. 2-pn, 4-pin, screw-in, etc.). Each campus should ensure the correct lamps are purchased.

In the instance that a ballast requires to be replaced due to failure or incompatibility, P2S recommends a qualified in-house electrician perform the task. Ballast replacement are expected to be rare. For all other fixture types, P2S recommends utilizing a lighting contractor unless M&O staff is qualified and has the necessary tools to complete the task.

ECM-01 OPTION 2:

Replacing the lamp and ballast requires qualified in-house electricians to perform the task. Re-lamping with LED type B (ballast bypass or direct wire) lamps requires modification to the electrical components of the existing fixtures. Additionally, Title 24 lighting control requirements may be triggered if the retrofit is completed at a large enough scale. The following fixture types can be retrofitted using in-house electricians:

- Fixtures with 4' 32W fluorescent T8 lamps replaced with 4' LED type B lamps, ballast removal and converting lamp sockets rewiring (shunted to non-shunted)
- Fixtures with 2' 17W fluorescent T8 lamps replaced with 2' LED type B lamps, ballast removal and converting lamp sockets rewiring (shunted to non-shunted)
- Fixtures with 3' 21W fluorescent T5 lamps replaced with 3' LED type B lamps, ballast removal and converting lamp sockets rewiring (shunted to non-shunted)

For all other fixture types, P2S recommends utilizing a lighting contractor unless M&O staff is qualified and has the necessary tools to complete the task.

ECM-01 OPTION 3:

Full fixture replacements will require a combination of either in-house electricians or a lighting contractor. Depending on the complexity, M&O staff can be utilized to replace the fixture. The following fixture types can be retrofitted using in-house electricians:

- The 1'x4', 2'x4', and 2'x2' recessed troffers replaced with 1'x4', 2'x4' and 2'x2' LED retrofit kits, respectively. The LED retrofit kits are typically designed to fit inside the existing fixture enclosures. Electricians need to remove the existing lens cover, lamps, ballasts, and sockets; install mounting or frame brackets, attach the LED retrofit kit, and make necessary electrical and grounding connections. P2S recommends following manufacturer instructions for LED retrofit kit installations.
- The 6" and 8" recessed can downlights replaced with 6" and 8" LED retrofit kits, respectively. The LED retrofit kits are designed to fit inside the existing fixture enclosures. Electricians need to remove the existing trim, lamps, ballasts (if necessary), and sockets; install a socket adapter (if necessary), attach the LED retrofit kit, and make necessary electrical connections. P2S recommends following manufacturer instructions for LED retrofit kit installations.

For all other fixture types, P2S recommends utilizing a lighting contractor unless M&O staff is qualified and has the necessary tools to complete the task.

Exterior Lighting

Retrofitting the exterior lighting can be completed in phases. One phase should utilize in-house staff to complete the easier retrofits. Within this phase, installation of new LED lamps or fixtures can be scheduled on a per building or walkway at the pace appropriate for in-house staff. The purchase of LED lamps and fixtures can be synchronized with the retrofit schedules. Mapping of the exterior fixtures for walkways, parking lots, and area lighting is also recommended. Exterior lighting retrofit to be completed by M&O staff may include recessed downlights upgrade to LED, re-lamping high-intensity discharge or compact fluorescent lamps with LED lamps, and small wall packs.

A second phase would utilize a lighting contractor to retrofit fixtures omitted by M&O staff. M&O staff should document and compile a list of such light fixtures to be retrofitted by a lighting contractor. Fixtures may include post-top area lights, pole-mounted shoebox fixtures, floor lights, and the high-mast stadium floor lights. Within this phase, P2S recommends a comprehensive contract that includes all lights omitted by M&O staff within the scope. A comprehensive contract would reduce the complexity from using multiple contractors and could benefit from the economics of scale to reduce cost. The exterior lighting retrofit can be completed with the interior lighting retrofit by the same lighting contractor.

Controls and Retro-Commissioning (RCx) Measures

P2S recommends a phased approach to upgrading the HVAC controls and implementing RCx measures. Due to the complexity of these measures, phases should encompass 1 to 4 buildings at a time. These buildings should be similar in scope to reduce complexity and not overburden project managers to properly oversee the project. Both controls retrofits and RCx measure require several weeks to properly implement. If project implementation timelines are short, overlapping of project phases between beginning and end should be considered. If pursuing utility incentives, timelines should be extended 3 to 6 months to accommodate the application review process.

For controls retrofits, P2S recommends hiring a HVAC contractor to implement the project. Implementation for HVAC controls upgrade are typically labor intensive and require a wide range of vendors and expertise. The actual installation may require a few days, but project will require additional weeks of commissioning, follow up, and staff training to ensure proper operation.

For RCx measures, P2S recommends a combination of in-house HVAC technicians and HVAC contractors be utilized to implement. Depending on the scale of the project, in-house HVAC technicians can implement simpler measures such as HVAC scheduling, setpoint and setback programming, damper linkage and actuator repair/replacement, control valve replacements on small water lines, and sensor replacement and repairs.

For more complex RCx measures, HVAC contractors with experience in commissioning and energy management system programming should be utilized. After identifying the operational issue, an in-depth investigation is needed to identify the root causes. The investigation may include trend analysis of equipment performance e, functional performance testing, and review of the HVAC programming sequence of operations. Measures that P2S recommends hiring an HVAC contractor may include fixing fan and pump VFDs to properly modulate, implementing setpoints resets, building over pressurization and air balancing, and major issues pertaining to central plant and water loop operations.

Fan Wheels Retrofit

P2S recommends upgrading the fan wheels based on the existing fan condition and operating hours. Larger, less efficient fans that operate long hours should be prioritized for replacement first. PS2 recommends M&O staff document and compile of a list of fans used throughout campus to identify the strongest candidates for fan wheel upgrades.

P2S recommends hiring a HVAC contractor to complete the task. Using the fan inventory list, campus can develop a project to advertise for competitive bids. Fan wheel upgrades can be implemented simultaneously with premium efficiency motor upgrades, HVAC controls upgrade, and RCx measures.

Plug Load Control

Installing plug load controls can be completed in phases utilizing in-house staff. Implementation should be completed on a per building level where buildings are surveyed for viable plug loads that would benefit from shut-off controls. After completion of the survey, plug-load controls can be deployed.

Tankless DHW Heaters

P2S recommends upgrading to tankless domestic hot water (DHW) heaters based on the existing water heater condition and hot water consumption. Larger, less efficient water heaters that serve a large hot water demand should prioritized for replacement first. PS2 recommends M&O staff document and compile of a list of DHW heaters used throughout campus to identify the strongest candidates for tankless DHW heater upgrades. Kitchens and buildings with significant hot water usage would be strong candidates.

Premium Efficiency Motors

P2S recommends upgrading to premium efficiency motors based on the existing motor condition and operating hours. Larger, less efficient motors that operate long hours should be prioritized for replacement first. PS2 recommends M&O staff document and compile of a list of motors used throughout campus to identify the strongest candidates for premium efficiency motor upgrades. It is recommended that campuses maintain the inventory of motors with the appropriate data, such as using a DOE (Department of Energy) tool called MotorMaster+.

Depending on the complexity of the system, P2S recommends using in-house staff where possible to replace the motor. For large, complex systems; P2S recommends hiring a HVAC contractor to complete the task. Using the motor inventory list, campus can develop a campus-wide motor replacement project to advertise for competitive bids. Premium efficiency motor upgrades can be implemented simultaneously with HVAC controls upgrade and RCx measures.

RTU Upgrade

P2S recommends upgrading the RTUs based on the age and operating performance of the existing RTUs. Older and less efficient RTUs should be prioritized for replacement first. RTU replacement is recommended to be implemented on a per building level. However, occasionally that is not feasible as one or more RTUs may fail prior to scheduled replacement.

Campus should consider standardizing the minimum efficiency of RTU replacements, manufacturer(s), and equipment series to ensure uniformity of systems for ease of future maintenance and parts replacement.

CHAPTER 3
Electrification And EV Charging Plan

OVERVIEW

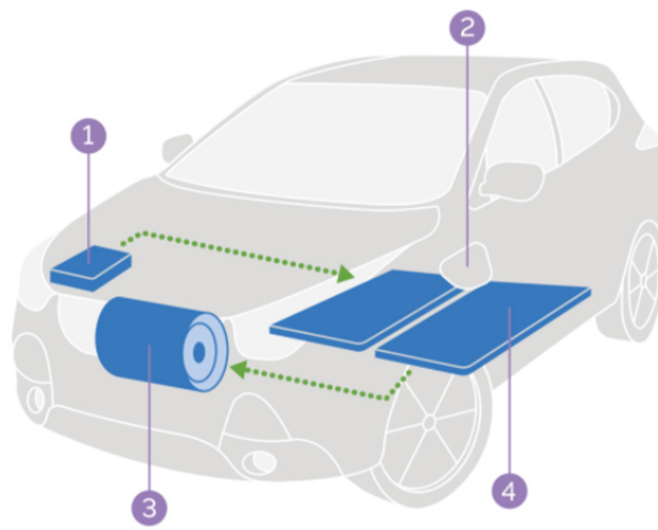
With states and cities across the nation driving mandating reduction in green house gas emissions, fleet electrification has become an important factor to achieve the zero net energy goal. Fleets are accelerating the shift to e-mobility, utility and government incentives are fueling the demand for electric vehicle (EV) charging infrastructure. Los Angeles, has committed to replacing its entire fleet of 2,300 buses with zero-emissions vehicles (ZEVs) by 2030.

California aggressively intends to move further away from its reliance on climate change-causing fossil fuel requiring all new passenger vehicles in the state to be zero-emission by 2035. The state is already targeting clean electric power by 2045 as part of its carbon neutral goal to reduce emissions. As part of the executive order N-79-20, dated September 23, 2020, state establishes the following goals for zero emission new commercial electric vehicles to be sold in the state of California.

California Executive Order N-79-20:

1. *It shall be a goal of the State that 100 percent of in-state sales of new passenger cars and trucks will be zero-emission by 2035. It shall be a further goal of the State that 100 percent of medium- and heavy-duty vehicles in the State be zero-emission by 2045 for all operations where feasible and by 2035 for drayage trucks. It shall be further a goal of the State to transition to 100 percent zero-emission off-road vehicles and equipment by 2035 where feasible.*
2. *The State Air Resources Board, to the extent consistent with State and federal law, shall develop and propose:*
    a. *Passenger vehicle and truck regulations requiring increasing volumes of new zero-emission vehicles sold in the State towards the target of 100 percent of in-state sales by 2035.*
    b. *Medium- and heavy-duty vehicle regulations requiring increasing volumes of new zero-emission trucks and buses sold and operated in the State towards the target of 100 percent of the fleet transitioning to zero-emission vehicles by 2045 everywhere feasible and for all drayage trucks to be zero emission by 2035.*
    c. *Strategies, in coordination with other State agencies, U.S. Environmental Protection Agency and local air districts, to achieve 100 percent zero-emission from off-road vehicles and equipment operations in the State by 2035.*

Currently, most electric cars are powered by rechargeable lithium-ion batteries that are compact and have a very high energy density. They are charged primarily by an external electricity source, which can be as simple as a standard 120-volt outlet. The onboard charger takes the incoming alternating current (AC) electricity and converts it to direct current (DC) power for charging the main battery. The power is delivered to the electric traction motor that drives the car's wheels.



1. **Onboard Charger –** Converts incoming AC electricity to DC power for charging the battery
2. **Charge Port –** Enables the car to be plugged in to an external power source to charge the battery
3. **Electric Motor –** Powered from the battery, the electric motor propels the car at all times
4. **Battery –** Typically positioned below the seats for better weight distribution, these batteries can be as large as 100kWh and power the electric motor

TYPES OF EV CHARGERS

Below are classifications of various types of chargers or electrical vehicle service equipment (EVSE) available in the market place:

Level 1: Level 1 EVSE provides charging through a 120 volt (V) AC plug and requires a dedicated branch circuit. Most, if not all, Plug in Electric Vehicles (PEV) will come with a portable Level 1 EVSE cordset, which does not require installation of additional charging equipment. Typically, on one end of the cord is a standard, three-prong household plug (NEMA 5-15 connector). On the other end is a standard SAE J1772 connector which plugs into the vehicle.

Level 1 works well for charging at home, work, or when only a 120 V outlet available. Based on the battery type and vehicle, Level 1 charging adds about 2 to 5 miles of range to a vehicle per hour of charging time.

Level 2: Level 2 EVSE offers charging through a 240 V (typical in residential applications) or 208 V (typical in commercial applications) AC plug. This requires installing charging equipment and a dedicated electrical circuit of 20 to 100 amperes.

Workplace charging typically uses Level 2 equipment as well. Level 2 and Level 1 equipment use the same type of connector on the vehicle. Based on the battery type, charger configuration, and circuit capacity, Level 2 charging adds about 10 to 20 miles of range to a PEV per hour of charging time.

DC Fast Charger or Level 3 Charger: DC fast-charging or Level 3 EVSE (480 V AC input to the EVSE) enables rapid charging at sites such as heavy traffic corridors and public fueling stations. A DC fast charger can add about 60 to 80 miles of range to a PEV in 20 minutes or less. This type of charging uses a separate type of plug than the J1772 Level 1 and Level 2 EVSE.

- DC Fast Charging bypasses all of the limitations of the on-board charger and required conversion, instead providing DC power directly to the battery, charging speed has the potential to be greatly increased. Charging times are dependent on the battery size and the output of the dispenser, and other factors, but many vehicles are capable of reaching an 80% charge in about or under an hour using most currently available DC fast chargers.
- DC fast charging is essential for high mileage/long distance driving and large fleets. The quick turnaround enables drivers to recharge during their day or on a small break as opposed to being plugged in overnight, or for many hours, for a full charge.
- Currently, in North America there are three types of DC fast charging: CHAdeMO, Combined Charging System (CCS) and Tesla Supercharger.

Type	Level 1	Level 2	DC Fast Charging
Power	3KW	7KW	~ 60- 250KW
Time	12.5Mi/ hour	20 Mi/hour	~180-500 Mi/hour
Features	Single Phase	Both single and three phase	Requires infrastructure upgrade and capacity to support DC FC equipment.

Most modern chargers and vehicles have a standard connector and receptacle known as the “SAE J1772.” Any vehicle with this plug receptacle can use any Level 1 or Level 2 EVSE. All major vehicle and charging system manufacturers support this standard, which eliminates owners concerns about whether their vehicles are compatible with available infrastructure.

Cut sheets of various chargers available in the market place today is provided in Appendix.

CURRENT AND PROPOSED LOCATIONS

A review of the existing parking lots at the campus revealed that the campus currently does not have any electric vehicle charging at their parking lots.

To promote and support electric vehicle charging at the campus consistent with the current and future legislations and in absence of any standard or legislation governing the number of EV chargers, the current CA Green Code requirements for number of EV chargers required were utilized in joint consultation with the campus. CA green code stipulates EV infrastructure for the proposed chargers based on the number of parking spaces in each of the parking lots. This number was used as a basis for specifying the number of EV chargers in each of the parking lots at the campus. The number of parking spaces in each of the parking lots were based on the campus wide ADA study conducted in 2013.

Table below provides the number of EV chargers infrastructure required in parking lots based on the current CA Green Code.

Total Number of Actual Parking Spaces	Number of Required EV Charging Spaces
0-9	0
10-25	1
26-50	2
51-75	4
76-100	5
101-150	7
151-200	10
201 AND OVER	6 PERCENT OF TOTAL

CALCULATION FOR SPACES ARE ROUNDED UP TO THE NEAREST WHOLE NUMBER

Based on the code table above, table 1 below provides the number of recommended EV chargers at each of the parking lots at the campus:

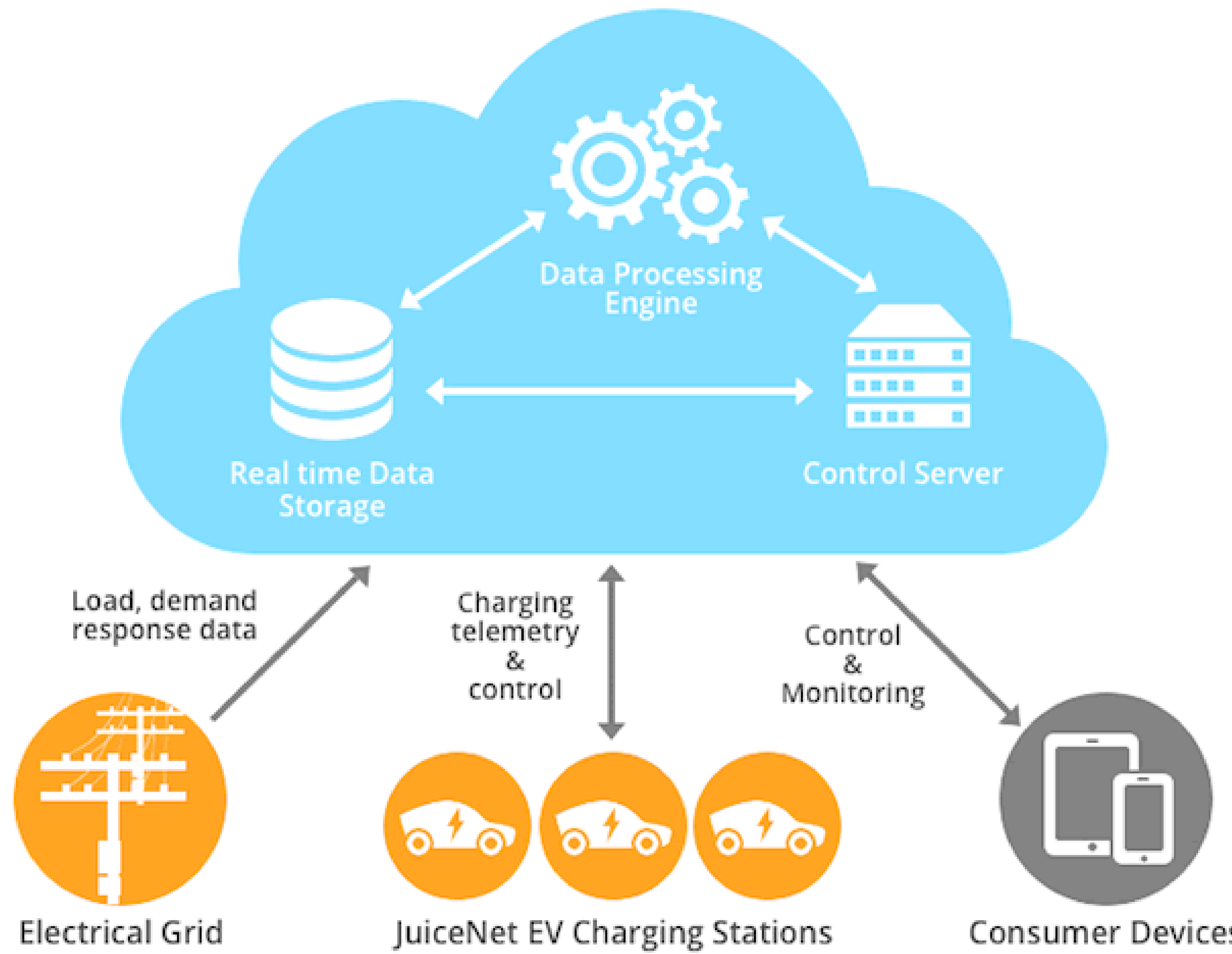
Parking Lot	Parking Spaces	EV Spaces
A	74	5
B	137	10
C	120	8
D	23	2
E	74	5
F	80	6
G	83	6
H	73	6
I	252	18
J	173	12
K	128	9
L	85	6
M	80	6
N	62	4
P	57	5
R	46	3
M&O	35	2
TOTAL	1588	112

An overall exhibit providing the number of EV chargers in each of the parking lots and enlarged plans showing location of each of these chargers is provided at the end of this section.

IMPACTS ON CURRENT INFRASTRUCTURE AND DEMAND

An evaluation of the current infrastructure to support the proposed EV chargers recommended in each of the parking lots was undertaken. Majority of the chargers can be connected to the existing infrastructure available in close proximity to the parking lots as shown in the exhibit with no major upgrades required to the existing infrastructure. Efforts should also focus to implement smart energy-efficient future mobility demands and management systems controllers to monitor, adjust and control the electric demands from electric vehicle charging rather than solely focus on upgrading infrastructure to support electric vehicle charger loads at all times. Controller should monitor the real time demand and guide charging network design, with solutions that go beyond simply adding more stations and even include potentially maintaining some slow-charging locations in contrast to switching over all charging stations to faster rates. Monitoring shall be implemented to effectively monetize the charging stations and maintain the demand profiles and integrate with controllers as required. Monitoring programs commercially available offer end-to-end distributed energy solutions, combining advanced analytics, software technology, and hardware systems.

Network management system equipped with Open Charge Point Protocol (OCPP) shall be installed to control all aspects of EV charging including access control, power management, traffic and waitlist management, Integration with 3rd party pay apps, real time and historical data analytic and trends. Emphasis for newtwork selection shall be to keep an open end network for various types of chargers as well as capability for open ended communication using OCPP. Charge Point Network, EV connect Network management and GreenLots SKY EV charging Network are examples of network software's presently available in the market with capability to meet the campus needs as well as provide flexibility in terms of monitoring, control and management. Cutsheets of network solution is included in the appendix.



Alternatively, the campus should await the roll out of utility program for Light Vehicle EV Chargers in fall of this year and utilize the SCE infrastructure available along the main campus drive to support the demands of the proposed EV chargers. This will have no impact on the current infrastructure and will not require any extension of existing infrastructure to support these EV chargers. In addition, optimal rates combined with both incentives and grants will be available to support the installation of these chargers which will help offset majority of the costs of these chargers.

A review of the current campus infrastructure revealed that the addition of the recommended EV chargers will have minimal or no impact to the current electrical infrastructure. The campus has plenty of electrical capacity to support the proposed EV chargers at each of the parking lots. An exhibit providing description of the proposed electrical service to each of the parking lots to support the EV chargers is included at the end of the section.

In addition, as the campus adds additional EV chargers to support the electrical vehicles, the campus should employ Charge Point Network -Open or similar. to program and charge the chargers during periods of low demands to minimize the impact on the current electrical infrastructure serving existing facilities at the campus or seek direct service from SCE to serve the proposed chargers.

INCENTIVES, GRANTS AND PILOT PROGRAMS

Below are the current grants and incentives being offered currently by SCE which can be used by the campus to avail benefits and cost savings.

CALIFORNIA ELECTRIC VEHICLE INFRASTRUCTURE PROJECT (CALEVIP) - SOUTHERN CALIFORNIA INCENTIVE PROJECT (SCIP):

- The Southern California Incentive Project (SCIP) promotes easy access to zero-emission vehicle infrastructure by offering rebates for the purchase and installation of eligible public electric vehicle (EV) chargers in Los Angeles, Orange, Riverside and San Bernardino counties with a total of $29 million in available funds. Eligible applicants include businesses, nonprofit organizations, California Native American Tribes listed with the Native American Heritage Commission or a public or government entity.
- Eligible rebates include up to $70,000 per DC fast charger (DCFC) for installations at new sites and sites with stub-outs and up to $40,000 per DC fast charger for installations at replacement and make-ready sites.

CHARGE READY FOR MEDIUM AND HEAVY DUTY VEHICLES AND LIGHT VEHICLE EV CHARGERS INCENTIVES

- Charge Ready transit is available today. Charge Ready supports medium and heavy-duty electric vehicles and includes the following:
  - Medium-Duty Vehicles
  - Heavy-Duty Vehicles
  - Forklifts
  - School Buses
  - Transit Buses
  - Port Cargo Trucks
  - Airport Ground Support Equipment
  - Transportation Refrigeration Units (TRU)
  - Truck Stop Electrification (TSE).
- For Charge Ready Passenger Vehicles, the current program pays 100% of the infrastructure costs and 25% of the charging station base cost unless the customer is in a disadvantaged community and in that case the utility offers an incentive equivalent to 100% of the base cost.

FUNDING & PROGRAM DURATION

- Five-year program
- Approved total program budget of $356.4M
- Program goals: minimum 870 sites with 8,490 electric vehicles procured or converted
- Covers cost of all infrastructure needed up to charging station

SCE'S NEW EV RATES

- Available now
- Zero demand charges until 2024
- Monthly peak demand can be reduced by building or other "general service" demand at the same site
- Encouraging off-peak charging: Higher energy rates on-peak (4-9 PM)
- EV rates available for separately-metered charging

Calendar Year	2019-2023	2024	2025	2026	2027	2028	2029+
% of Final Demand Charges	0%	16.67%	33.33%	50%	66.7%	83.33%	100%

New EV Rates level fueling costs with phased-in demand charges

2019-2023 Energy only; No Demand Charges	2024-2028 Phase-in Demand Charges	2029+ Return to Energy + Demand Charges
Favorable Pricing for EV Charging	**Increased EV Adoption**	**Steady Operations**
• Rates w/ no or low demand charges • Suited for lower load factor – infrequent & spikey – charging (e.g., in-depot charging).	• Rates w/ low demand charges + low energy charges (mid-day) • Suited for hybrid charging strategies (e.g., combination of overnight in-depot + in-route opportunity charging)	• Rates w/ demand charges + low energy charges (mid-day) • Suited for higher load factor – frequent & steady – charging (e.g., co-located in-depot charging)

* TOU-EV-7, TOU-EV-8, and TOU-EV-9 rates are applicable to commercial customers whose monthly max demand is 20 kW or less, 21 kW to 500 kW, and above 500 kW, respectively. Rates are available starting March 1, 2019.

QUALIFIED CHARGING STATIONS

- Two charging levels are available for Charge Ready:
  - Level 1 (120 V)
  - Level 2 (208 V – 240 V): Communication/DR and metering capabilities
- Only SCE-approved vendors may participate in the program. They provide:
  - Qualified charging stations that meet the program's technical requirements
  - Installation
  - EV network services for data management and future DR programs (Level 2 only)

CHARGE READY FINANCIAL INCENTIVES

- SCE installs and maintains the complete electric infrastructure serving charging stations at no cost to participating customers (before and after the meter)
- SCE provides a rebate to offset charging station costs (hardware and installation). Each charging station category will have a discrete base cost
- Customers negotiate the actual price for the charging stations and their installation directly with the vendor

Segment	Rebate (% Base Cost)
All segments in Disadvantaged Communities	100%
Multi-unit Dwellings	50%
All other segments (workplace, fleet, destination centers)	25%

Charge Ready DR Pilot Event Types

Load Shift and Reduction Timeline

Load Shift and Reduction Details

	Load Reduction	Load Shift
Incentive Period	4 PM to 9 PM M-F, except holidays	11 AM to 3 PM M-F, except holidays
Control and Baseline Period	4 PM to 9 PM	6 AM to 11 AM
Months	June through September	March through May and October through December
Number of events per day	Single one-to-five hour control event	Single one-to-five hour control event
Number of events	Up to 10 each year	Up to 10 each year
Shift or Reduction	Up to 50%	Up to 50%
Credits	$0.10 per kWh reduced during Control/Incentive Periods	$0.05 per kWh used during the Incentive Period
Notification	Day ahead	Day ahead

LIGHT VEHICLE EV CHARGERS INCENTIVE PROGRAM

Discussions with SCE on available light vehicle EV chargers incentives revealed that the incentive program is currently in development and will be rolled out in third quarter of next year (2021). The incentive program will be similar to the Medium and Heavy Duty Vehicles Incentive Program currently in effect.

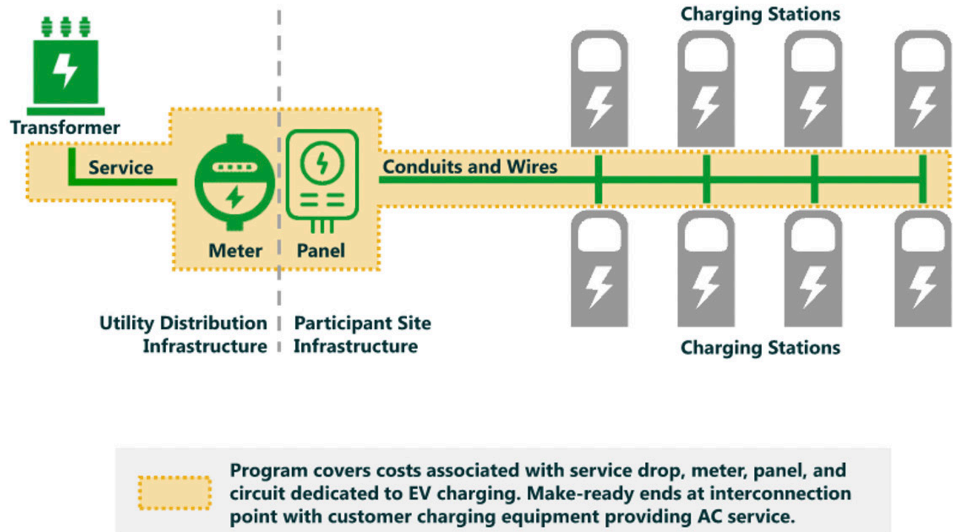
No demand charges will be levied up to five years. Demand charges will go in effect after ten years to 100% level. Special EV rate will be provided and will mimic the program outlined below. This will be applicable for all customers applying for a separate service to serve the proposed EV chargers.

Base costs of charging stations will be covered by SCE from 25%-100% based on disadvantage status. Discussions with SCE revealed that the current program does not include incentives for EV chargers served by the campus infrastructure but the exact program requirements will not be known until the program rolls out next year.

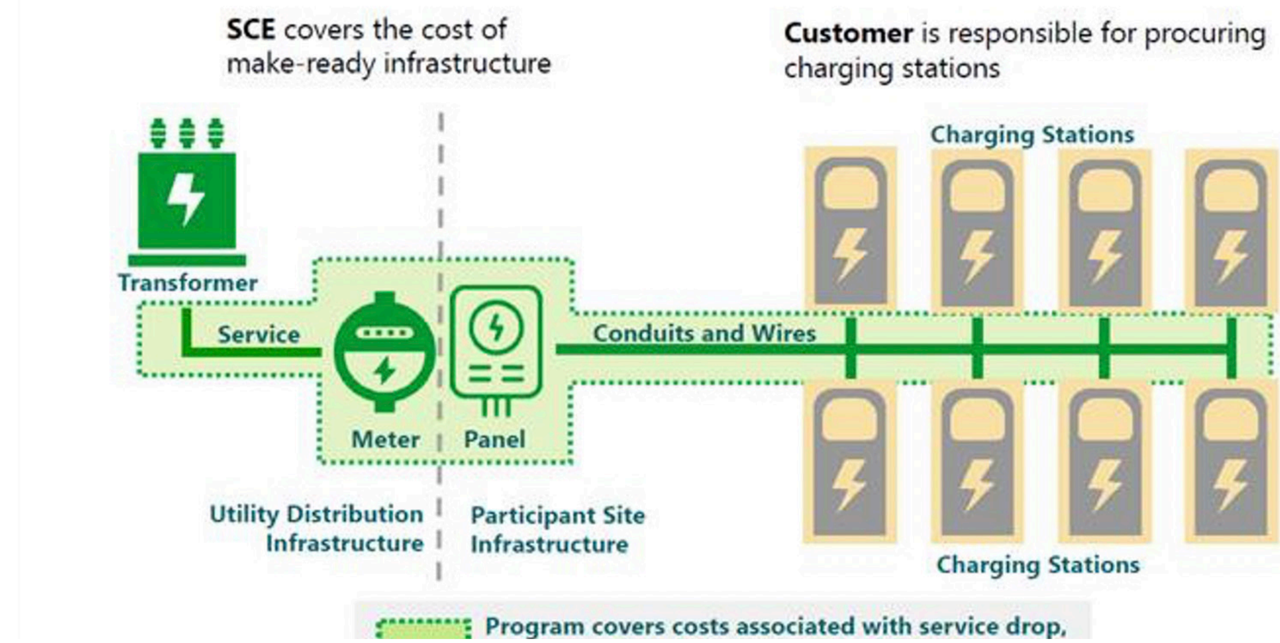
The Light Vehicle incentive program that will follow the current Heavy Duty and Medium Duty Incentive program will offer the following options for customers:

SCE installs "make-ready" electrical infrastructure at no cost

- Standalone charging station model

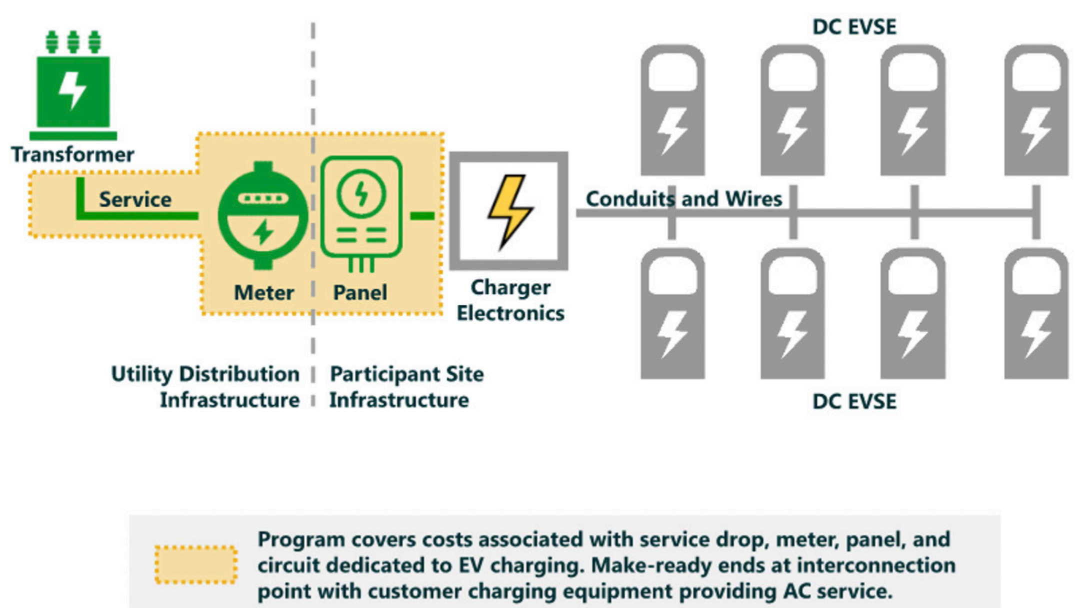


Make-Ready Deployment Overview

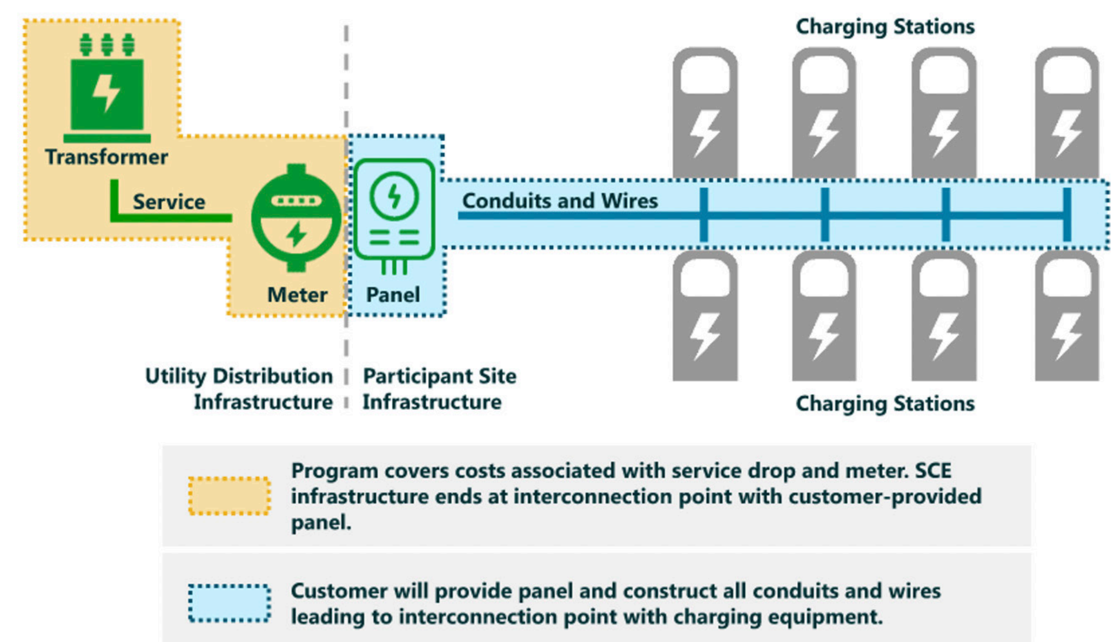


Defining Make-Ready Infrastructure

- Centralized charger electronics with modular DC power distribution



Make-Ready Infrastructure (Customer-Built)



PHASED IMPLEMENTATION PLAN AND RECOMMENDATIONS

To promote and support electric vehicle charging at the campus consistent with the current and future legislations and in absence of any standard or legislation governing the number of EV chargers, we recommend that the campus follow the current CA Green Code requirements for number of EV chargers required in each of its parking lots.

Tables 1 and 2 on this page provide the number of recommended level 2 and DC fast EV chargers at each of the parking lots at the campus.

We recommend that the subject EV chargers in each of the parking lots above be added to the campus in phases once the SCE incentive program rolls out next year. This will provide a clear direction on the available incentives and the available options for dedicated service for these chargers. Providing dedicated utility service to serve these chargers in lieu of connecting the same to the campus infrastructure will help the campus a) leverage majority of the costs of the EV chargers and the associated infrastructure, b) get a competitive rate and avoid demand charges and c) minimize the overall costs of extending the current campus infrastructure to serve these chargers. An overall exhibit providing the number of EV chargers in each of the parking lots and enlarged plans showing location of each of these chargers is provided at the end of this section.

As the campus adds additional EV chargers to support the electrical vehicles, the campus should seek additional services from SCE to serve the proposed chargers and take advantage of the offered incentives, optimal rates and grants to offset the overall costs of the chargers.

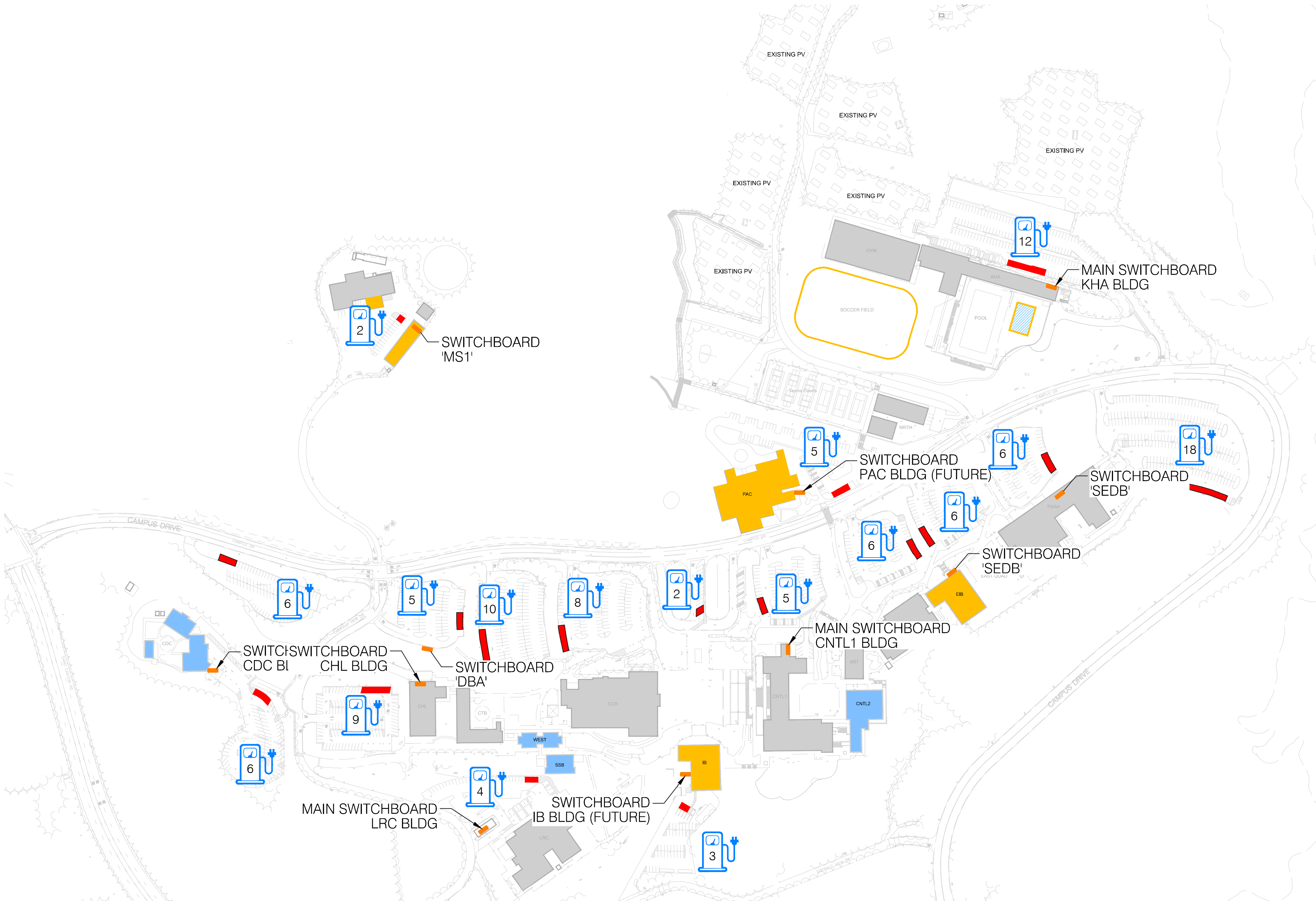
CHC - Level 2 Charging

Parking Lot	Parking Spaces	EV Spaces	Electrical POC	Electrical POC Capacity	Electrical POC Existing Load (kW)	Proposed Load Addition (kW)	Proposed Electrical POC Estimated Load (kW)
A	74	5	PARKING LOT A, SWITCHBOARD DBA	500	200	41.44	385.36
B	137	10	PARKING LOT A, SWITCHBOARD DBA			76.72	
C	120	8	PARKING LOT A, SWITCHBOARD DBA			67.2	
D	23	2	CENTRAL COMPLEX, MAIN SWITCHBOARD	500	200	12.88	254.32
E	74	5	CENTRAL COMPLEX, MAIN SWITCHBOARD			41.44	
F	80	6	PROPOSED EIB BUILDING, MAIN SWITCHBOARD	500	200	44.8	291.28
G	83	6	PROPOSED EIB BUILDING, MAIN SWITCHBOARD			46.48	
H	79	6	PSAH BUILDING, MAIN SWITCHBOARD	500	200	44.24	385.36
I	252	18	PSAH BUILDING, MAIN SWITCHBOARD			141.12	
J	173	12	GYM BUILDING, MAIN SWITCHBOARD	750	300	96.88	396.88
K	128	9	CRAFTON HALL, MAIN SWITCHBOARD	500	200	71.68	271.68
L	85	6	PROPOSED CDC BUILDING, MAIN SWITCHBOARD	300	120	47.6	212.4
M	80	6	PROPOSED CDC BUILDING, MAIN SWITCHBOARD			44.8	
N	62	4	LRC BUILDING, MAIN SWITCHBOARD	1500	600	34.72	634.72
P	57	5	PROPOSED PAC BUILDING, MAIN SWITCHBOARD	500	200	40	240
R	46	3	PROPOSED IB BUILDING, MAIN SWITCHBOARD	500	200	25.76	225.76
M&O	35	2	M&O BUILDING, MAIN SWITCHBOARD	750	300	19.6	319.6
TOTAL	1588	112					

CHC - DC Fast Charging

Parking Lot	Parking Spaces	EV Spaces	Electrical POC	Electrical POC Capacity	Electrical POC Existing Load (kW)	Proposed Load Addition (kW)	Proposed Electrical POC Estimated Load (kW)
D	23	2	CENTRAL COMPLEX, MAIN SWITCHBOARD	500	200	120.75	320.75
F	80	6	PROPOSED EIB BUILDING, MAIN SWITCHBOARD	1500	200	420	1055.75
G	83	6	PROPOSED EIB BUILDING, MAIN SWITCHBOARD	0	0	435.75	
L	85	6	PROPOSED CDC BUILDING, MAIN SWITCHBOARD	1000	120	446.25	986.25
M	80	6	PROPOSED CDC BUILDING, MAIN SWITCHBOARD	0	0	420	
N	62	4	LRC BUILDING, MAIN SWITCHBOARD	1500	600	325.5	925.5
P	57	5	PROPOSED PAC BUILDING, MAIN SWITCHBOARD	750	200	375	575
R	46	3	PROPOSED IB BUILDING, MAIN SWITCHBOARD	500	200	241.5	441.5
M&O	35	2	M&O BUILDING, MAIN SWITCHBOARD	750	300	183.75	483.75
TOTAL	551	40					
TOTAL	1588	112					

PROPOSED EV SITE PLAN



FACILITY LEGEND

ART	VISUAL ARTS
CYN	CANYON HALL
CNTL1	CENTRAL COMPLEX
CNTL2	CENTRAL COMPLEX 2
CDC	CHILD DEVELOPMENT CENTER
CTB	CLOCK TOWER BUILDING
CCR	CRAFTON CENTER
CHL	CRAFTON HALL
EAST	EAST COMPLEX
EIB	EAST INSTRUCTIONAL BUILDING
EVPSTC	EAST VALLEY PUBLIC SAFELY TRAINING CENTER
GYM	GYMNASIUM
IB	INSTRUCTIONAL BUILDING
KHA	KINESIOLOGY, HEALTH EDUCATION, AQUATIC COMPLEX
LRC	LEARNING RESOURCES CENTER
M&O	MAINTENANCE AND OPERATIONS
M&O ADD	MAINTENANCE AND OPERATIONS ADDITION
NRTH	NORTH COMPLEX
PAC	PERFORMING ARTS CENTER
PSAH	PUBLIC SAFETY AND ALLIED HEALTH
SSB	STUDENT SUPPORT BUILDING
WEST	WEST COMPLEX

BUILDING LEGEND

EXISTING BUILDING................................
UNDER CONSTRUCTION........................
FUTURE BUILDING...................................
BUILDING RENOVATION/EXPANSION...

SYMBOL LEGEND

EV CAR CHARGER
EV CHARGING SPACES
SELECTOR SWITCH
EC CHARGER POC
SWITCHBOARD

Parking Lot	Parking Spaces	EV Spaces
A	74	5
B	137	10
C	120	8
D	23	2
E	74	5
F	80	6
G	83	6
H	79	6
I	252	18
J	173	12
K	128	9
L	85	6
M	80	6
N	62	4
P	57	5
R	46	3
M&O	35	2
Total	**1588**	**112**

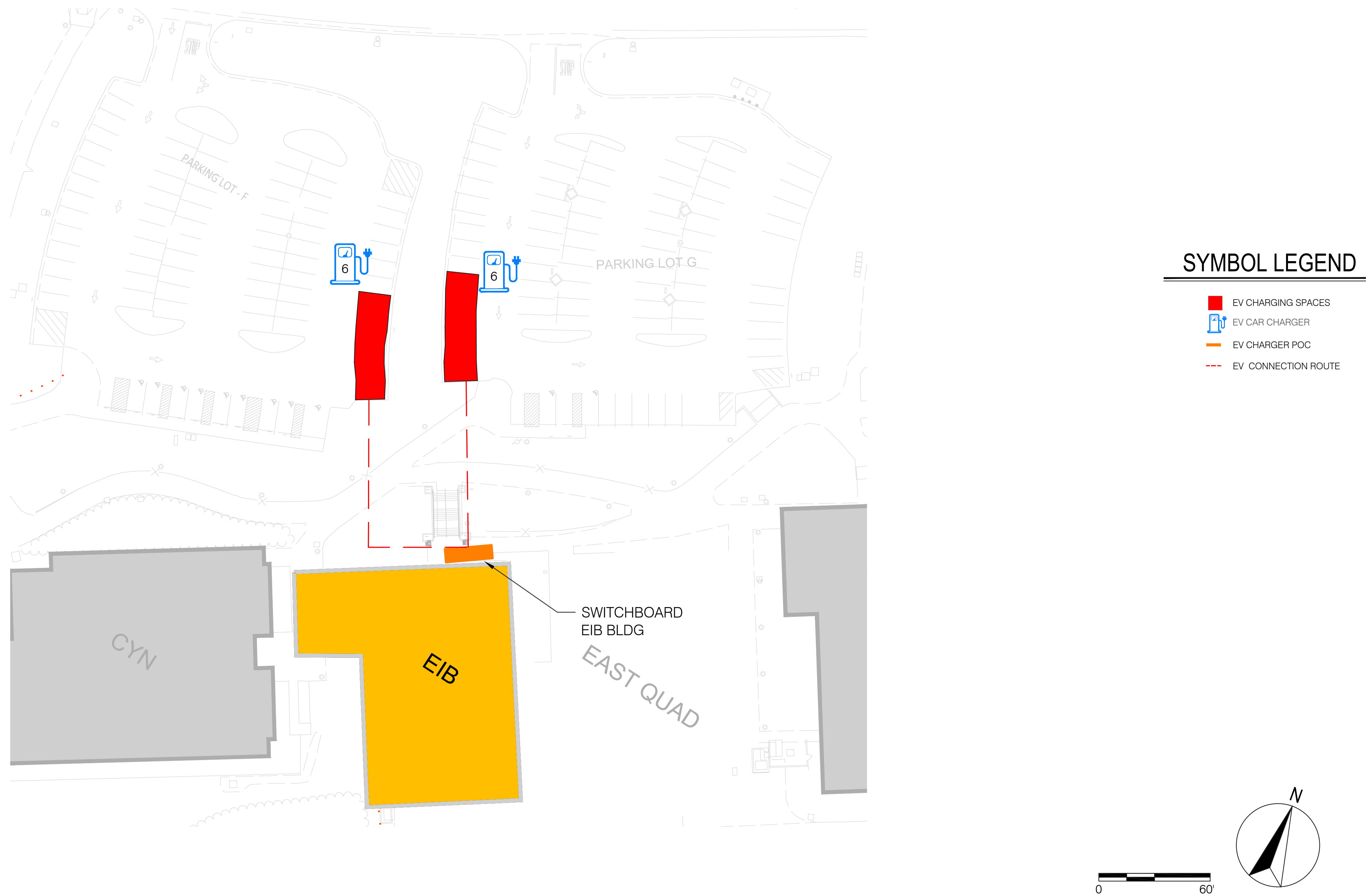
0 300'

N

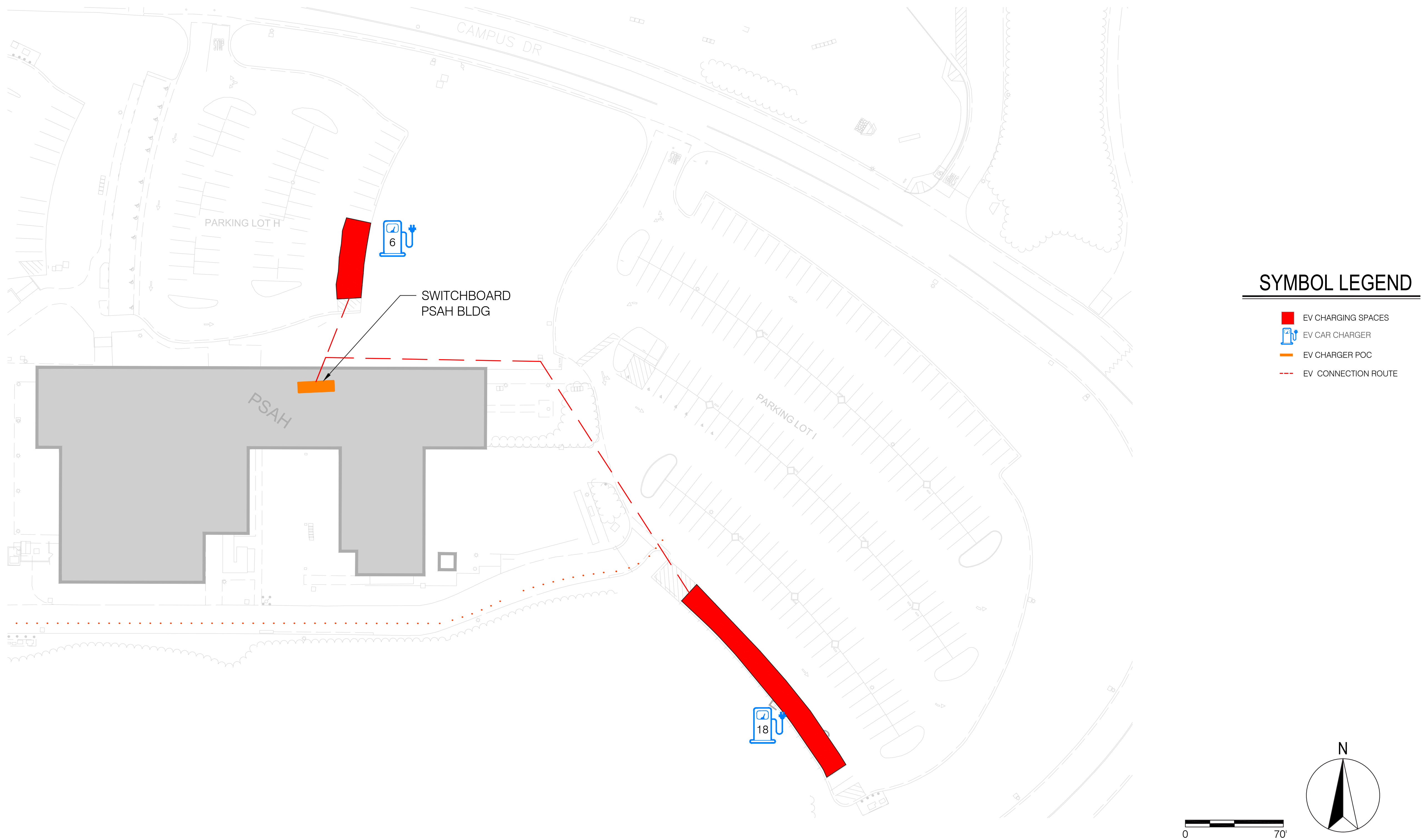
Parking Lot A, B, & C


PARKING LOT - D
PARKING LOT - E
2
5
SWITCHBOARD
CNTL1 BLDG
CNTL1
SYMBOL LEGEND
EV CHARGING SPACES
EV CAR CHARGER
EV CHARGER POC
EV CONNECTION ROUTE
N
0
70'

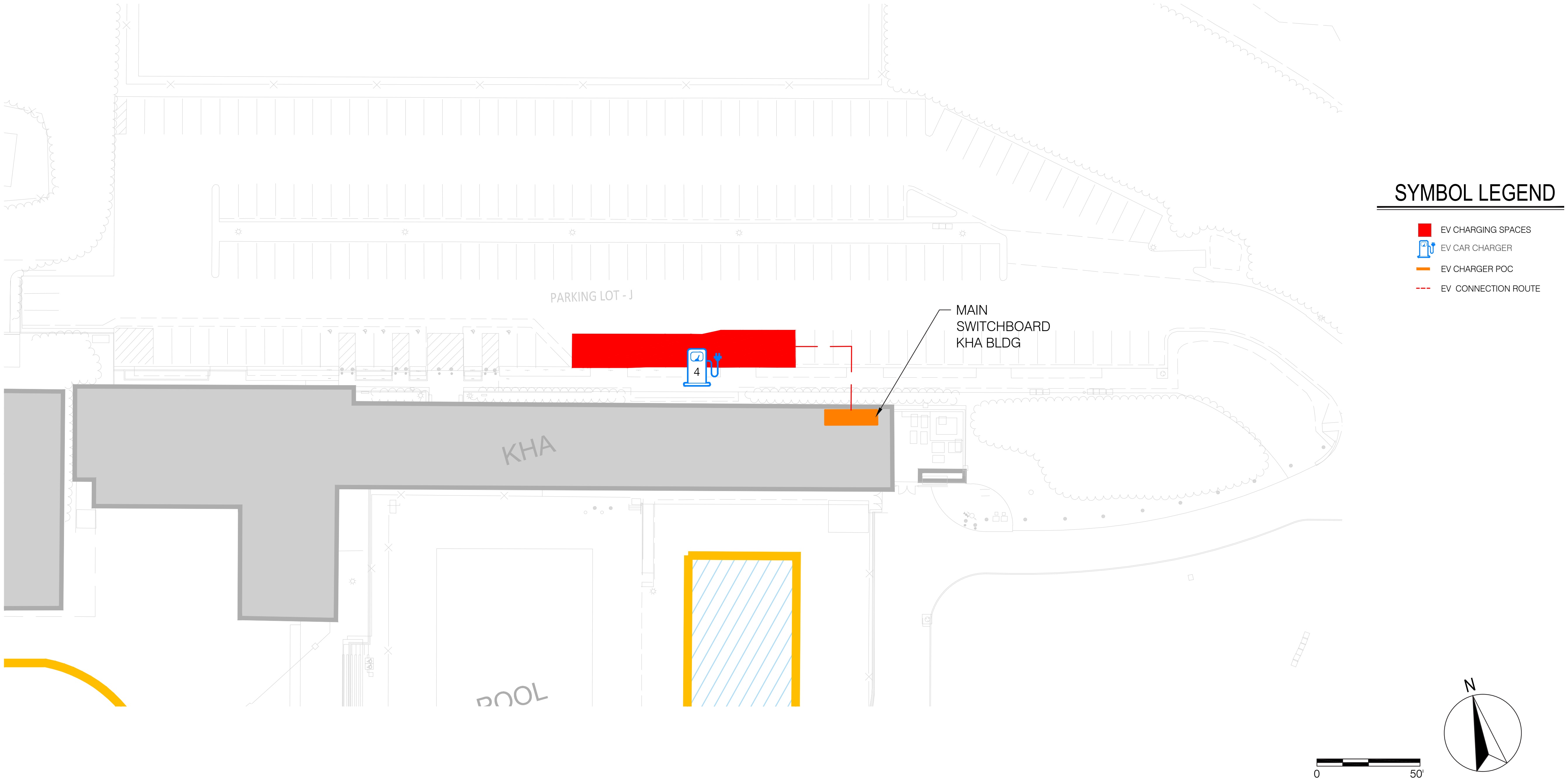
Parking Lot F & G



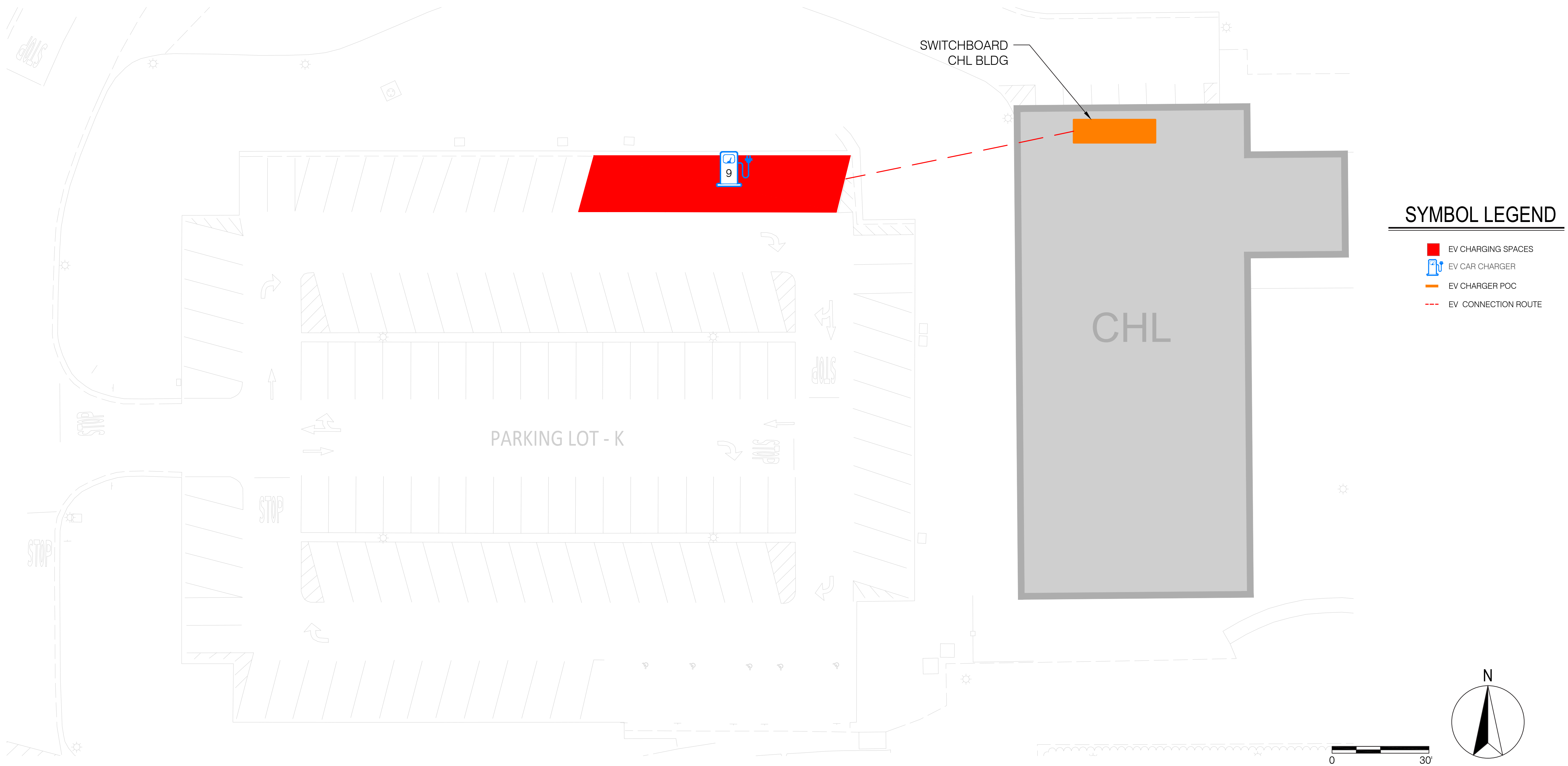
Parking Lot H & I



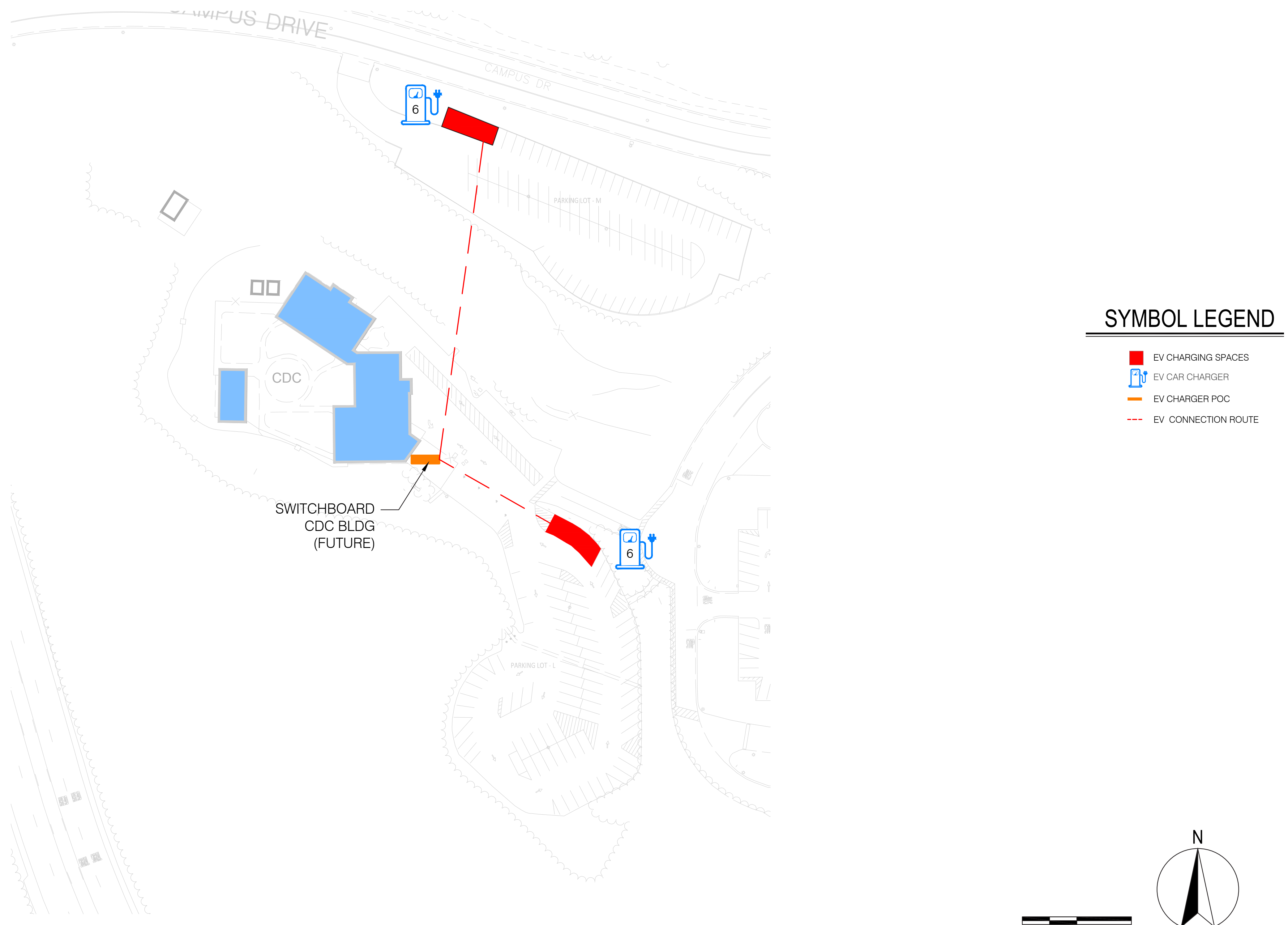
Parking Lot J



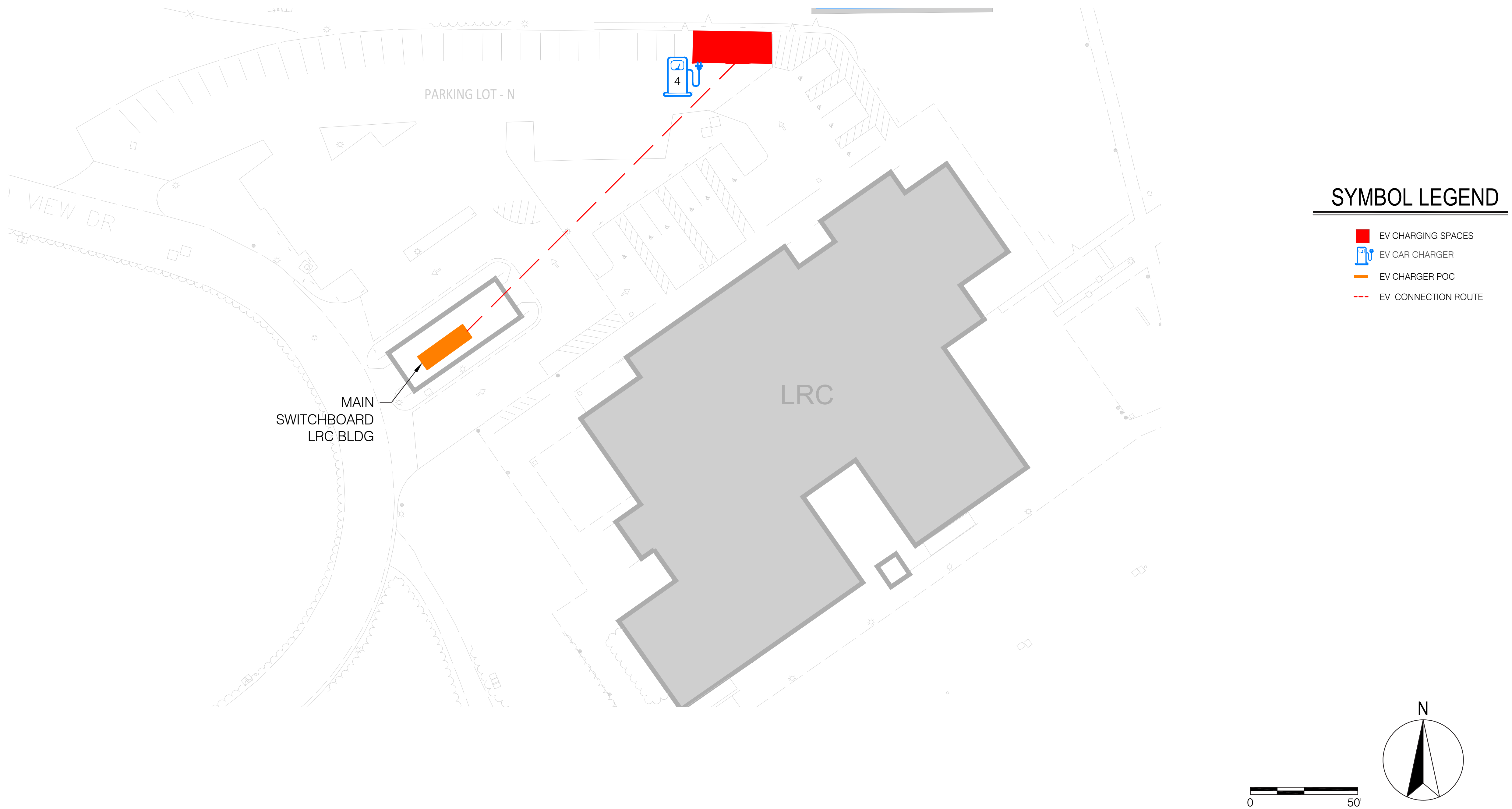
Parking Lot K



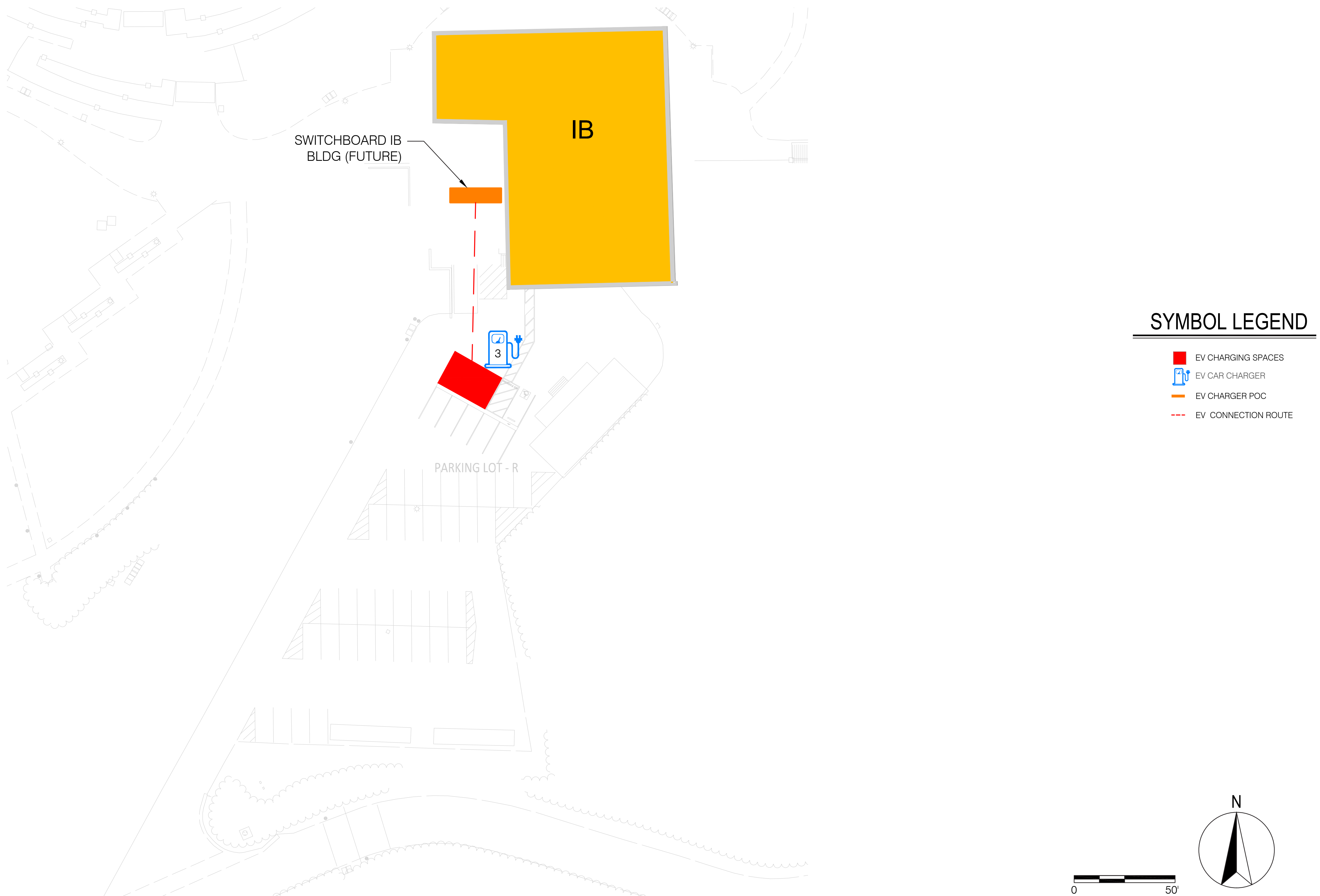
Parking Lot L & M



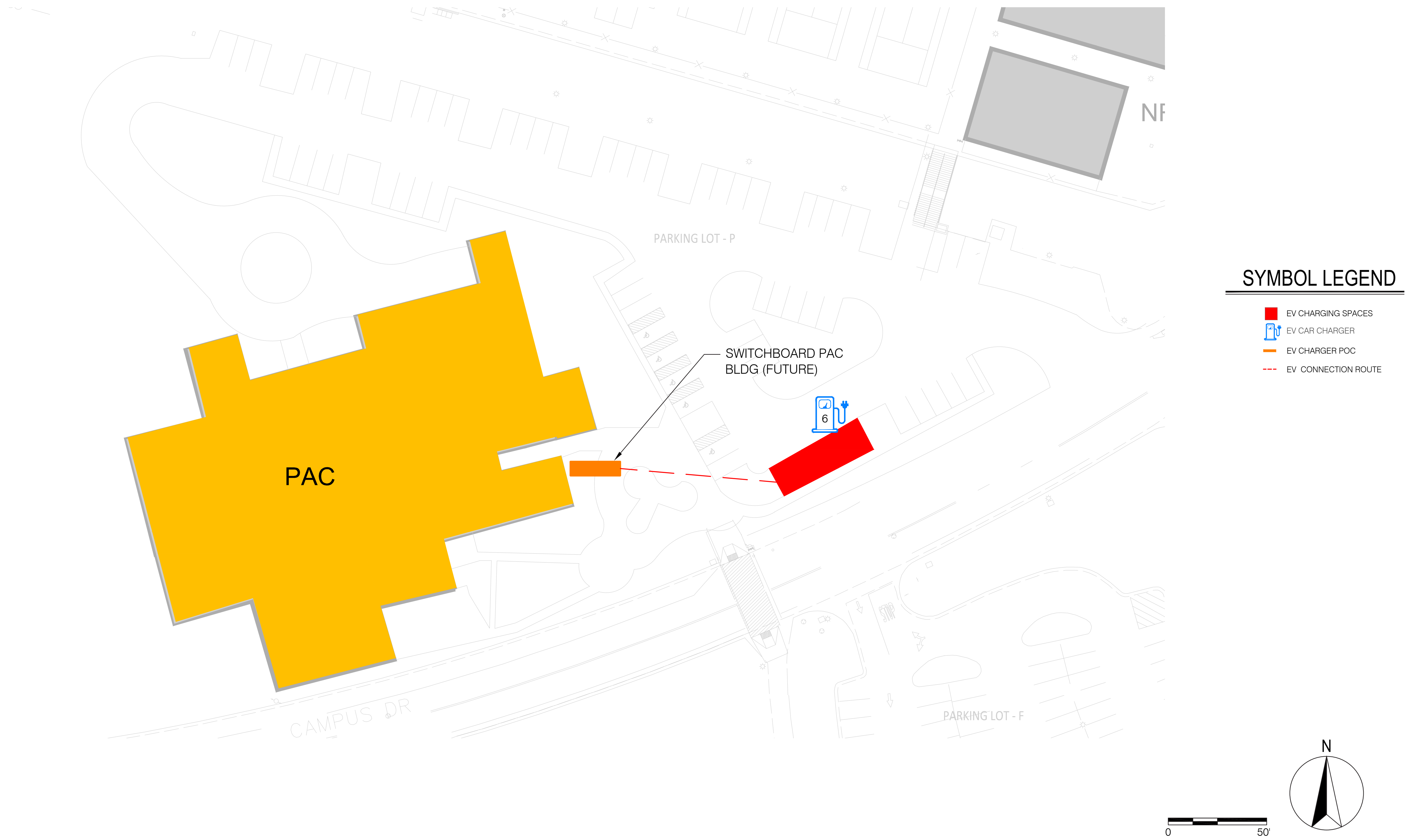
Parking Lot N



Parking Lot R



Parking Lot P



CHAPTER 4

Renewable Energy and Storage Systems

OVERVIEW

Majority of our nation's electrical energy requirements are currently met by fossil fuels such as coal and natural gas. These fossil fuels are nonrenewable sources, that is, they draw on finite resources that will eventually dwindle or disappear, become too expensive or too environmentally damaging to retrieve in the future. In contrast, renewable energy resources—such as wind and solar energy—are constantly replenished and will never run out. It is thus important for us to not only conserve energy but also promote the use of these renewable energy sources to deliver clean energy that improves our lives and minimizes our impact on the environment.

The State of California has committed to reduce its global warming emissions to 1990 levels by 2020 (25% below business as usual), and 80% below 1990 levels by 2050. California passed the AB 32 that requires that the state's global warming emissions be reduced to 1990 levels by 2020. AB 3232 establishes an intermediate target of 40% below 1990 levels by 2030. The CCC Sustainability policy has embraced this legislation and has an Intermediate goal to reduce GHG emissions to 30% below 1990 levels by 2025 and 40 percent below 1990 levels by 2030.

The State of California predicts that electrical rates will continue to escalate at approximately 3.0%-3.5% per year. Carbon costs have been added to future energy production costs with AB32 becoming effective in 2012.

The CCC Sustainability Policy mandates that all campuses shall pursue energy procurement and production to reduce energy capacity requirements from fossil fuels and promote energy independence using available economically feasible technology for on-site and/or renewable generation. All campuses shall endeavor to increase their renewable energy consumption to 25% by 2025 and increase the same to 50% by 2030.

In addition, the following bills/orders issued by the state of CA reaffirm and strengthen the overall commitment to promoting renewables and minimizing overall greenhouse gas emissions as we move forward towards achieving carbon neutrality at the grid level and at individual facilities level.

Senate Bill No. 100 (SB-100), also known as the 100% Clean Energy Act passed in September of 2018, requires that by December of 2045, California electricity is acquired from 100% carbon-neutral renewable sources with an intermediate target of 50% by December 2030. It is thus critical that the campus adopt and implement technologies that promote electrification and minimize combustible sources to minimize overall greenhouse gas emissions.

Executive Order B18-12 passed in 2012 states that all new State buildings and major renovations beginning design after 2025 be constructed as Zero Net Energy facilities with an interim target for 50% of new facilities beginning design after 2020 to be Zero Net Energy. It also states that State agencies shall also take measures toward achieving Zero Net Energy for 50% of the square footage of existing state-owned building area by 2025. Consistent with this order, the campus shall ensure that all future new and renovated facilities are designed as net zero energy facilities.

There are a variety of renewable power technologies that have been developed to take advantage of solar, bio gas and wind energy and meet the current legislations. These include concentrating solar power systems, solar water heating, photovoltaic systems, wind mills and Fuel Cells. These renewable power technologies help in:

Minimizing the use of natural resources,

Provide a constant electrical energy price for renewable supplied energy that will hedge against fuel price increases, carbon pricing/trading and rising electrical rates

Reduce peak demand and thus operating costs at each of the campuses;

Provide environmental benefits by reducing greenhouse gas emissions consistent with current AB 32 and help reduce the campus exposure to future carbon emission charges;

Viewed as environmentally responsible in community.

RENEWABLE ENERGY SYSTEMS

The following sections include a description of each of the technologies considered and our analysis of each of the systems as they are applicable to the campus:

Fuel Cells

Fuel cells are an emerging technology that can provide heat and electricity for buildings and electrical power for vehicles and electronic devices.

HOW THEY WORK:

Fuel cells work like batteries, but they do not run down or need recharging. They produce electricity and heat as long as fuel is supplied. A fuel cell consists of two electrodes—a negative electrode (or anode) and a positive electrode (or cathode)—sandwiched around an electrolyte. A fuel, such as hydrogen, is fed to the anode, and air is fed to the cathode. Activated by a catalyst, hydrogen atoms separate into protons and electrons, which take different paths to the cathode. The electrons go through an external circuit, creating a flow of electricity. The protons migrate through the electrolyte to the cathode, where they reunite with oxygen and the electrons to produce water and heat.

TYPES OF FUEL CELLS

Although the basic operations of all fuel cells are the same, numerous varieties have been developed to take advantage of different electrolytes and serve different application needs.

POLYMER ELECTROLYTE MEMBRANE FUEL CELLS

Polymer electrolyte membrane (PEM) fuel cells, also called proton exchange membrane fuel cells, use a polymer membrane as the electrolyte. These cells operate at relatively low temperatures and can quickly vary their output to meet shifting power demands. PEM fuel cells are the best candidates for powering automobiles. They can also be used for stationary power production.

DIRECT-METHANOL FUEL CELLS

The direct-methanol fuel cell (DMFC) is similar to the PEM cell in that it uses a polymer membrane as an electrolyte. However, DMFCs use methanol directly on the anode, which eliminates the need for a fuel reformer. DMFCs are of interest for powering portable electronic devices, such as laptop computers and battery rechargers.

ALKALINE FUEL CELLS

Alkaline fuel cells use an alkaline electrolyte such as potassium hydroxide or an alkaline membrane. Originally used by NASA on space missions, alkaline fuel cells are now finding new applications, such as in portable power.

PHOSPHORIC ACID FUEL CELLS

Phosphoric acid fuel cells use a phosphoric acid electrolyte held inside a porous matrix, and operate at about 200°C. They are typically used in modules of 400 kW or greater and are being used for stationary power production in hotels, hospitals, grocery stores, and office buildings, where waste heat can also be used. Phosphoric acid can also be immobilized in polymer membranes, and fuel cells using these membranes are of interest for a variety of stationary power applications.

MOLTEN CARBONATE FUEL CELLS

Molten carbonate fuel cells use a molten carbonate salt immobilized in a porous matrix as their electrolyte. They are already being used in a variety of medium-to-large-scale stationary applications, where their high efficiency produces net energy savings. Their high-temperature operation (approximately 600°C) enables them to internally reform fuels such as natural gas and biogas.

SOLID OXIDE FUEL CELLS

Solid oxide fuel cells use a thin layer of ceramic as a solid electrolyte. They are being developed for use in a variety of stationary power applications, as well as in auxiliary power devices for heavy-duty trucks. Operating at 700 – 1000°C with zirconia-based electrolytes, and as low as 500°C with ceria-based electrolytes, these fuel cells can internally reform natural gas and biogas, and can be combined with a gas turbine to produce electrical efficiencies as high as 75%.

Fuel cells can deliver electrical conversion efficiencies in the range of 40 to 60%. Even higher total energy conversion efficiencies (approaching 60 to 70%) are possible when used in co-generation applications, where both electricity and the heat of reaction are effectively utilized. Another promising feature of fuel cells is low emissions. Since they produce electricity without combustion, the usual products of combustion are not present. Fuel cells also operate quietly and reliably.

The legacy fuel cell technologies like proton exchange membranes (PEMs), phosphoric acid fuel cells (PAFCs), and molten carbonate fuel cells (MCFCs), have all required expensive precious metals, corrosive acids, or hard to contain molten materials. Combined with performance that has been only marginally better than alternatives, they have not been able to deliver a product that offers attractive economics.

Some makers of these legacy fuel cell technologies have tried to overcome these limitations by offering combined heat and power (CHP) schemes to take advantage of their wasted heat. While CHP does improve the overall economics, it only really does so in environments with exactly the right ratios of heat and power requirements on a 24/7/365 basis. Everywhere else the cost, complexity, and customization of CHP tends to outweigh the benefits. Fuel cells are being developed in the size range of a few kilowatts up to a few megawatts. The costs of fuel cells currently vary between $4500-$5000 per kW. Like most new technologies, as more units are installed and new manufacturers join the market, prices are likely to fall. At the current price, units are only used in high value, “niche” markets where reliability is premium, and in areas where electricity prices are very high and natural gas prices are low.

While this technology can reduce overall greenhouse gas emissions when the waste heat can be utilized, this is not a renewable energy technology unless biogas is utilized to serve these fuel cells. In addition, gas companies are currently working on evaluating the production and transportation of hydrogen that could be utilized in the future to serve these fuel cells and produce electricity and waste heat.

The current emissions of a standard fuel cell is approximately 750lbs/MWh compared to state of CA emissions of 450-500lbs/MWh.

Maintenance costs of the legacy fuel cells are extremely high due to replacement of stacks every 3-4 years. The costs of stacks are roughly 40-50% of the total fuel cell costs and thus do not render this technology economically feasible for the district.

Various manufacturers over the years have been looking at reducing the overall costs and increasing the efficiency of the fuel cell system. One such promising manufacturer is Bloom Energy that is currently manufacturing fuel cells from solid oxide. With low cost ceramic materials, and extremely high electrical efficiencies, Solid Oxide Fuel Cells (SOFC) can deliver attractive economics. Bloom Energy currently offers 50kW, 100 kW, 200kW and 250kW units and have installations in northern and southern CA sites.

The product is promising and needs to stand the test of time to confirm the product can meet their objectives. We recommend the campus evaluate similar technologies in the future once the same stand the test of time, become cleaner and cost effective and have commodity hydrogen gas available to power up these units.

INCENTIVES

The California Public Utilities Commission currently provides incentives of $0.60/watt for generation of power through various wind technologies. For projects with capacities greater than 1 MW, the first 1 MW receives 100% of the incentive rate; the next capacity increment above 1 MW up to 2 MW receives 75% of the incentive rate, while the last capacity increment above 2 MW up to 3 MW receives 50% of the incentive rate. Maximum incentive is capped at $5 million, or 60% of eligible project costs, whichever is less. Incentive payment is also capped at 3 MW.

Micro turbines

Micro turbines are small combustion turbines that produce between 25 kW and 500 kW of power. Most micro turbines are single-stage, radial flow devices with high rotating speeds of 90,000 to 120,000 revolutions per minute (RPM). However, a few manufacturers have developed alternative systems with multiple stages and/or lower rotation speeds.

MICRO TURBINE OVERVIEW

Size Range	25 – 500 kW
Building Name	Natural gas, hydrogen, propane, diesel
Efficiency	20 -30% (Recuperated)
Environmental	Low (<9 – 50 ppm) NOx
Other Features	Cogeneration (50 - 80°C)

Micro turbine capital costs range from $2000/kW for larger units to approximately $1,500/kW for smaller ones. These costs include all hardware, associated manuals, software, and initial training. The addition of a heat recovery system adds between $150 - $350/kW. Site preparation and installation costs vary significantly from location-to-location but generally add 30-70% to the total capital cost.

With fewer moving parts, micro turbine can provide higher reliability and require less maintenance than conventional reciprocating engine generators. Typical maintenance intervals for Micro turbines are in the range of 5,000-8,000 hours. Estimated maintenance forecasts range from $0.015-$0.025 per kWh, which would be comparable to costs for small reciprocating engine systems.

Capital Cost	$1500 - $2000 per kW
O&M Cost	$0.015 – 0.025 per kW
Maintenance Interval	5000 – 8000 hrs.

While this technology can reduce overall greenhouse gas emissions when the waste heat can be utilized, this is not a renewable energy technology unless bio gas is utilized to power the units.

The primary challenge with micro turbines is to utilize enough of the waste heat throughout the year to provide adequate return on the investment. In addition, these mciroturbines require regular maintenance leading to higher maintenance costs. Due to non availability of bio gas at the campus and regular maintenance associated with these units, we do not currently recommend this technology for the campus.

WIND POWER

Wind power is a viable energy source with wide-ranging applications for distributed generation. Wind farms can be sized for small- or large-scale power generation. Wind power is becoming popular due to the fast and simple installation and low maintenance requirements once installed.

There are two basic designs of wind electric turbines: vertical-axis, or "egg-beater" style, and horizontal-axis machines. Horizontal-axis wind turbines are most common, comprising more than 95% of the "utility-scale" (100 kilowatts (kW) capacity and larger) turbine market.

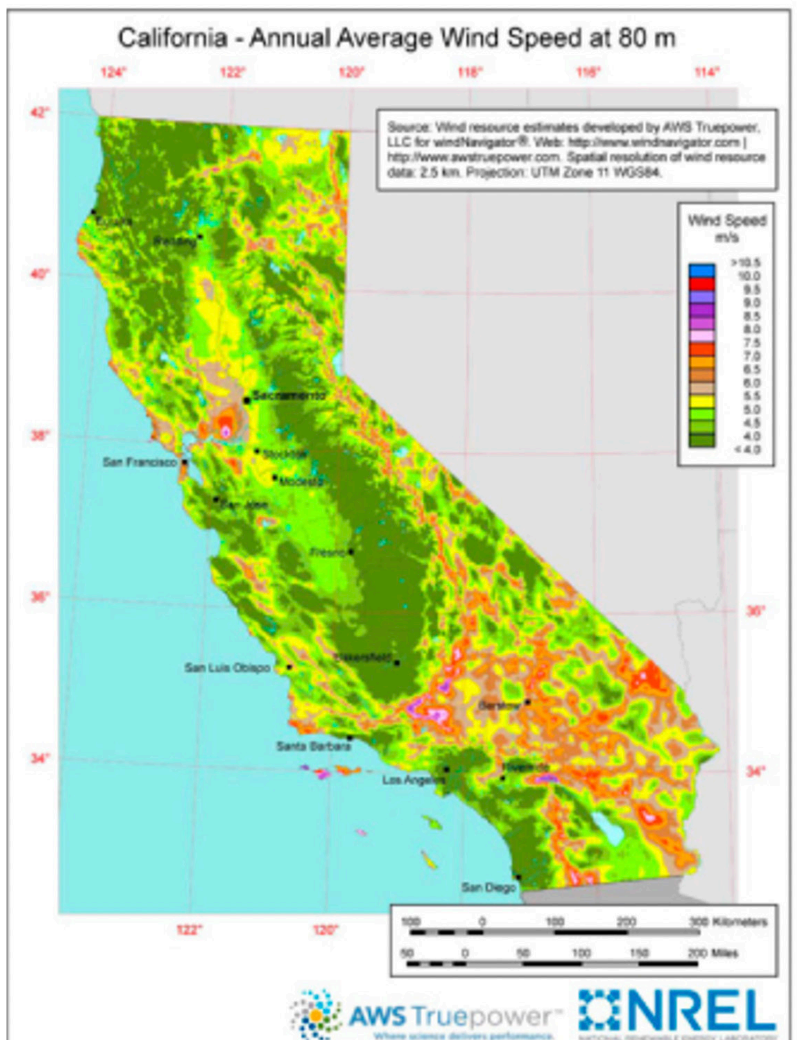
TURBINE SUBSYSTEMS INCLUDE:

- A rotor, or blades, which convert the wind's energy into rotational shaft energy;
- A nacelle containing a drive train, usually including a gearbox* and a generator;
- A tower, to support the rotor and drive train; and
- Electronic equipment such as controls, electrical cables, ground support equipment, and interconnection equipment.

Generally, wind farms are located in areas with good winds and typically have annual capacity factors ranging from 20% to over 40%. A typical life of a wind turbine is 20 years. Maintenance is required at 6-month intervals.

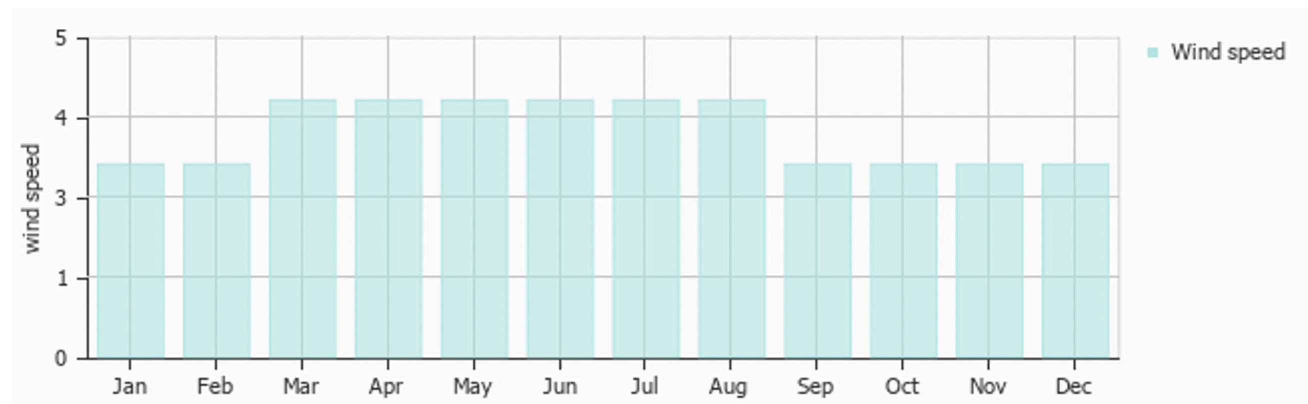
Large-scale wind farms can be installed for about $3,000-$3,500/kW. The cost of electricity produced from wind farms depends on the annual capacity factor, location/wind quality, maintenance costs, and installation costs; but typically ranges from 5 to 8 cents/kWh. The cost for small-scale wind turbines is higher. Wind turbines do not produce any harmful emissions or require any fuel product for operation. Minimal space is required for a turbine farm.

The class of winds required to provide adequate power where it becomes economically attractive are Class 3 (6meters/sec) and above (Class 1 is Poor and Class 7 is Superb). A review of the San Bernardino, CA wind map below indicates that the wind speeds at the campus location fall below the required wind class required for generating power and fall in the poor class having 1% out of 100% wind potential. Thus a wind turbine in a poor wind speed (Class 2 and below) will produce 25-30% less



Classes of Wind Power Density at 10 m and 50 m(a)

Wind Power Class	10 m (33 ft.) Wind Power Density (W/m 2)	Speed (b) m/s (mph)	50 m (164 ft.) Wind Power Density (W/m 2)	Speed (b) m/s (mph)
1	100	4.4 (9.8)	200	5.6 (12.5)
2	150	5.1 (11.5)	300	6.4 (14.3)
3	200	5.6 (12.5)	400	7.0 (15.7)
4	250	6.0 (13.4)	500	7.5 (16.8)
5	300	6.4 (14.3)	600	8.0 (17.9)
6	400	7.0 (15.7)	800	8.8 (19.7)
7	1000	9.4 (21.1)	2000	11.9 (26.6)



Average wind speed in Los Angeles, United States of America Copyright © 2019 www.weather-and-climate.com

power than in a class 3 and above winds. In addition, the capacity factor of the system will be reduced by the same factor and thus increasing the cost of production. Based on a comparison of costs of this technology versus the PV technology at the campus, this technology would cost approximately 2-3cents/kWh more compared to the PV technology. Thus based on the availability of class of wind at the campus, this technology proves to be expensive and is not recommended for the campus.

INCENTIVES

The California Public Utilities Commission currently provides incentives of $1.07/watt for generation of power through various wind technologies under the Self Generation Incentives Program (SGIP). For projects with capacities greater than 1 MW, the first 1 MW receives 100% of the incentive rate; the next capacity increment above 1 MW up to 2 MW receives 50% of the incentive rate, while the last capacity increment above 2 MW up to 3 MW receives 25% of the incentive rate. Maximum incentive is capped at $5 million, or 60% of eligible project costs, whichever is less. Incentive payment is also capped at 3 MW.

Solar Photovoltaic Systems

Photovoltaic technology relies on the electrical properties of certain materials known as semiconductors. When hit by sunlight, a semiconductor material responds by creating an electrical charge which can then be transferred to anything that uses electricity.

In connecting a photovoltaic system to an end use, several additional structures and technologies are needed. While photovoltaic panels can be mounted on ground or roofs, it is important to consider the angle at which they face the sun. To transfer electricity to its end use, photovoltaic panels are connected through intermediary technologies that condition and modify the electricity they produce. These considerations are known as balance of system components, as they maximize the system's efficiency and allow higher amounts of electricity to reach its end use.

Some photovoltaic systems are called "stand-alone" or "off-grid" systems, which mean they are the sole source of power to a, water pump or other load. Stand-alone systems can be designed to run with or without battery backup. Remote water pumps are often designed to run without battery backup, since water pumped out of the ground during daylight hours can be stored in a holding tank for use any time. In contrast, stand-alone home power systems store energy generated during the day in a battery bank for use at night. Stand-alone systems are often cost-effective when compared to alternatives, such as lengthy utility line extensions. Other PV systems are called “grid-connected” systems. These work to supplement existing electric service from a utility company. When the amount of energy generated by a grid-connected PV system exceeds the customer’s loads, excess energy is exported to the utility, crediting the customer’s electric meter. Conversely, the customer can draw needed power from the utility when energy from the PV system is insufficient to power.

All of the power ratings of the PV arrays are presented in direct-current (DC) kW at Standard Test Conditions (STC). These test conditions are defined as 1,000W/m2 irradiance, 25°C cell temperature, and spectral distribution of Air Mass 1.5. Estimated electrical energy harvest is calculated with PV Watts software and estimates the annual net expected AC output of the system after overall power conversion efficiency and local weather data is taken into account. Since these Standard Test Conditions are not usually typical of how PV modules and arrays operate in the field, actual performance is usually 85 to 90 percent of the STC rating.

It is standard practice to size the photovoltaic array DC power rating to be larger than the AC output power rating of the inverter that is specified for the array. This is done because it is uncommon that PV modules will operate at the standard test conditions described above. The typical environmental conditions are often less than this ideal. In particular, as the modules increase in temperature, their power output decreases. This is most pronounced during the summer months when ambient temperatures are highest and the strongest sun is available. This sizing approach also compensates for the small amount of power that is lost when the DC electricity from the array is converted to AC electricity.

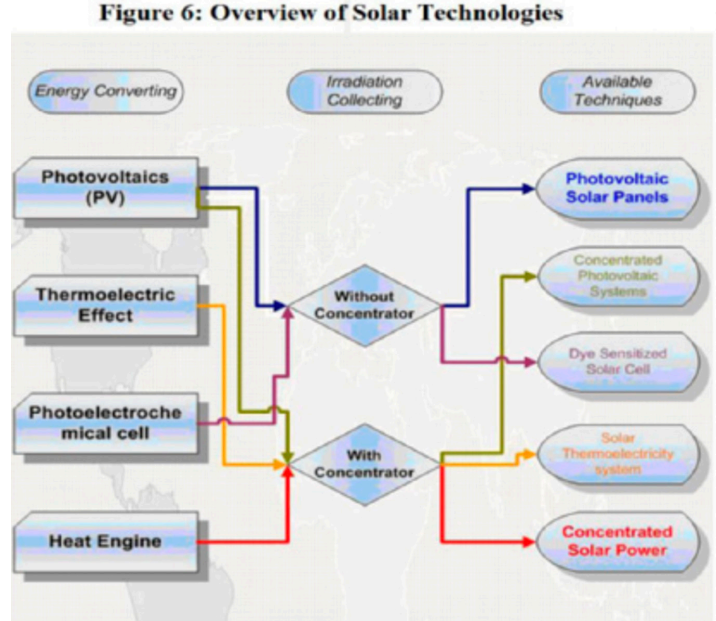
On University campuses, these systems are typically installed on ground or on roof of buildings or parking structures or on top of carports provided on parking lots.

AVAILABLE TECHNOLOGIES

There are several kinds of solar techniques that are currently available. However, each of them is based on quite different concepts and science and each has its unique advantages. Analysis and comparison between different technologies will help us to adopt the most efficient and beneficial technology given a specific set of conditions.

Overall, non-concentrated photovoltaic solar panels (PV) and concentrated solar power (CSP) are the two most mature technologies that are currently being used in the market place. They have been commercialized and expected to experience rapid growth in the future, thus our emphasis below will be on these two technologies.

Figure 6: Overview of Solar Technologies



Photovoltaic Solar Panels	Most commonly used techniques in today's market
Concentrated Photovoltaic Systems	The highest efficiency ever achieved in lab
Dye Sensitized Solar Cell	Biomimics techniques based on cheap organic materials
Solar thermoelectricity system	Based on the application of thermoelectricity materials
Concentrated Solar Power	Commonly used based on the application of mature heat engine

solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect. These solar panels are composed of a number of solar cells containing a photovoltaic material. Materials presently used for photovoltaics include monocrystalline silicon, polycrystalline silicon, amorphous silicon, cadmium telluride, and copper indium gallium selenide/sulfide. Photovoltaic solar panel is the most commonly used solar technology to generate electricity energy.

Average daily output of a flat plate collector at latitude tilt in the contiguous United States is 3 – 7 kilowatt·h/m^2/day and the performance will be less n high-latitude areas like Europe. Solar cells produce direct current (DC) which must be converted to alternating current (AC) using a grid tie inverter in existing distribution grids that use AC. This incurs an energy loss of 4 – 12 percent.

Applying tracking systems to PV is also possible. The cost of a PV tracking system is usually greater than the cost of fixed PV system and its performance is greater than the performance of the fixed PV system – approximately 20 percent more energy produced on a yearly basis. In terms of land occupation, fixed PV field requires about half of the area necessary for a tracker PV system and, as highlighted above, the selection of PV modules may play an important role in determining the area required by the plant. Therefore, it can be concluded that for a large utility scale PV plant, the fixed PV field arrangement should be preferable when land impact is considered. These Photovoltaic technologies are the most commonly used solar energy collecting technologies today and considering the cost of the system and its low maintenance, we recommend the same to be installed at the campus.

TYPES OF PHOTOVOLTAIC SYSTEMS

Following is a description of two major types of photovoltaic systems:

Stand Alone Systems

Stand-alone systems are not connected to the electrical grid and generally include storage batteries that store energy to provide power when solar energy is not available. Stand-alone systems are particularly suited for remote locations for powering a single piece of equipment where normal power is either difficult to distribute or is not available.

Grid-Connected Systems

Grid connected systems are the most preferred method for installing photovoltaic power generation on University campuses. Grid connected systems put the power they make onto the electrical grid. The serving electric utility company provides the balance of electric power when the campus uses more power than the PV system is generating. If the campus demand is below the amount made by the PV system the excess power credits the electric meter. The electric utility company will not buy power from the campus, but the electric bill will be reduced by the amount created by the PV system. This scheme is known as “Net Metering”.

A grid connected system has few major components, requires very little maintenance, and has a long life span. The solar panels are available with a 25-year performance warranty and the inverters have warranties up to 10-years long or longer. The support structure, wiring, and other electrical components will last much longer than the PV panels. It is conceivable that a system could be built so that once the first 25-years was up it could be fitted with new panels and continue to operate for another 25-years.

A grid-connected photovoltaic system is also eligible for utility incentives. In the case of Universities, this would be through their local utility company. There are no self-generation penalties for making electricity with photovoltaic systems.

There are three main parts of a grid connected system. The biggest element is the photovoltaic panels and their support structure. The second major component is the power inverter(s). The final part is the interconnecting equipment and metering to tie the system into the power grid.

PHOTOVOLTAIC PANEL TYPES

Although photovoltaic panels are based on a similar structure of cells and enabling components, there are many variations on the standard solar panel, differing primarily in the types of photovoltaic cell that they use. Each panel type is manufactured in a different way and has its own advantages and disadvantages.

The vast majority of solar panels produced today depend on the use of crystalline silicon as the material in their cells. It is used in monocrystalline (or single-crystalline), polycrystalline (or multicrystalline), and ribbon (or thin-layer) silicon panels.

Other panels, like thin-film technologies, depend on amorphous silicon, and still others use completely different semiconductors known as Group III-IV materials. Panels can also be enhanced in a number of ways to increase their efficiency or improve their versatility through the use of multi junction devices, concentrator systems, or building integrated systems.

The following is a description of each of the following panel types available in the market today with their advantages and disadvantages.

Monocrystalline Silicon Panels

- 22-25% efficiency

Monocrystalline panels use crystalline silicon produced in large sheets which can be cut to the size of a panel and integrated into the panel as a single large cell. Conducting metal strips are laid over the entire cell to capture electrons in an electrical current.

These panels are more expensive to produce than other crystalline panels but have higher efficiency levels and, as a result, are sometimes more cost-effective in the long run.

Polycrystalline Silicon Panels

- 17-18% efficiency

Polycrystalline, or multicrystalline, photovoltaics use a series of cells instead of one large cell. These panels are one of the most inexpensive forms of photovoltaics available today, though the costs of sawing and producing wafers can be high. At the same time, they have lower conversion efficiencies than monocrystalline panels.

For this technology, several techniques are used:

Cast Polysilicon

In this process, molten silicon is first cast in a large block which, when cooled, is in the form of crystalline silicon and can be sawn across its width to create thin wafers to be used in photovoltaic cells. These cells are then assembled in a panel. Conducting metal strips are then laid over the cells, connecting them to each other and forming a continuous electrical current throughout the panel.

String Ribbon Silicon

String ribbon photovoltaics use a variation on the polycrystalline production process, using the same molten silicon but slowly drawing a thin strip of crystalline silicon out of the molten form. These strips of photovoltaic material are then assembled in a panel with the same metal conductor strips attaching each strip to the electrical current. This technology saves on costs over standard polycrystalline panels as it eliminates the sawing process for producing wafers. Some string ribbon technologies also have higher efficiency levels than other polycrystalline technologies.

Amorphous Silicon or Thin Film Panels

- 12-13% efficiency

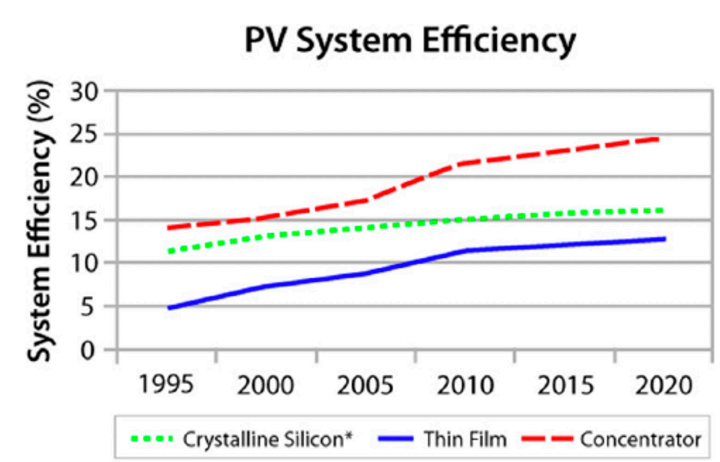
Thin-film panels are produced very differently from crystalline panels. Instead of molding, drawing or slicing crystalline silicon, the silicon material in these panels has no crystalline structure and can be applied as a film directly on different materials. Variations on this technology use other semiconductor materials like copper indium diselenide (CIS) and cadmium telluride (CdTe). These materials are then connected to the same metal conductor strips used in other technologies, but do not necessarily use the other components typical in photovoltaic panels as they do not require the same level of protection needed for more fragile crystalline cells.

The primary advantages of thin-film panels lie in their low manufacturing costs and versatility. Because amorphous silicon and similar semiconductors do not depend on the long, expensive process of creating silicon crystals, they can be produced much more quickly and efficiently. As they do not need the additional components used in crystalline cells, costs can be reduced further. Because they can be applied in thin layers to different materials, it is also possible to make flexible solar cells.

However, thin-film panels have several significant drawbacks. What they gain in cost savings, they lose in efficiency, resulting in the lowest efficiency of any current photovoltaic technology. Thin-film technologies al so depend on silicon with high levels of impurities. This can cause a drop in efficiency within a short period of use.

Thin-film panels have the potential to grow in use, and already figure in some of the most exciting enhanced photovoltaic systems, including high-efficiency multi-junction devices and building integrated photovoltaics.

Though these technologies are very effective, their current use is limited due to their costs. They are currently employed in space applications and continue to be researched for new applications.



Enhanced Systems

BUILDING-INTEGRATED PHOTOVOLTAICS (BIPV)

BIPV technologies are designed to serve the dual purpose of producing electricity and acting as a construction material. There are many forms that this technology can take. One common structure is the integration of a semi-translucent layer of amorphous silicon into glass, which can then be used as window panes that let controlled amounts of light into a building while producing electricity. Another common structure is the use of shingle-sized panel of amorphous silicon as a roofing material.

Currently, BIPV technologies have very low efficiency levels due to their use of amorphous silicon, but present the advantage of replacing other construction materials and offering a wide variety of aesthetic choices for the integration of photovoltaics into buildings.

Concentrator Systems

Concentrated photovoltaic technology uses optics, such as lenses to concentrate a large amount of sunlight onto a small area of high efficiency solar photovoltaic materials to generate electricity.

These solar cells are typically more expensive than conventional cells used for flat-plate photovoltaic systems. However, the concentration decreases the required cell area while also increasing the cell efficiency.

CPV's are also now available that generate both electricity and hot water at the same time.

CPV systems are categorized according to the amount of solar concentration, measured in suns (the square of the magnification).

Part	Class of CPV	Typical Concentration Ratio	Type of Converter
L	High-Concentration, MJ cells	>400X	Multijunction
LI	Medium-concentration, cells	~3X-100X	Silicon or other cells
LII	Enhanced concentration, modules	<3X	Silicon modules

ADVANTAGES

Despite the energy lost during the concentrating process, CPV can achieve the highest efficiency among all kinds of solar technologies.

Unlike traditional, more conventional flat panel systems, CPV systems are often much less expensive to produce, because of the reduced use of semi-conductor material compared with flat-plate silicon. This reduces risk for the investor and allows more rapid adjustment of plans based on changing markets.

DRAWBACKS

Like most concentration systems, CPV is unable to collect diffuse irradiation. However, CPV can collect more energy than non-concentrated PV techniques due to superior performance during morning and late afternoon time. Although the energy consumption by a tracking system is minimal, the moving parts of the tracking system make it less reliable and increases both manufacturing and maintenance costs.

Even a small cloud may drop the production to zero. Unlike concentrated solar power, the storage system that can mitigate this problem above is expensive since it is much easier to store heat than electric energy. This kind of instability will not be preferable when connected to the grid.

The use of concentrated sunlight on very small, but highly efficient (~40 percent) solar cells has the potential to provide cost-effective, large-scale, solar-electricity generation, especially in sunny locations. There are a number of companies that are currently manufacturing multi-junction concentrator cells and positioning themselves to respond to the growing demand for this technology. However, the prices for these systems are currently high and the application of this technology considering the maintenance required for the moving parts is not being recommended for the campus.

PV SYSTEM INSTALLATION CONSIDERATIONS

Of the various technologies discussed above, PV panels should be selected based on various factors for each specific project. These factors include overall efficiency, available space for installation and installed $/watt. In addition, consideration of the panel's output over their lifetime is also critical. The cells made from mono-crystalline silicon have the highest performance in terms of efficiency, and lifespan. These cells are available with performance warranties as long as 25-years, and are made by manufactures that are well established in the solar industry.

To work its best, a complete photovoltaic system depends on several considerations and intermediary technologies to efficiently generate electricity and transfer it to an end use. These elements include mounting structures that help an array gain the best tilt towards the sun, and technologies that both condition the electricity produced and connect it in a variety of ways to one or more end uses. In the photovoltaic industry, these elements are called balance of system components because they help in matching a photovoltaic panel or array to its site and use.

FOLLOWING ARE AREAS OF CONSIDERATION IN INSTALLING PHOTOVOLTAICS.

INSTALLING AN ARRAY TO MAXIMIZE EFFICIENCY

A primary consideration in installing a photovoltaic array on a building is the availability of solar energy in the space where the system will be mounted. As solar cells are connected within panels and as panels are connected to each other in the array, any shade from a tree, building or other structure that falls on a cell or panel can reduce the efficiency of the entire system. For this reason the majority of arrays are installed on roofs where they can receive unimpeded solar energy throughout the day.

A second consideration is the angle at which the array is mounted. Solar energy does not reach the earth at the same angle throughout the day and year or in different parts of the country. In the Northern Hemisphere, the summer sun is almost directly overhead, but, as the earth tilts away from the sun in the winter, the sun follows a path lower in the sky and towards the south, causing solar energy to reach the earth's surface at a much more acute angle.

While the sun's angle changes throughout the year, our need for electricity does not change very much. To allow for the breadth of angles of solar energy, photovoltaic systems are typically mounted at an angle that accommodates both the high summer sun and the low winter sun, maximizing its efficiency at all times of year.

As a rule of thumb, photovoltaic panels that best accommodate the range of solar angles in a particular location are facing south tilted at an angle equal to the latitude of the location.

While a photovoltaic system can operate without directly facing the path of solar energy, the closer it comes to meeting this path, the more efficiently it works. However, this efficiency is often traded off with the additional cost of certain mounting structures and need to be evaluated on a case-by-case basis.

MOUNTING STRUCTURES

The following are various methods utilized to install photovoltaics panels:

FLAT MOUNTING:

Flat mounting is the simplest way to install photovoltaics on a roof. In this situation, photovoltaic panels are simply arranged in an array and mounted to the roof using direct attachments or a weighted framework to make the system resistant to the wind.

While efficiency is diminished, the system is still relatively effective and can be an attractive choice for buildings that want to install large arrays at minimal cost.

Flat mounted systems can also be installed on slanted roofs, which keep installation costs down while gaining a tilt closer to the region's ideal angle.

There are two primary mounting methods for PV systems on commercial building roofs:

BALLASTED RACKING

This method uses heavy weights, typically concrete blocks, to anchor PV systems on a flat roof. Some hybrid-ballasted systems use a combination of ballast and roof penetrating anchors to fasten the system to the roof. The number of roof penetrations for these systems usually depends on how much weight the roof can handle in terms of ballast, and how much additional support the PV system will need to meet wind load requirements.

ADVANTAGES:

Simple to install; require few or no roof Ballasted PV Racking System;

Hybrid-ballasted systems require less weight that fully-ballasted systems

Disadvantages: Only applicable for flat roofs that are capable of supporting the ballast weight; some jurisdictions limit the use of fully-ballasted systems; may require more advanced wind-loading evaluations; hybrid-ballasted systems have an increased risk of roof leaks from faulty roof

ATTACHED RACKING

Uses roof penetrating hardware to mount PV systems on any type of roof. There are many types of attached racking systems for different applications. The number of required roof penetrations depends on the roof structure, PV system design, and building codes.

Advantages: Can be used on sloped or flat roofs and in more jurisdictions than ballasted systems

Disadvantages: Can be more difficult to install than ballasted systems; faulty roof penetrations can reduce the weather-tight integrity of the roof

RACK STRUCTURES:

Rack mounting systems allow more control over the array's angle. These systems rely on a simple metal frame that supports the array at the desired angle toward the south.

Rack systems are best used on buildings with flat roofs or on the ground, as even a slightly tilted roof can sometimes make installation difficult.

POLE MOUNTING:

Pole mounting is used similarly to rack mounting but supports the photovoltaic array on a pole mounted in the ground. These systems are most often used in rural locations or locations where the best sunlight is not near a building.

Solar charging stations are convenient way of bringing electricity to areas where students congregate but where there is little or no infrastructure to support it at the campus. They are also a great way of demonstrating commitment towards green power and towards fulfilling the campus goal of reducing carbon emissions.

The solar tables provide a clean and renewable source of energy for charging the multitude of mobile devices typically found on campus while offering much needed shade. Not only do the tables provide access to green energy, they also enhance areas on campus that were underutilized and make them more inviting and attractive.

The tables also become a piece of infrastructure on campus that provide social gathering point for students.

Tracking Structures: Tracking structures literally track the sun's angle as it changes throughout the day and year. Two types of tracking structures are available: one-axis and two-axis. One-axis trackers follow the sun from east to west as it passes through the sky and still need to be mounted at a 34-degree angle facing the south. Two-axis trackers can track both the sun's daily course and its changing path throughout the year. While these systems are the most effective in capturing direct sunlight as its angle changes, they also require more expensive, high-maintenance components than other mounting structures. They are typically reserved for technologies like photovoltaic concentrator systems that depend solely on direct sunlight to function.

CONNECTING AN ARRAY TO A LOAD

Because photovoltaic technologies rely on the sun, their energy production changes with the availability of solar energy. To ensure that a photovoltaic system can provide electricity when it is needed, additional components are needed to either temporarily store electricity for later use, or to connect the array to a building that has an alternate power source, like the local utility, available when electricity from the array is not.

Another factor complicating connection of an array to a building is that buildings use electricity in a different form than the electricity provided by a photovoltaic array. The electricity from photovoltaic arrays travels in a direct current (DC current) while buildings are structured to rely on alternating current (AC current). To make photovoltaic electricity usable, it needs to be transformed from direct current to alternating current and its flow needs to be controlled as it joins the currents used in different buildings.

There are several different ways to structure a photovoltaic array in relation to its load. The most straightforward is a direct connection, or direct-coupled system which connects the direct current to an end use. These systems are useful for small-scale daytime applications like water pumps and ventilation fans, but because of the complicating factors mentioned above, most applications require several additional components.

BALANCE OF SYSTEM COMPONENTS

All PV modules generate direct-current (DC) electricity and will require additional equipment beyond the PV array to interface with the building's electrical distribution system. This equipment is often referred to as the 'balance-of-system' (BOS) equipment. The components consist of structures, enclosures, wiring, switchgear, fuses, ground fault detectors, charge controllers, and inverters.

INVERTER TECHNOLOGY

Inverters are used to convert DC power, which is not compatible with the AC power used on the grid into AC power. The power and voltage output of the panels changes with the intensity of the sunlight striking them. The inverters convert the power to AC, and keep the output voltage constant. The inverter will match its output power to the frequency, phasing, and voltage of the grid power. Inverter technology is based on insulated-gate bipolar transistors (IGBT).

The following types of inverters currently exist in the market:

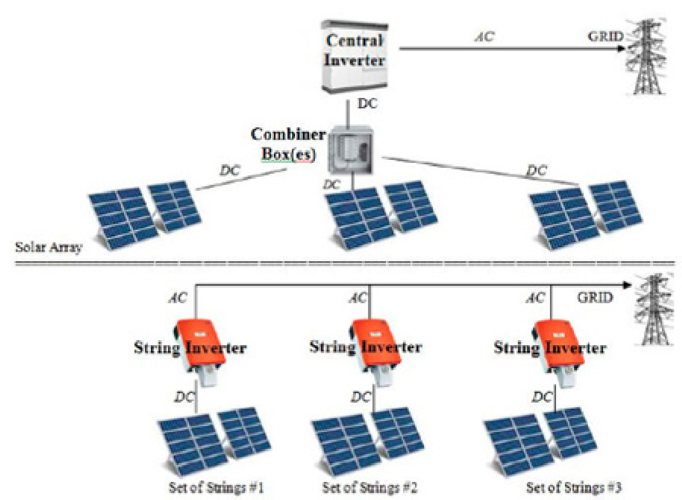
- Centralized Inverters
- String Inverters
- Micro Inverters

Centralized inverters:

- The centralized inverters offer the following advantages:
- Low capital price per watt
- High efficiency
- Comparative ease of installation – a single unit in some scenarios
- Remote system monitoring capabilities
- The centralized inverters offer the following disadvantages:
- Size
- Noise
- A single potential point of entire system failure
- No panel level MPPT
- High voltage levels present a potential safety hazard

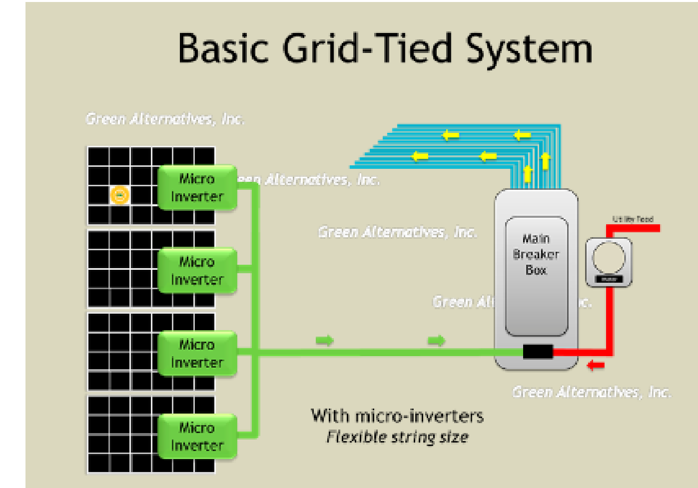
String Inverters:

- The string inverters offer the following advantages:
- Allows for high design flexibility
- High efficiency
- Robust
- 3 phase variations available
- Well supported (if buying trusted brands)
- Remote system monitoring capabilities
- The string inverters offer the following disadvantages:
- No panel level MPPT
- No panel level monitoring
- High voltage levels present a potential safety hazard



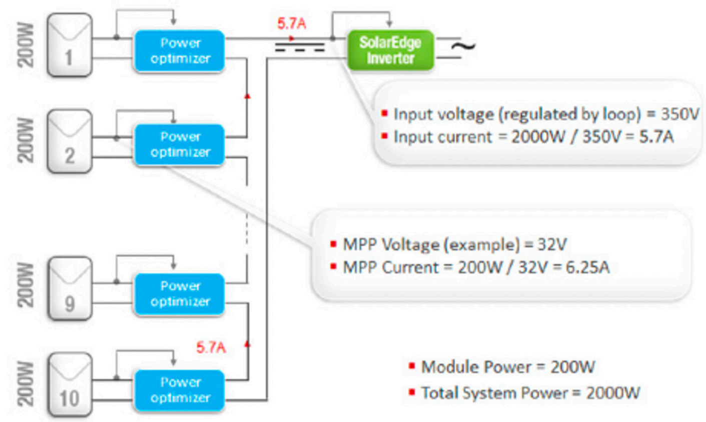
Micro Inverters

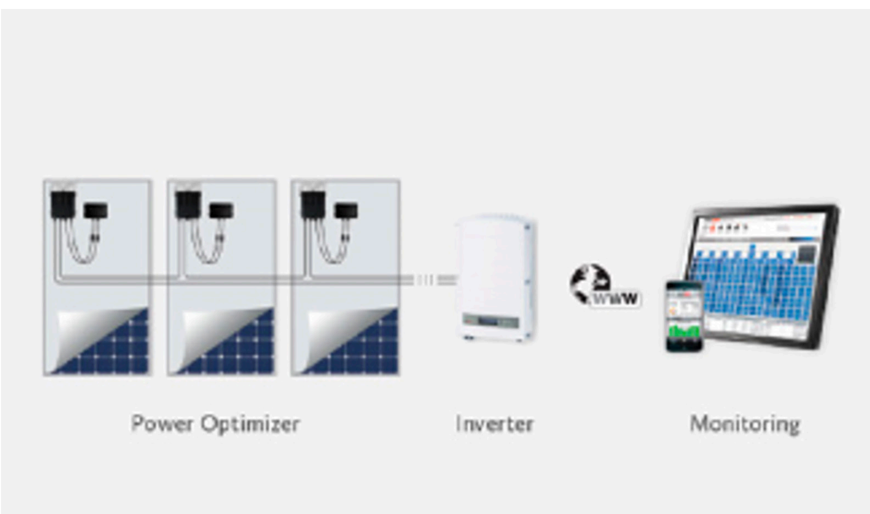
- The micro inverters offer the following advantages:
- Panel level MPPT (Maximum Power Point Tracking)
- Increase system availability – a single malfunctioning panel will not have such an impact on the entire array
- Panel level monitoring
- Lower DC voltage, increasing safety. No need for ~ 600 V DC cabling requiring conduits
- Allows for increased design flexibility, modules can be oriented in different directions
- Increased yield from sites that suffer from overshadowing, as one shadowed module doesn't drag down a whole string
- No need to calculate string lengths – simpler to design systems
- Ability to use different makes/models of modules in one system, particularly when repairing or updating older systems
- The micro inverters offer the following disadvantages:
- Higher costs in terms of dollars per watt, currently up to one and a half times the cost compared to string inverters
- Increased complexity in installation
- Given their positioning in an installation, some micro-inverters may have issues in extreme heat
- Increased maintenance costs due to there being multiple units in an array
- Lightning Strike can take out micro inverters

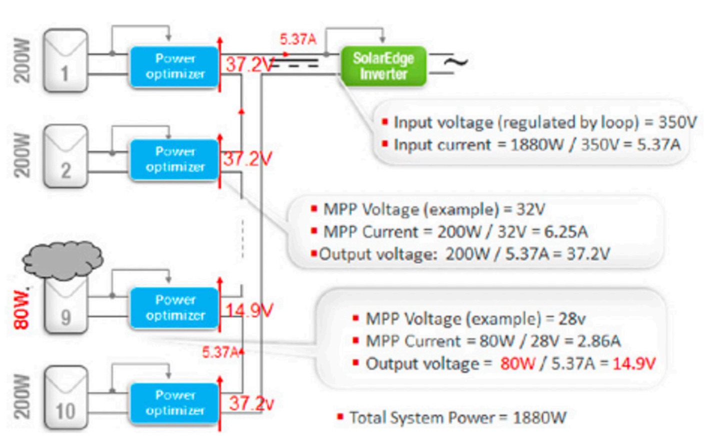


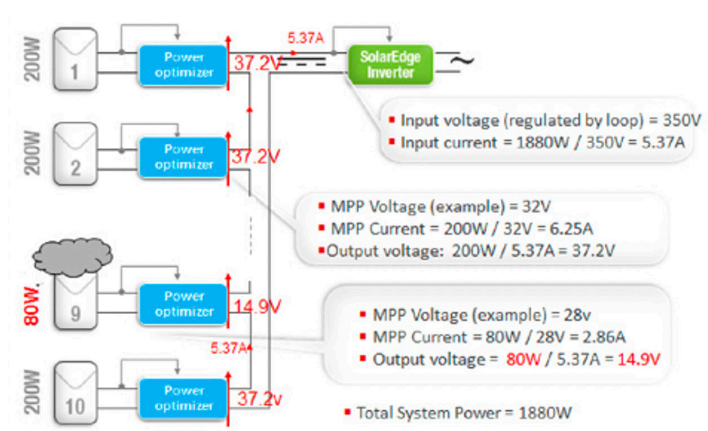
Power Optimizers

- Power optimizer is a DC/DC converter connected by each PV module or embedded by module manufacturers, replacing the traditional solar junction box. They are used to increase energy output from PV systems by constantly tracking the maximum power point (MPPT) of each module individually. They have superior efficiency (99.5% peak efficiency, 98.8% weighted efficiency) and mitigate all types of modules mismatch-loss, from manufacturing tolerance to partial shading. They are designed for extreme environmental conditions and have a 25 year reliability and warranty. They also offer advanced, real-time performance measurement and automatic module DC voltage shut-down for installer and firefighter safety. They are currently embedded by module manufacturers, or connected by installers to c-Si and thin-film modules.



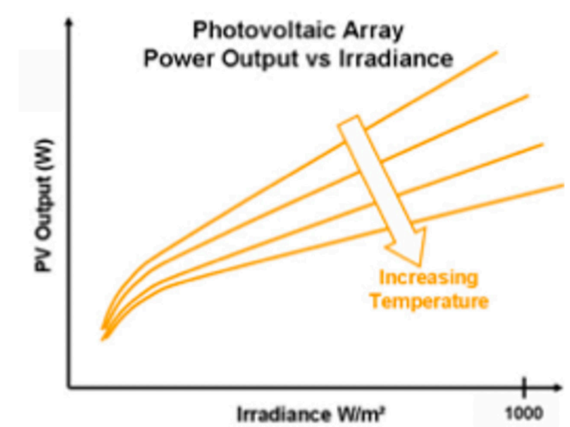






PV PANELS INSTALLATION

- The solar cells convert sunlight into DC electricity. Groups of 5-12 panels are wired in series arrays. This develops the desired output voltage of approximately 400VDC. The actual number of PV panels in an array is dependent on the actual installation, since the output voltage will varies between models, and brands of panels.
- The arrays are wired in parallel to develop the desired system capacity (kW). A typical system will use a large number of panels. As an example a 225kW system will use approximately 1700 each of 175W panels. The overall system capacity equates typically to a 300kW system, since it is common to install 30% or more in panel rated capacity than the system size. There are two main reasons to do this. First the panel rating is based on ideal conditions; the actual operating conditions will differ. Secondly, the panels do not produce full power most of the day (power is a function of the position of the sun).



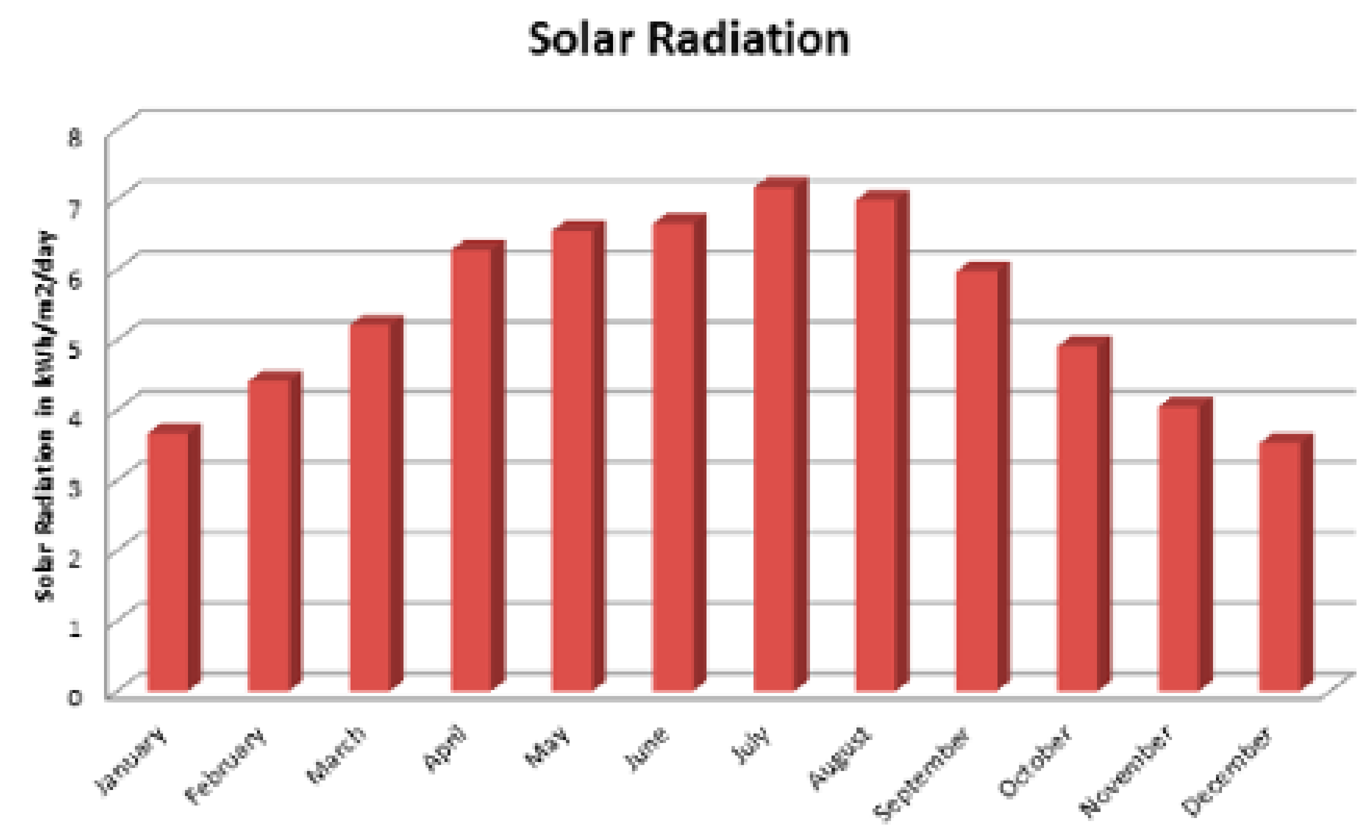
The power from the arrays is collected in junction boxes. The junction boxes are located outside with the PV panels. Inside these boxes the arrays are tied together in parallel connections. The feeders from the junction boxes are routed to the inverter, which is typically located in an electrical room near the grid connection point.

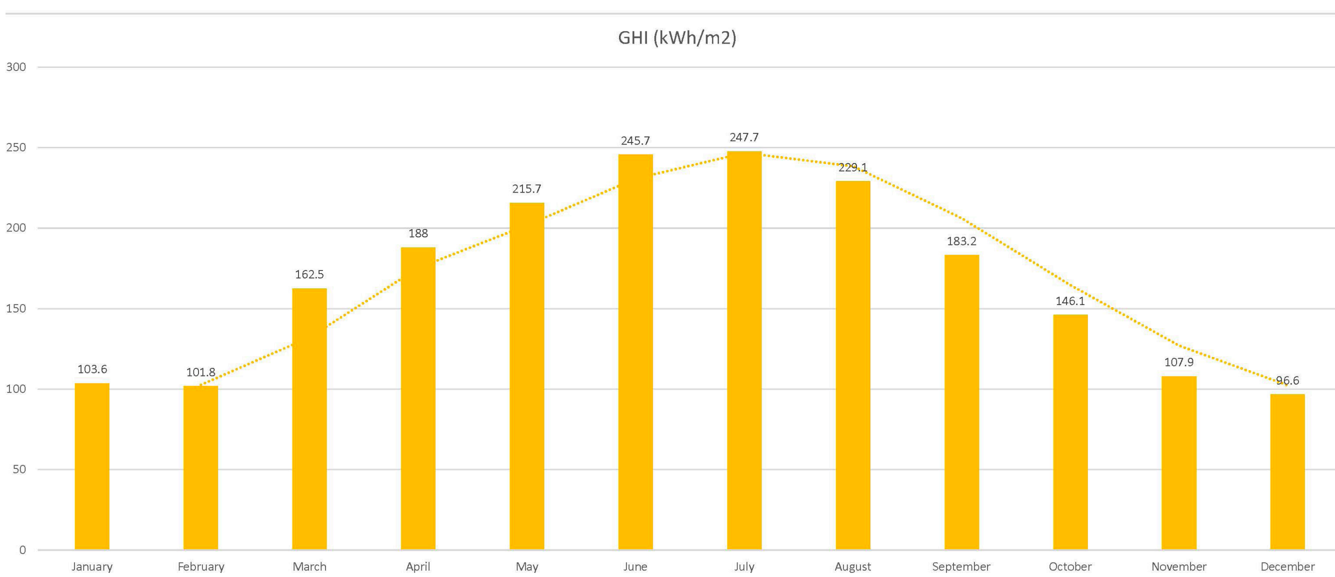
The DC current from the cells is connected to an inverter. The inverter converts the DC power into 480VAC or 208V and matches the incoming phase, voltage and frequency of the grid power. The inverters for grid connected PV plants are pre-approved by the utilities for this purpose. The inverter has disconnect switches on both PV and utility sides.

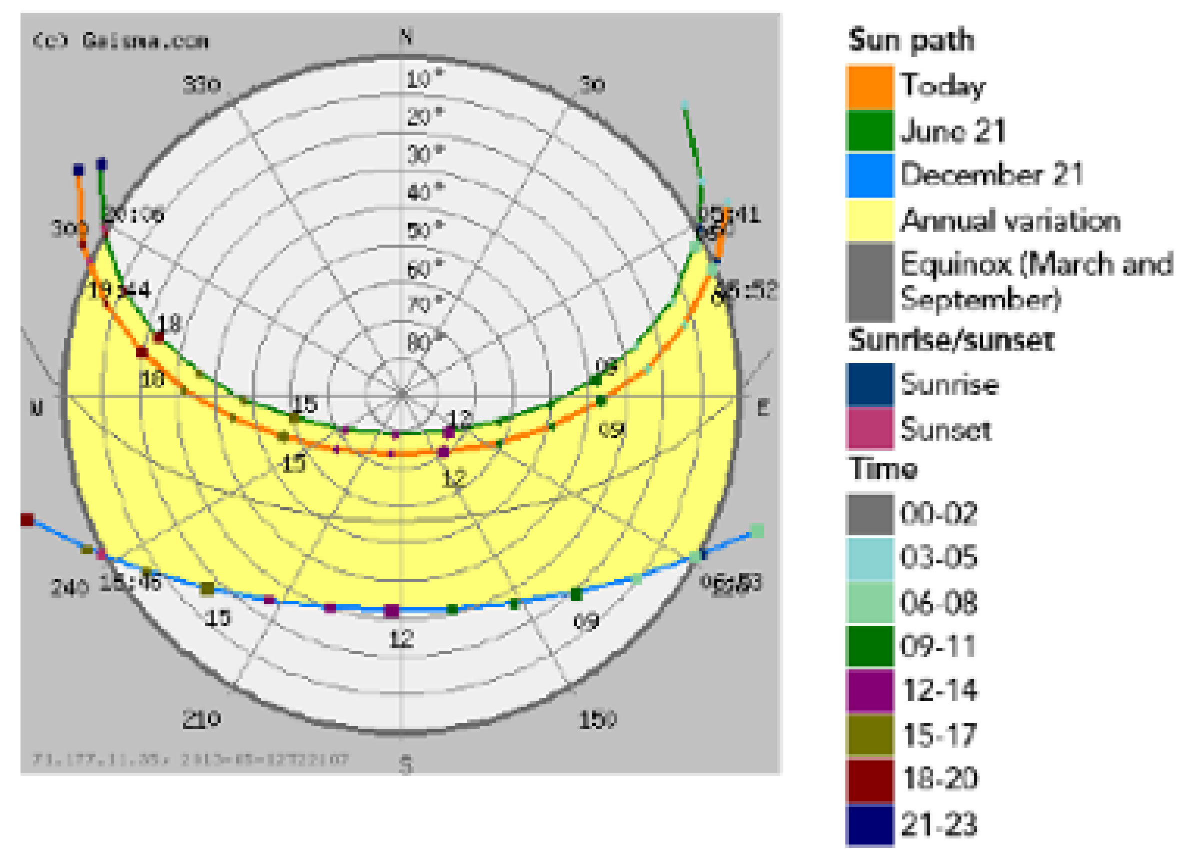
The electricity leaving the inverter travels through a meter section and switch-gear before entering the power grid. A specialized meter and switch-gear design is required for a PV system. During the day when the PV system is creating power the unusual situation exist of having live power on both sides of the meter, and the design has to allow for this.

Weather conditions play an important role in determining the amount of power generated from a PV plant. Obviously cloud cover will greatly degrade performance. The outside air temperature also plays an important role in generated output. The solar panels output is also reduced with an increase of temperature of the cell. Figure below represents the decrease in the cell's performance with the increased temperature of the cell. This is not the ambient temperature, but the actual cell's temperature. It is not advisable to put a PV panel right against another surface, such as a roof. It is a better design that allows for airflow all-round the cell. Most roof top systems have an air gap on the underside to allow natural convection to take place. The carport style of construction also does not have this problem.

The figure below provides the sun path for both winter and summer seasons and the associated solar radiation in kWh/m2/day at the campus.







Installation and Costs

A photovoltaic system requires approximately 90 -115 ft2 of footprint area per installed kW DC. In addition, this area should be free from solar shading from other buildings, trees, light poles, or other structures. Thus rooftops and parking lots are the preferred PV locations.

Maintenance typically involves replacing DC-AC power inverters every 10 years. Current inverter replacement cost is approximately $0.50 per watt (DC). Replacement costs are projected to be $0.20-0.30 per watt (DC).

These PV systems could either be purchased and owned by the District or procured using a 3rd party under the Power Purchase Agreement (PPA). Using a PPA, the owner of the PV system will own the renewable energy credits and will offer the same to the District at a specified rate/kWh. The cost of these REC's currently vary from $0.01-$0.015 per kWh. The cost for electricity under these agreements are typically structured to ensure the owner of the PV system will recover their investment with profit by providing escalation rates (typically 3% per year) to the power purchase costs. The District should consider the possible rewards and risks of both options during the early phases of implementation.

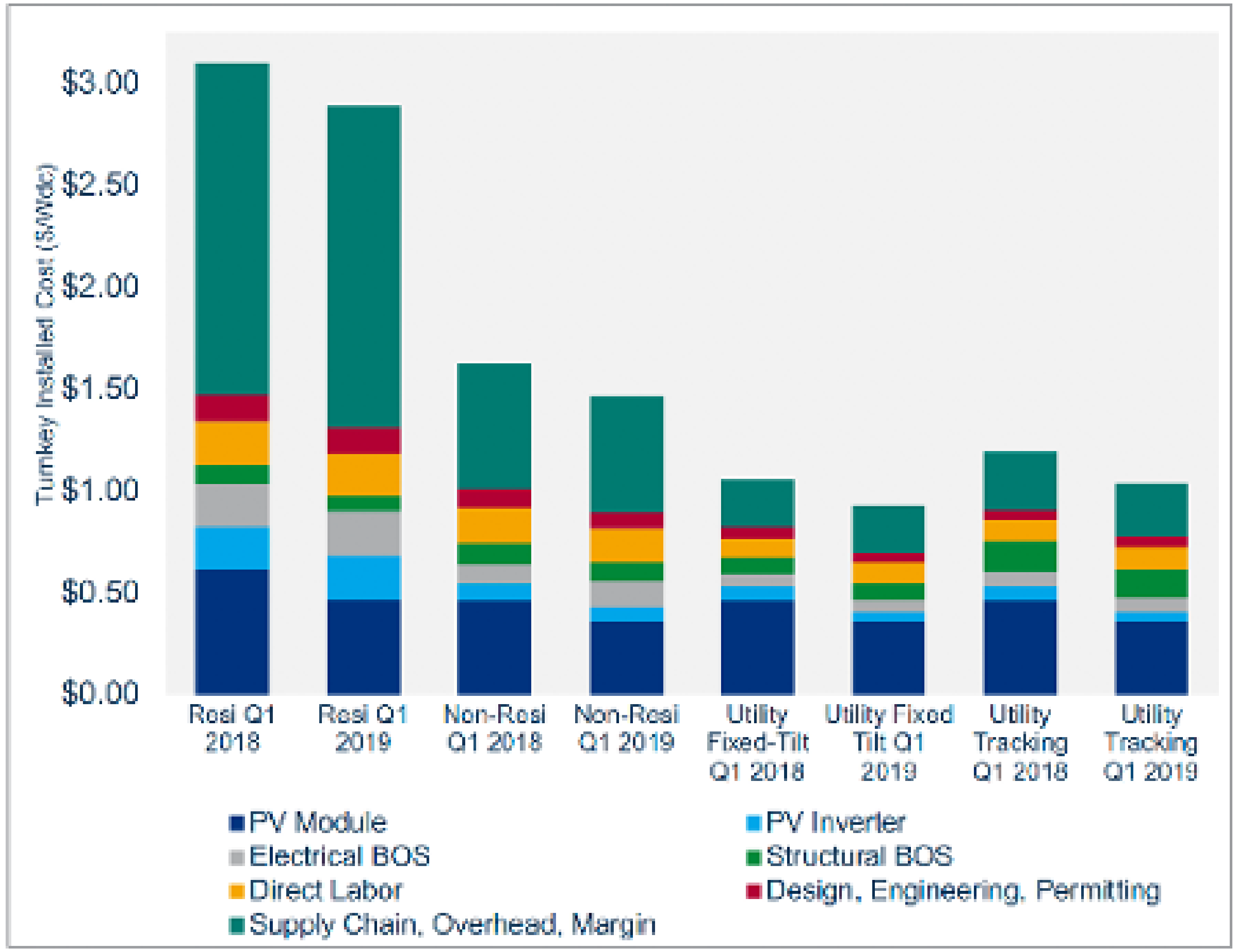
PRICING TRENDS

The solar energy industry typically uses price per watt as its primary unit of measurement.

As a rule of thumb, the solar module represents 40-50% of the total installed cost of a Solar System. This percentage will vary according to the nature of the application. A complete solar system includes all the other components (called the balance of systems) required to create a functioning system, whether it is to feed energy in to the grid or to be used in stand-alone off-grid applications.

Average installed cost of PV modules fell roughly 30 percent in 2014 from 2012, almost 50% from 2014-2018 and approximately 65% by 2020. This is despite the large shift to the more labor-intensive (and expensive) residential installations. With new innovations in the installation process, increasing economies of scale and innovative equipment increasing energy yields, the cost reductions are expected to continue.

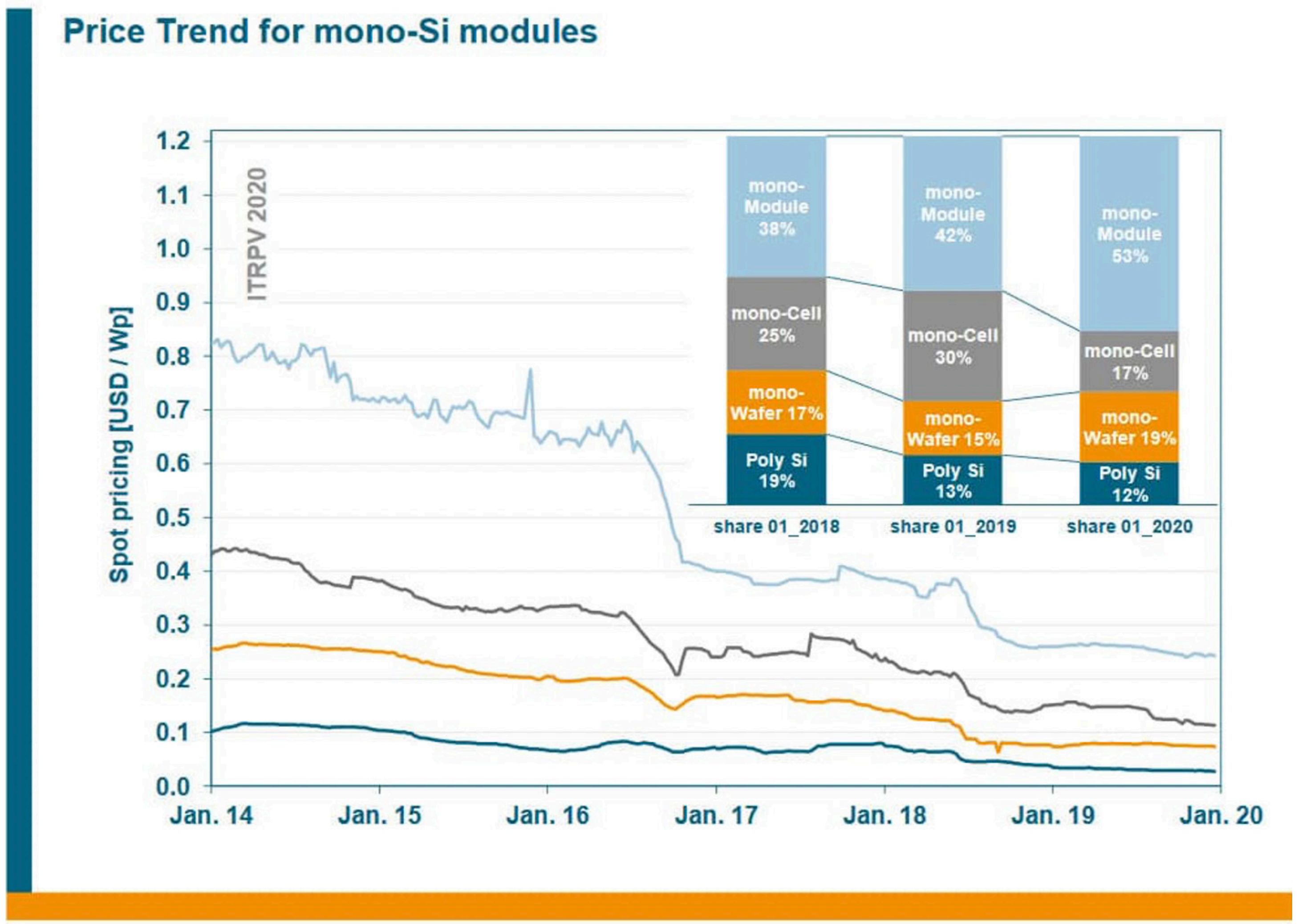
The graph below shows the trend in PV installed costs per watt over the years. These costs continue to decline this year thus making PV's more attractive in the commercial market. It also shows the module costs that have been declining consistently over the years thus making the overall system cost attractive.

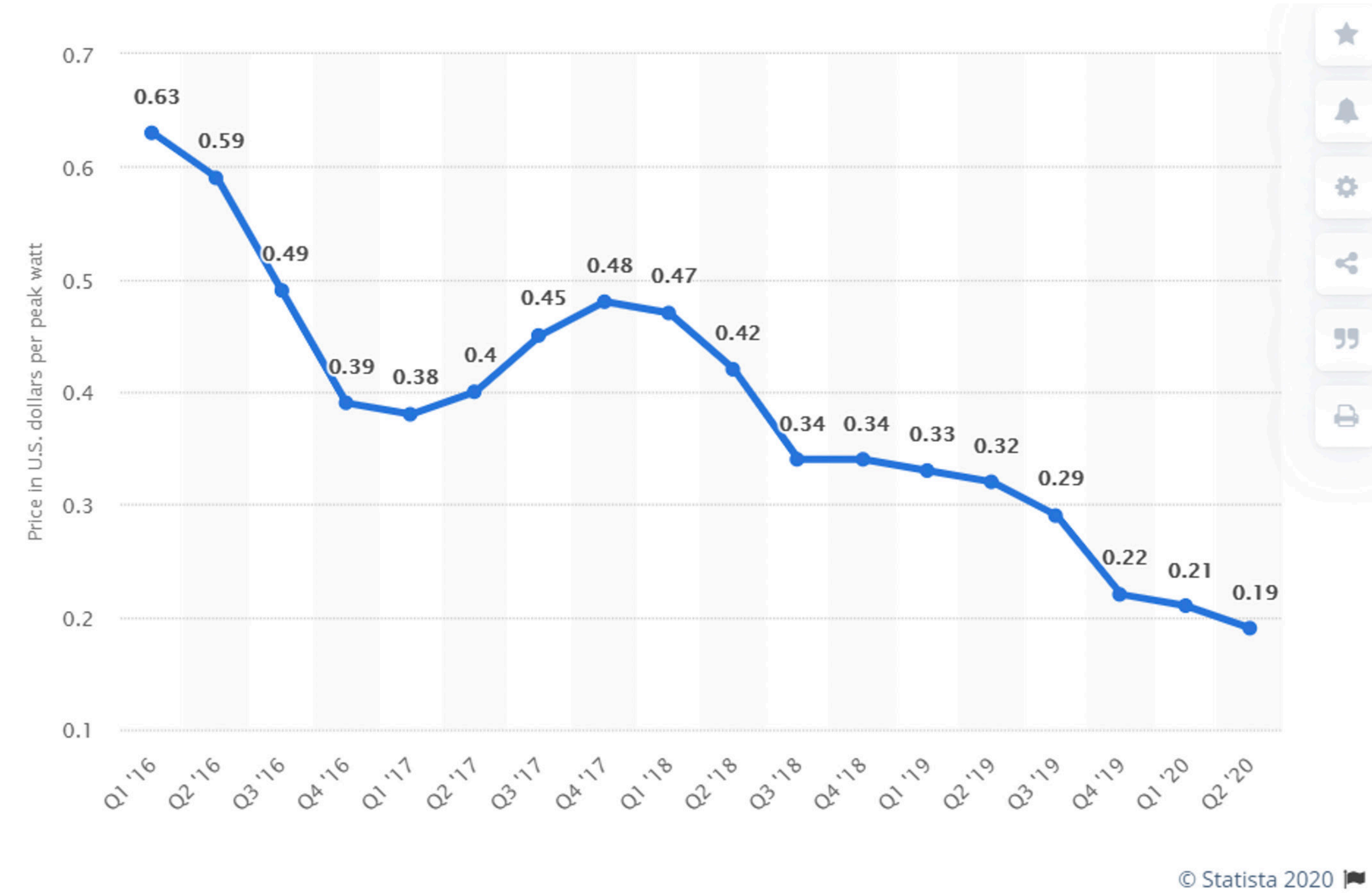


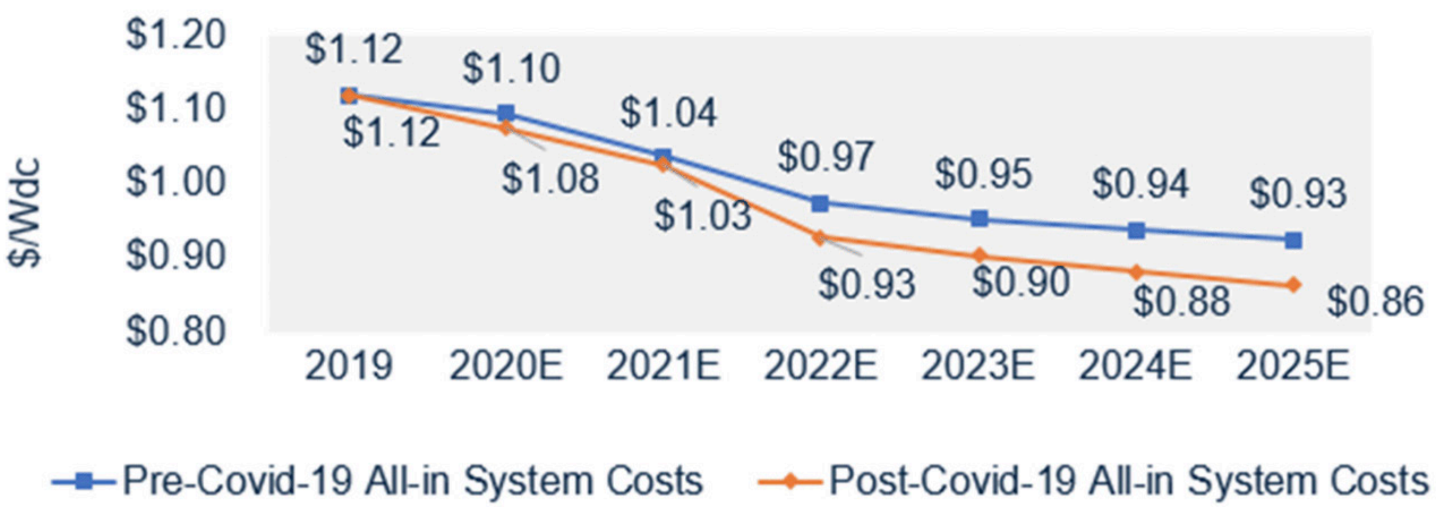
Source: Wood Mackenzie Power & Renewables

Note: Detailed information about national system prices by market segment and component is available in the full report.

NATIONAL SOLAR PV SYSTEM PRICING







The cost of a ground mount fixed PV installation is currently projected to be about $3/watt.

Costs of car port structures on parking lots and on parking structures are currently projected to be approximately $4/watt due to the costs of additional steel structure required to elevate and support the panels.

Incentives

The California Solar Initiative (CSI) incentives are currently reached their Step 10 and are not available for the campus.

Solar Water Heating

Solar water heating systems have two main parts: (1) a solar collector and (2) a storage tank. The most common collector used in solar hot water systems is the flat plate collector.

Solar water heaters use the sun to heat either water or a heat-transfer fluid in the collector. Heated water is then held in the storage tank ready for use, with a conventional system providing additional heating as necessary. The tank can be a modified standard water heater, but it is usually larger and very well insulated. Solar water heating systems can be either active or passive, but the most common are active systems.

ACTIVE SOLAR

Active solar water heaters rely on electric pumps, and controllers to circulate water, or other heat-transfer fluids through the collectors.

PASSIVE SOLAR

Passive solar water heaters rely on gravity and the tendency for water to naturally circulate as it is heated. Because they contain no electrical components, passive systems are generally more reliable, easier to maintain, and possibly have a longer work life than active systems.

SOLAR WATER HEATING FOR POOLS

Solar water heating systems for pools can provide an efficient and cost-effective means of heating pools if pools are heated throughout the year. The most common collector used in solar hot water systems is the flat plate collector.

Solar water heaters use the sun to heat the pool water in the collector.

TYPES OF SOLAR COLLECTORS

Two types of solar collectors currently exist in the market: Flat plate collectors and Evacuated tube collectors.

FLAT PLATE COLLECTORS

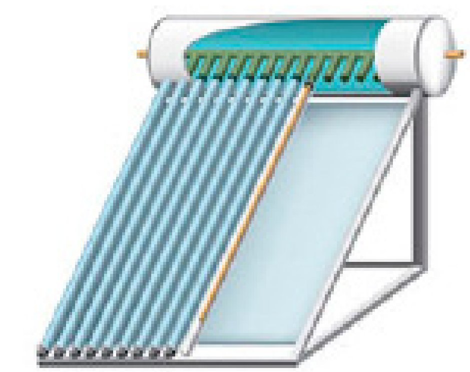
Flat plate collectors typically consist of copper tubes fitted to flat absorber plates. The most common configuration is a series of parallel tubes connected at each end by two pipes (the inlet and outlet manifolds). The flat plate assembly is contained within an insulated box and covered with tempered glass.

FLAT PLATE AND COMPOUNDED PARABOLIC COLLECTORS

Flat Plate collectors are a common type of collectors used in southern climate zones. For pools, flat plate collectors for direct heating are developed from compounded polypropylene to withstand UV radiation and thermal cycles.

EVACUATED TUBE COLLECTORS

Evacuated tube collectors are the most efficient collectors available and similar to a thermos in principle. A glass or metal tube containing the water or heat transfer fluid is surrounded by a larger glass tube. The space between them is a vacuum, so very little heat is lost from the circulating fluid. These collectors also work well in overcast conditions and operate in temperatures as low as -40°F. Individual tubes have a life expectancy of 25-30 years and can be replaced as needed.



EVACUATED TUBE TYPE COLLECTORS

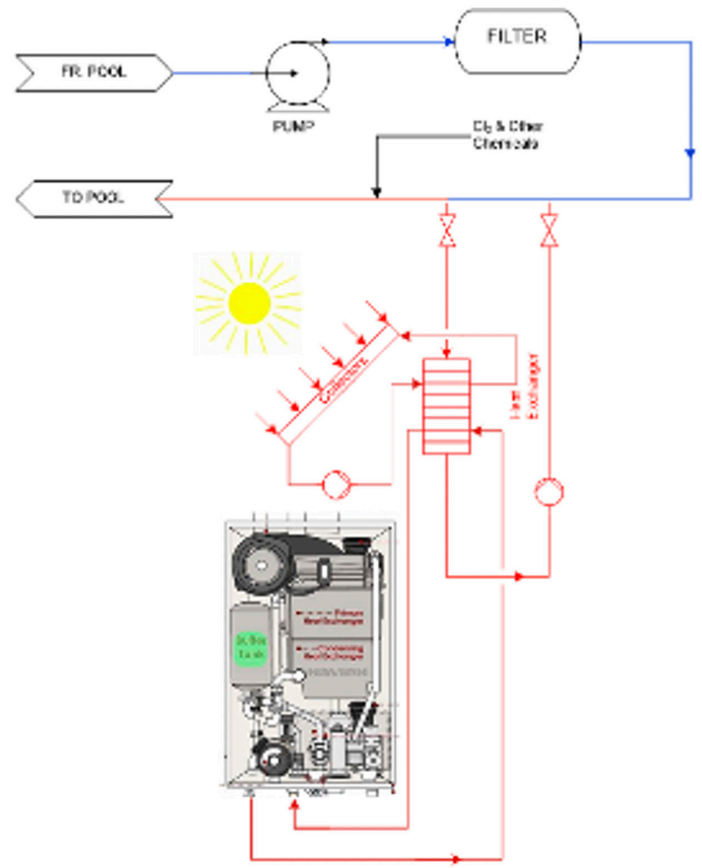
CIRCULATION SYSTEMS

DIRECT CIRCULATION SYSTEMS

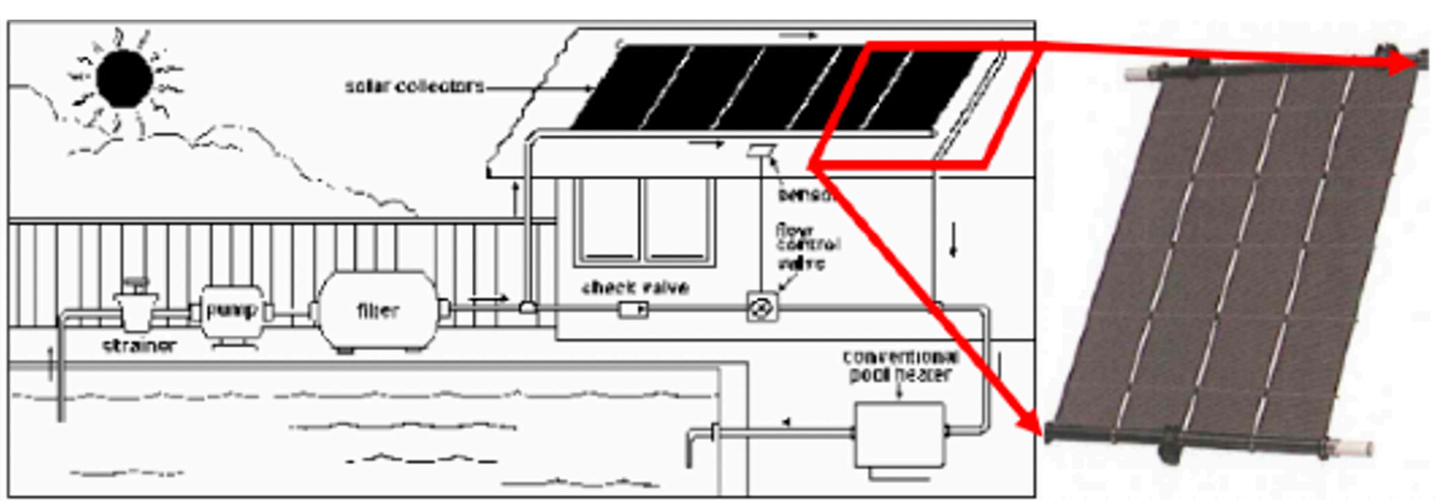
Direct systems circulate water through solar collectors where it is heated by the sun. The heated water is then used directly in the pool. These systems are preferable in climates where it rarely freezes. Freeze protection is necessary in cold climates. Scaling can be an issue due to water hardness and can add a performance barrier to the heat transfer over time

INDIRECT CIRCULATION SYSTEMS

Closed-loop, or indirect, systems use a non-freezing liquid to transfer heat from the sun to water in a storage tank. The sun's thermal energy heats the fluid in the solar collectors. Then this fluid passes through a heat exchanger in the storage tank, transferring the heat to the water. The non-freezing fluid then cycles back to the collectors. Glycol is typically to fluid of choice, but brings with it special handling and disposal requirements due to its classification. Good alternatives to glycol, especially in non-freezing climates, are deionized water and the use of biodegradable water softeners. These systems are appropriate where high hardness of domestic water is encountered. The clean design of the indirect system (i.e. not circulating the pool water through the collectors) results in a very low degradation rate for the fluid. An example of an indirect system with high-efficiency tankless water heaters is shown in Figure below.



INDIRECT SWIMMING POOL WATER HEATING DESIGN



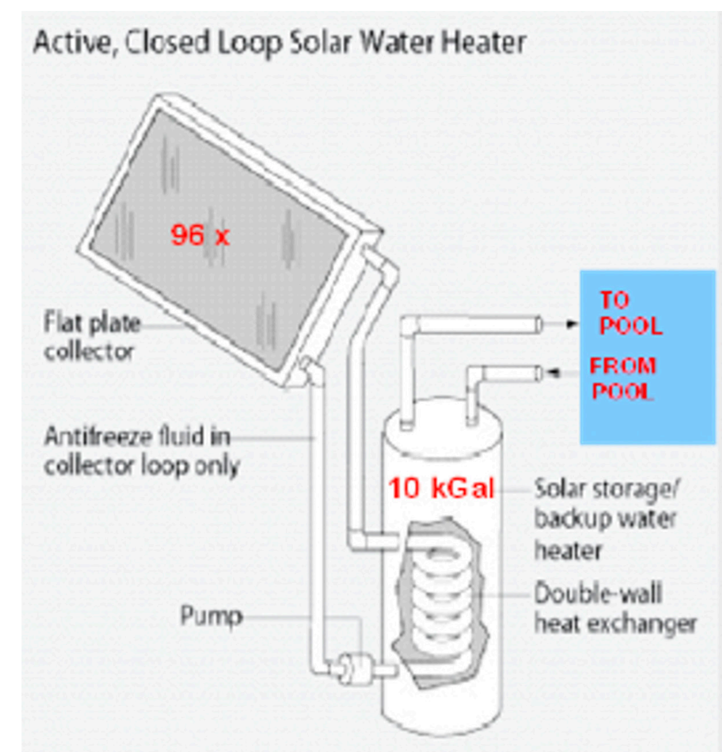
DIRECT SWIMMING POOL WATER HEATING DESIGN

ACTIVE (FORCED-CIRCULATION) SYSTEMS

Active - or forced-circulation - systems use electric pumps, valves and controllers to move water from the collectors to the storage tank. This type of system is needed for storing solar thermal energy to be supplied during off sun hours of pool use. An example of an active system is shown in Figure below.

ACTIVE SWIMMING POOL WATER HEATING DESIGN

This technology is still very expensive and does not have a good rate of return on investment. As the technology develops, prices would come down and will make the technology more attractive in the coming years. We thus do not recommend this technology for implementation at the campus.



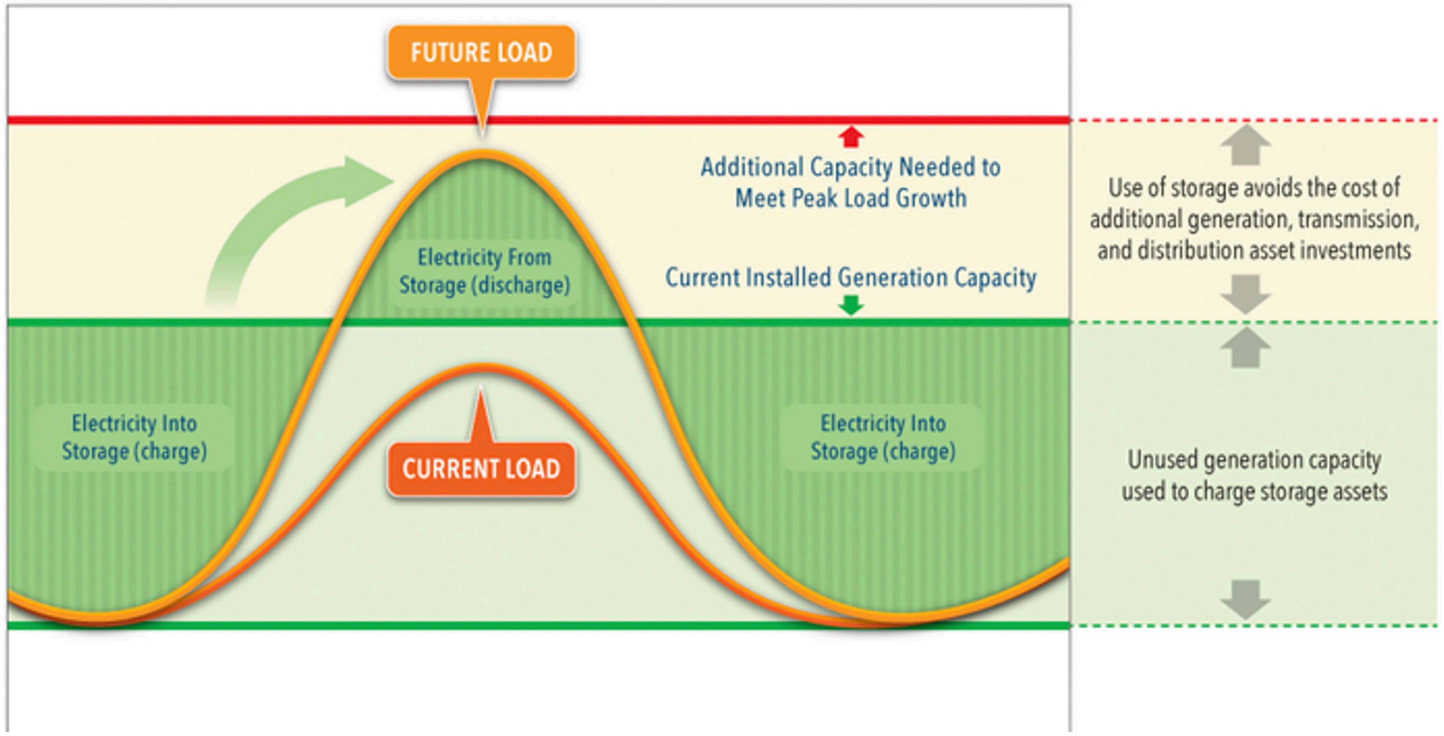
ACTIVE SWIMMING POOL WATER HEATING DESIGN

No incentives are currently offered by the state for this technology for building heating. Incentives are however available for commercial pools. The building solar water heating system costs are high and the technology is not cost effective due to the intermittent service water heating loads. This technology is currently not recommended.

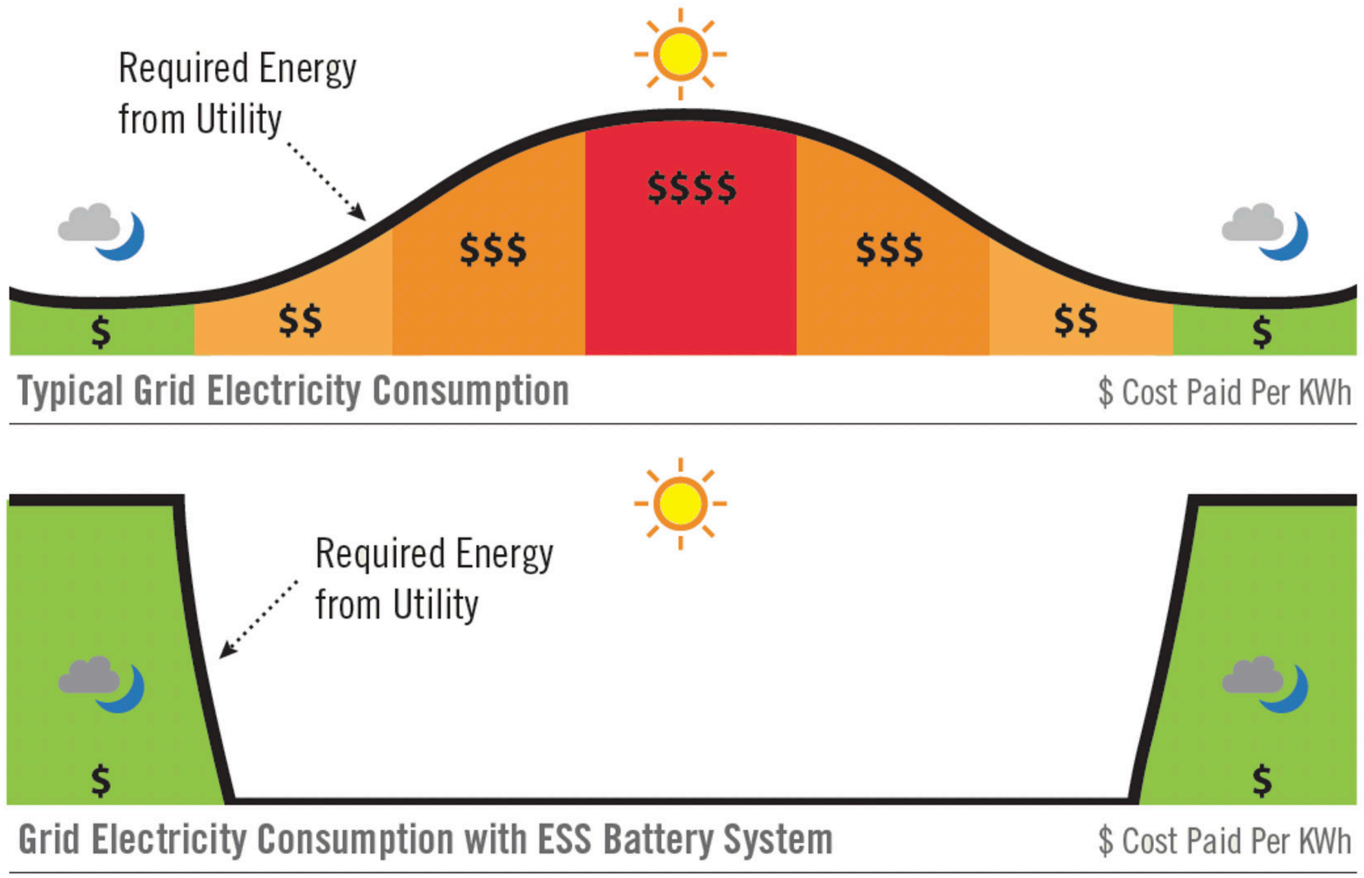
BATTERY STORAGE SYSTEMS

Grid battery energy storage system provide a means of storing electrical energy within an electrical campus power grid. Electrical energy is stored during off peak and mid peak periods when the demand and prices are lower and then supplied to the grid during peak demand periods. The energy storage systems help reduce operating costs by offsetting time of use and demand charges, keep the power on during disruption, demand response events and outages, Integrate solar and other renewable energy sources on site and lower carbon footprint by minimizing use of generation from fossil fuels and cogeneration

Intelligent energy storage systems employ microprocessor based controllers that help interface with the overall campus grid and improve power efficiency by flattening facilities' power demand peaks by discharging and charging from its batteries at critical moments.



TAKING ADVANTAGE OF TOU WITH AN ESS BATTERY SYSTEM

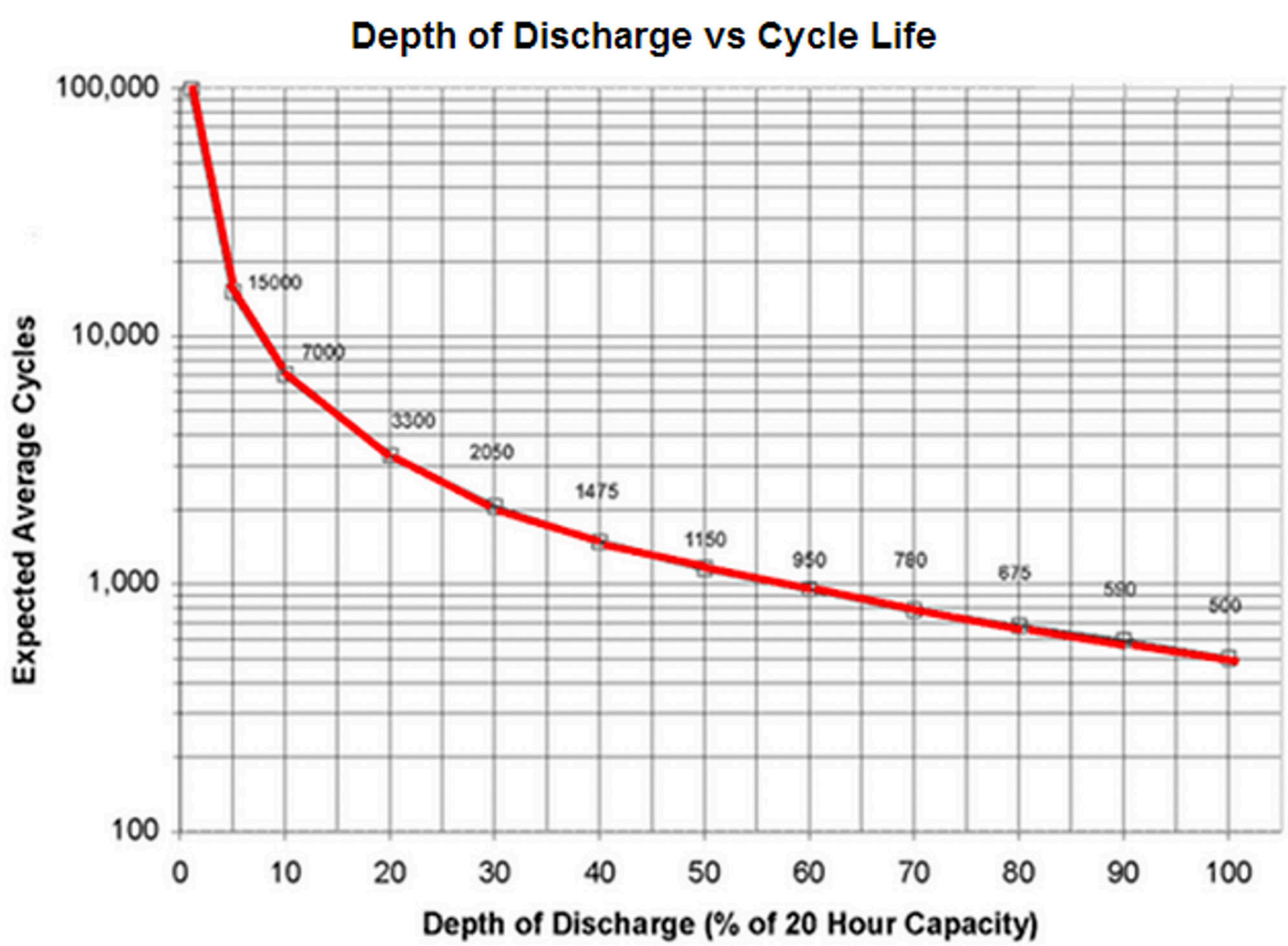


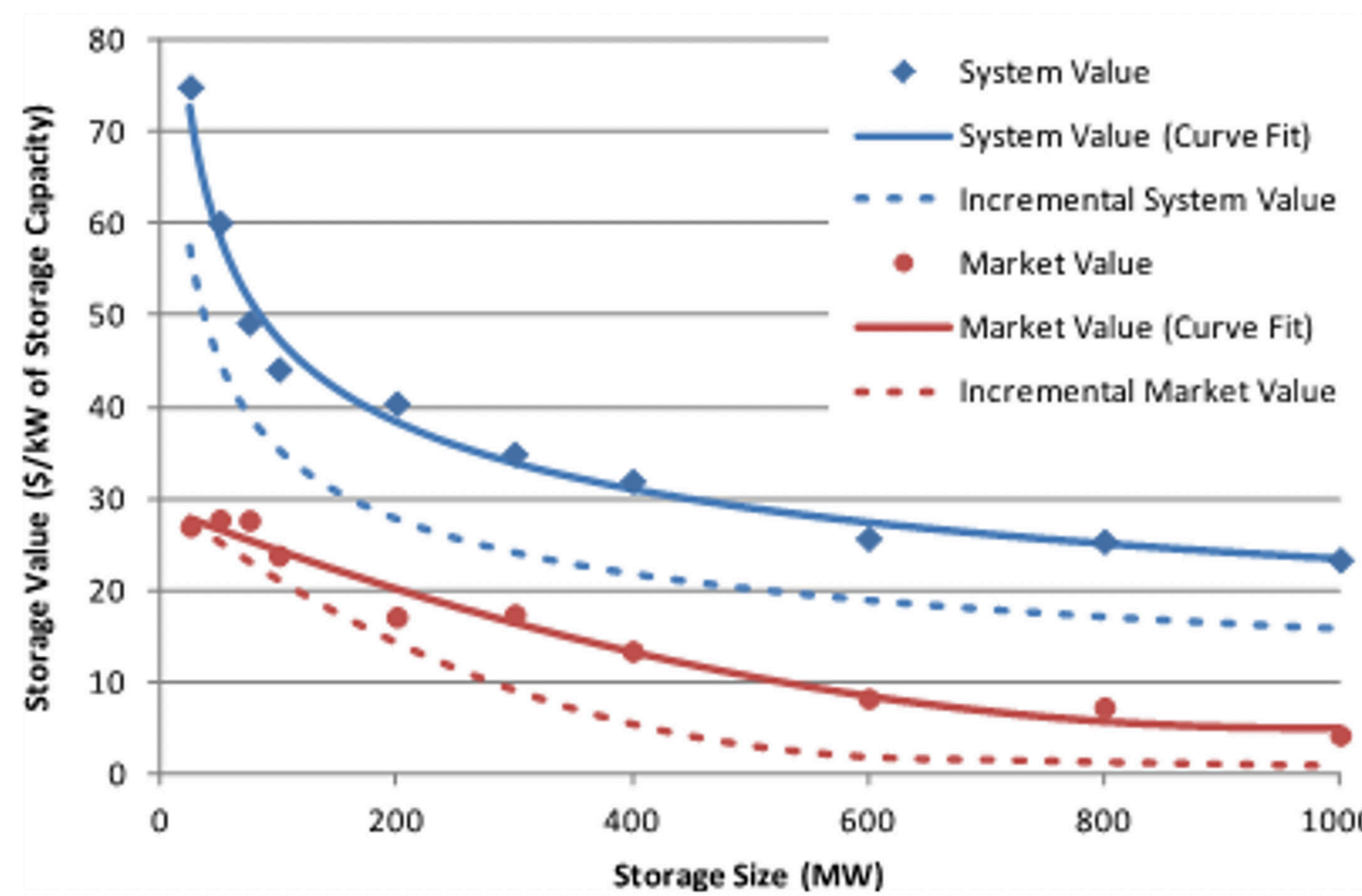
Li-ion batteries are the common batteries currently being employed in battery storage systems. The batteries depth of discharge is often an important determinant in battery lifetime where shallower cycles can significantly prolong battery life as evident from the graph below. In addition, battery lifetime is not only measured in cycles, but also in years. For example, reported Li-ion battery lifetimes range from 1000-10000 cycles and 5-15 years.

The cost of a battery storage system varies with the design application and the size and usage of the system. The costs of battery storage systems currently vary between $450/kWh - $800/kWh. In majority of the cases, primary use of distributed energy storage systems are currently limited to peak shifting and backup power provision and these high cost of distributed energy storage prevent cost-effective provision of these systems. Thus, battery balance-of-system costs must come down in order to enable cost-effective participation in both current and future markets.

Considering the electric utilities migrating to a 4-9pm peak Time-of-Use rates, Campus shall plan to add battery energy storage system to store the excess on site generation during daytime and utilize the stored energy to offset the demand during the 4-9pm period. Based on the existing demand and PV systems installed under phase 1, 740kW/2960kWh Battery Energy Storage System shall be integrated into the campus distribution system.

Campus shall plan to add battery energy storage system to store the excess on site generation during daytime and utilize the stored energy to offset the demand during the 4-9pm period. Based on the existing demand and PV systems installed under phase 1, 740kW/2960kWh Battery Energy Storage System shall be integrated into the campus distribution system. The availability of enhanced self generation incentives due to location of the campus (Equity Incentives), the paybacks are really attractive to combine the solar system with the battery storage to not only offset the overall peak demand charges but also offset overall peak energy consumption charges and save overall operational costs. Payback analysis and associated costs for integrating the solar system with battery storage. District shall pursue the Incentive to offset the capital cost for Battery Energy Storage System. Based on the proposed battery size and project area, current SGIP Plan will offset ~60% of the capital cost.





MICROGRIDS

Microgrids are electricity distribution systems containing loads and distributed energy resources, (such as distributed generators (CHP), renewable energy sources, storage devices, or controllable loads) that can be operated in a controlled, coordinated way either while connected to the main power network or while islanded.

The U.S. Department of Energy (DOE) defines a microgrid as:

"A group of interconnected loads and distributed energy resources with clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid [and can] connect and disconnect from the grid to enable it to operate in both grid connected or island mode."

Microgrids are modern, small-scale versions of the centralized electricity system. Micro grids offer reliability, carbon emission reduction, diversification of energy sources, and cost reduction. Like the bulk power grid, smart microgrids generate, distribute, and regulate the flow of electricity to consumers, but do so locally. Smart microgrids are an ideal way to integrate renewable resources on a campus level and form building blocks of a perfect power system. Figure below illustrates typical elements of a microgrid at a campus.

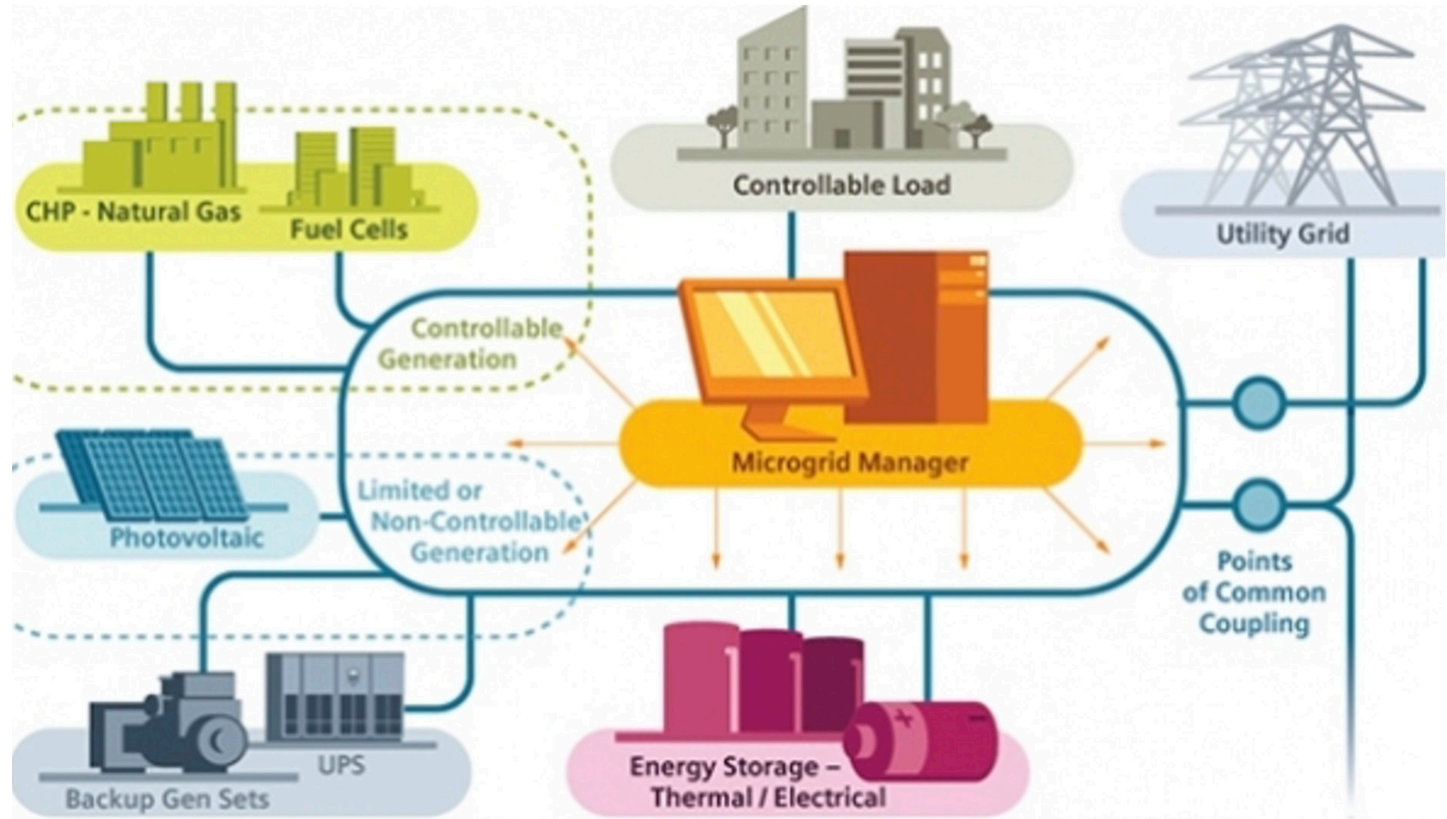
As represented in the following figure, a microgrid consists of two overlapping infrastructures:

Energy Infrastructure

The physical assets that generate, deliver, transform, and disrupt power e.g. power lines, circuit breakers, transformers, conventional and renewable generators and more.

COMMUNICATION AND CONTROL

The means of communication and the controls among the physical assets e.g. Local ethernet network, cellular network, serial connection, microgrid controller, protective relay, etc.



The operation of a microgrid offers distinct advantages in a campus environment. They include:

IMPROVED ENERGY SECURITY

Providing improved power supply to critical facilities. Through electrical feeder automation, a microgrid controller can assure the routing of available energy to predetermined critical facilities.

IMPROVED ENERGY RESILIENCY

Ability to provide power during utility grid outages and to recover quicker if outages occur. Generator portfolio dispatch is a basic microgrid controller function that assures energy resiliency to loads within the microgrid.

HIGHER POWER QUALITY

Ability to mitigate the impact of power quality fluctuations on the utility grid. Intermittency from renewables is an issue that a microgrid platform mitigates through dispatching energy storage and switchable loads.

REDUCED LOAD ON THE UTILITY

A carefully planned microgrid platform can have an important role in reducing utility infrastructure needs and costs. For example, net-zero energy consumption could be achieved at the primary metering point due to optimized local energy production and consumption.

INCREASED GRID FUNCTIONALITY

Providing improved management and control of loads and energy consumption.

LOWER ELECTRICITY COSTS

Enables best use of controllable loads and distributed generation resources, including renewables, as part of an optimum generation asset portfolio.

REDUCED ENVIRONMENTAL IMPACT

Reduced energy usage from utility grid and the use of renewable energy sources and storage systems with in the micro grid helps reduce greenhouse gas emissions and overall environmental impact.

A microgrid can operate connected or disconnected from the utility grid. Each microgrid mode of operation has unique characteristics and technical requirements which the campus needs to evaluate when reviewing its energy infrastructure options.

GRID-CONNECTED OPERATION

In the grid-connected mode of operation, a group of interconnected loads and distributed generation assets are joined to the utility at a point of common coupling. The amount of energy produced at any given time by local onsite generation or imported from the utility grid can vary depending on the campus preferred optimization criteria. The microgrid controls can be configured based on a variety of criteria include: minimize cost, maximize renewable penetration, participate in utility programs such as demand response, etc.

The microgrid control software is responsible for the operational management of the generation resources (supply-side) and ensuring the system is balanced with the existing and forecasted load (demand-side). The microgrid software functionally includes:

- Monitoring and enforcement of the microgrid frequency and voltage (simplified due to grid support)
- Day-ahead forecast of energy demands, renewable generation output, and utility prices

Optimal resource scheduling (generation, storage, grid power import), based on minimizing:

- The total cost of energy to supply the microgrid load
- The total emissions required to supply the microgrid load
- Intentional microgrid load reduction to accomplish:
- Decreased operational cost, energy efficiency
- Peak load reduction
- Reliability, in the case of a contingency (e.g. a generator trips offline, there is load greater than generation output, load needs to be reduced)
- Microgrid islanding and grid resynchronization
- Black start restoration in the event of a microgrid black out

ISLANDED OPERATION (OFF-GRID OPERATION)

In the off-grid or islanded mode of operation, the microgrid is disconnected from the utility grid and no longer benefits from energy supply, or the frequency and voltage stability, provided by connection to the utility's network. Advanced energy management software functionality is required from a microgrid control system to operate the islanded system in lieu of the local utility. These include:

- Dispatch generation and storage to meet instantaneous demand of loads within the microgrid
- Advanced monitoring and enforcement of frequency and voltage within the microgrid, relative to a defined value (e.g. 60hz, 4.16kVkV)
- For frequency, defining one or multiple energy source to act as "regulating" resources, and delegating set points for power output to the remainder of generating assets
- For voltage, continually adjusting the reactive power output of generation and storage to keep system voltage close to the defined value
- To ensure both the frequency and voltage control have the real and reactive power "bandwidth", there must be a reserve monitoring and enforcement function, i.e., the controller must have knowledge of the available capacity of all generation to immediately raise or lower output (reserves). This is critical to manage frequency and voltage within the microgrid.

Table 2 provides a summary of some of the key differences between operating a microgrid connected to the utility grid vs. disconnected (islanded) from the utility grid.

A review of the campus electrical distribution system revealed that significant modifications and sophisticated controls will need to be added to enable the system function as a microgrid. Automatic load shed controls will need to be added to ensure that the cogeneration system continues to function and is not overloaded in event of a power outage when the campus demand exceeds generation. The campus will also need to diversify its on-site energy generation portfolio and include renewable energy sources and storage systems to maximize the advantage of implementation of the micro grid system. Our recommendation therefore is to plan the implementation of the micro-grid in the future as prices of storage systems and on site generation fall and additional funding is available to implement provision of these additional renewable energy sources and an automatic load shed control system.

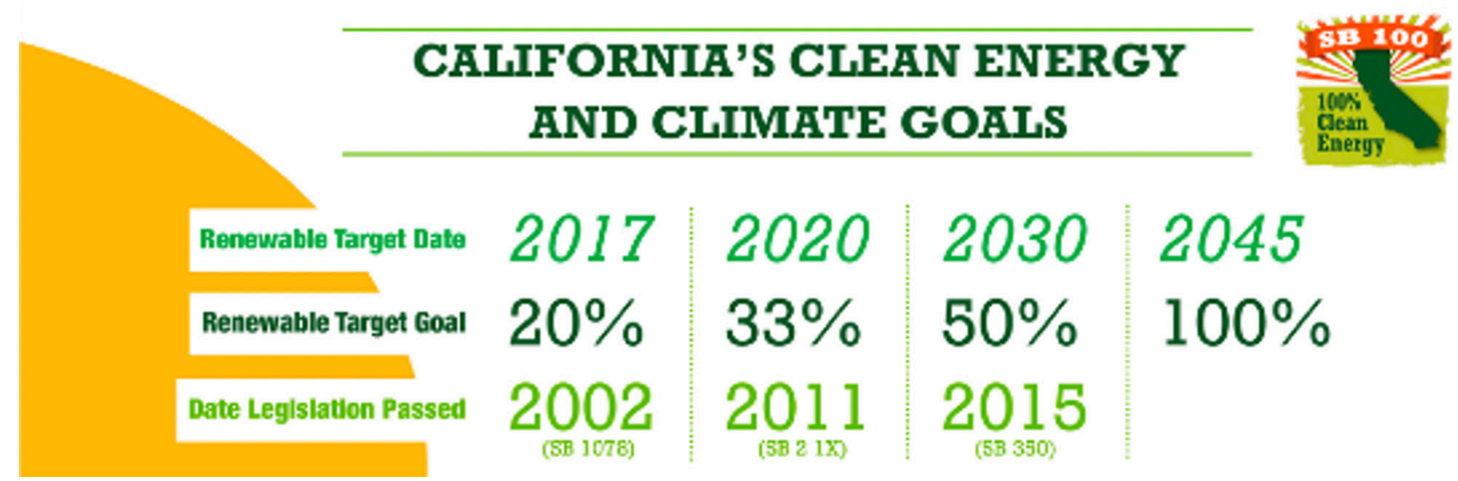
FUTURE INFRASTRUCTURE

The primary components of infrastructure the campus should include in the future for incorporating a microgrid should include:

- Advanced controls of both energy supply and energy demand.
- Communication infrastructure
- Local generation sources to improve resiliency and reliability, better manage energy usage and costs and employ greater renewable generation
- Energy storage system in order to offer enhanced economic optimization and the potential ability for time-of-use rate arbitrage
- Redundancy in supply, distribution facilities, and controls to improve resiliency and reliability

Table 2. Key Differences between Connected and Disconnected Microgrid

Function	Connected	Disconnected
Frequency and voltage stability	Monitored, but mostly provided by the utility's large, stable system	Provided by local microgrid generation under direction of a microgrid controller
Economic optimization	Objective is to maximize profit or minimize costs by understanding the available revenue (e.g., wholesale electricity, ancillary services) and the cost associated with supplying local load and generating excess for sale (e.g., fuel costs, startup costs, operating costs, etc.)	Objective is to minimize the total cost of supplying the load by scheduling the lowest cost assets to provide power.
Renewable generation intermittency mitigation	Provided by utility energy management systems controlling assets including: spinning reserves, voltage regulators, capacitor banks, etc.	Provided by a microgrid controller scheduling local generation and storage ahead of time, and dynamically dispatching assets in real time
Day-ahead load forecast	Conducted by the utility at a system level (i.e., not granular enough for individual locations and microgrids)	Provided by microgrid controller if loads are integrated into overall control scheme providing real-time data
Day-ahead energy production forecast	Provided by the utility at a system level (i.e., not granular enough for individual locations and microgrids)	Provided by microgrid controller for proper energy resource scheduling



UTILITY PROGRAMS AND INCENTIVES

NEM 2.0: California's new net metering policy

The original policy for net metering in California was very simple: for every kilowatt-hour (kWh) of solar electricity you feed into the grid, you get a bill credit for one kWh of utility-generated electricity. When your solar panels produce more than you need, you "bank" the excess to use when your panels don't produce enough to meet your monthly use. If your system is the right size, net metering makes it possible for you to cover your electricity use for the entire year with solar.

Net Metering 2.0 made a few minor changes to California's original net metering policy, but it preserves the key element that makes solar economical for California businesses: retail rate bill credits. Businesses that enroll in NEM 2.0 will still receive per-kWh credits for their solar electricity that are equal to the value of a kWh of utility electricity. This means that the economics of solar are still very favorable under NEM 2.0.

The NEM 2.0 however levies Non-bypassable charges (NBC) per-kilowatt hour charges and are built into utility electric rates. They add up to approximately 2-3 cents per kWh and go towards funding energy efficiency, low-income customer assistance, and other related programs.

A a Customer is responsible for NBCs, assessed on a $-perkilowatthour (kWh) basis using the NBC factors contained in the Customer's OAT (Otherwise Applicable Tariff), for each kWh of electricity that is consumed/imported from the grid net of exports (i.e., net consumption) in each metered interval (e.g., one hour or 15-minute). For example, if a Customer consumes/imports 5 kWh from the grid in a metered interval and exports 3 kWh to the grid in that same metered interval, the Customer is assessed NBCs on 2 kWh for that metered interval. If a Customer consumes/imports 2 kWh from the grid in a metered interval and exports 3 kWh in that same metered interval, the Customer is assessed NBCs on 0 kWh for that metered interval since there was no net consumption from the grid in that metered interval. NBCs are assessed on a $-per kWh basis for each kWh of electricity that is consumed/imported from the grid net of exports (i.e., net consumption) in each metered interval (e.g., one hour or 15-minute).

In the original net metering policy, system owners did not have to pay NBCs on the electricity that they bought from the utility on a month-to-month basis. Under NEM 2.0, new system owners will have to pay NBCs, but only for the kWh of electricity delivered by the utility.

RES-BCT

The RES-BCT program (formerly AB 2466) was established by the legislature effective January 1, 2009, and is codified in Section 2830 of the Public Utilities Code. It allows a Local Government with one or more eligible renewable generating facilities to export energy to the grid and receive generation credits to benefitting accounts of the same Local Government (AB 1031 expanded applicability to universities). AB 512, signed into law in 2011 and effective on January 1, 2012, further modified this program to increase the generator size limit to 5 MW per generation account.

The Renewable Energy Self-Generation Bill Credit Transfer (RES-BCT) program allows local governments and college campuses to generate energy for their own use. Energy that is not used can be exported to SCE's grid. All generation exported to SCE's grid is converted into "generation credits" and is applied to the accounts you designate. To qualify and enroll in the program, your facility must meet the requirements below and must receive permission-to-operate (PTO).

The RES-BCT program is available on a first-come, first-served basis. Once the combined rated generating capacity of participating customers within SCE's service territory reaches 124.591 MW out of the 250 MW statewide cap the program will be closed to additional applicants.

Distributed Generation Incentive Programs

Since 1998, California has supported distributed generation technologies such as solar photovoltaics, solar hot water, wind, batteries, fuel cells, biogas and more through a variety of incentive programs, including the Emerging Renewables Program and later the Self-Generation Incentive Program. In 2006, the California Solar Initiative was created by Senate Bill 1 with a total budget of $2.167 billion and a goal to install approximately 1,940 MW of new solar generation capacity between 2007 and 2016. The CSI program, implemented by various program administrators and overseen by the CPUC, aimed to incentivize 1,750 MW of market rate solar in IOU territories by 2017 with an incentive budget of $1.947 billion dollars and has since been retired.

California Solar Initiative - Thermal

A component of the California Solar Initiative includes providing residential and non-residential incentives for electric-, natural gas-, or propane-displacing solar hot water heating systems. The CSI Thermal program has a budget of $250 million to promote the installation of 200,000 solar thermal systems in homes and businesses by 2017. The program is overseen by the CPUC and administered by PG&E, SCE and CSE (in SDG&E territory).

Self-Generation Incentive Program (SGIP)

In 2001 the Self-Generation Incentive Program (SGIP) was created to provide financial incentives to support existing, new, and emerging distributed energy resources that are installed to meet all or a portion of the electric energy needs of a facility. The purpose of the SGIP is to contribute to Greenhouse Gas (GHG) emission reductions, demand reductions and reduced customer electricity purchases, resulting in the electric system reliability through improved transmission and distribution system utilization; as well as market transformation for distributed energy resource (DER) technologies.

The CPUC's Self-Generation Incentive Program (SGIP) provides incentives to support existing, new, and emerging distributed energy resources. SGIP provides rebates for qualifying distributed energy systems installed on the customer's side of the utility meter. Qualifying technologies include wind turbines, waste heat to power technologies, pressure reduction turbines, internal combustion engines, microturbines, gas turbines, fuel cells, and advanced energy storage systems.

Currently Displayed: Large-Scale Storage as of 12/28/2020

	CSE	SCE	SCG	PG&E
Step Status	Open	Open	Open	Open
Active Step	3	3	3	3
Step Opening Date	June 11, 2018	Jan. 11, 2018	March 5, 2018	July 15, 2020
Days in Step	931	1082	1029	166
Authorized Collections	$17,401,755.28	$43,559,870.61	$12,182,057.77	$55,157,590.50
Reallocations	$1,921,316.42	$4,698,616.15	$2,246,011.59	$10,789,397.62
Authorized Rollover	$7,614,159.84	$22,869,216.49	$5,908,728.58	$1,612,812.91
Allocated Funds	$13,291,056.35	$44,284,661.30	$5,320,099.72	$32,264,739.93
Available Funds	$9,803,542.35	$26,843,041.95	$10,524,675.04	$13,716,265.86

Energy Storage Equity Budget	$/WH
Equity	$0.85
Equity Resiliency	$1.00

Incentive Rates for Current Steps
The equipment and biogas incentive rates per Program Administration territory are displayed in the table below.

	CSE	SCE	SCG	PG&E
Large-Scale Storage	Step 3	Step 3	Step 3	Step 3
Energy Storage**	$0.35/Wh	$0.35/Wh	$0.35/WH	$0.35/WH
Energy Storage + ITC**	$0.25/Wh	$0.25/Wh	$0.25/Wh	$0.25/Wh
Non-Residential Storage Equity	Step 5	Step 5	Step 5	Step 5
Energy Storage**	$0.85/Wh	$0.85/Wh	$0.85/Wh	$0.85/Wh
Equity Resiliency	Step 5	Step 5	Step 5	Step 5
Equity Resiliency	$1.00/WH	$1.00/WH	$1.00/WH	$1.00/WH
Generation	Step 3	Step 3	Step 3	Step 3
Wind	$2.00/W	$2.00/W	$2.00/W	$2.00/W
Other Generation	$2.00/W	$2.00/W	$2.00/W	$2.00/W
Max Biogas Adder*	$0.60/W	$0.60/W	$0.60/W	$0.60/W

*** Biogas adder does not apply to wind and waste heat to power. Final biogas adder will be prorated based on fuel blending and minimum renewable fuel blending requirements.**
**** Energy Storage rates are subject to change if all PA territories close within 10 days after the step opens**

Criteria	Pathways for eligibility	Description	Additonal Guidance
1	Have experienced more or less than PSPS events;	Located in a Hire Fire Threat District (HFTD) Tier 2 or Tier 3. Process initiated in D.17-01-009 and modified by D.17-06-024.	Maps available here: https://www.cpuc.ca.gov/gneral.aspx?id=64424549
	Customers whose electricity was shut off during two or more discrete Public Safety Power Shutoff (PSPS) events prior to the date of application for SGIP incentives.	Customers whose electricity was shut off during two or more discrete Public Safety Power Shutoff (PSPS) events prior to the date of application for SGIP incentives.	List of circuits with two or more PSPS events posted on SGIP portal. To be updated 30 days after new PSPS event. `
AND:			
2	Is a critical facility or critical infrastructure provider.	Police stations, fire stations; emergency response providers with the addition of tribal government providers; emergency operations centers; 911 call centers (also referred to as Public Safety Answering Points); medical facilities including hospitals, skilled nursing facilities, nursing homes, blood banks, health care facilities, dialysis centers and hospice facilities; public and private gas, electric, water, wastewater or flood control facilities; jails and prisons; locations designated by the IOUs to provide assistance during PSPS events; cooling centers designated by state, local or tribal governments; homeless shelters supported by federal, state, local, or tribal governments; grocery stores, corner stores, markets and supermarkets that have average annual gross receipts of $15 million or less as calculated at the single location applying for SGIP incentives over the last three tax years; independent living centers; and food banks.	
AND:			
3	Provides critical services or infrastructure to one or more communities in a Tier 3 or Tier 2 HFTD or a community with customers who electricity was. Shit off during 2 or more discrete PSPS events, AND	Equity budget eligible community refers here to a disadvantaged community or low-income census tract as defined in D.17-10-004 or California Indian Country as defined in D.19-09-027.	
	At least one of those communities is eligible for the equity budget.		

Equity

HOST CUSTOMER ELIGIBILITY FOR THE EQUITY BUDGET

NON-RESIDENTIAL PROJECTS:

For the Equity Budget, a non-residential project must meet one of the following customer criteria:

- Local governmental agency
- State governmental agency
- Tribal government agency
- Educational institution
- Non-profit organization
- Small business

Additionally, one of the following two criteria must be met:

- The project site must be located in a disadvantaged, tribal, or low-income community or document that at least 50% of the census tracts it serves are disadvantaged, tribal, or low-income communities.

Equity Resiliency

Non-Residential customers are eligible for the Equity Resiliency Budget if they meet each of the following:

- Located in Tier 3 or Tier 2 HFTD, or were subject to two or more discrete PSPS events prior to the date of application for SGIP incentives; and
- Provides critical facilities or critical infrastructure during a PSPS event to at least one community that is located at least partially in a Tier 3 or Tier 2 HFTD or were subject to two or more discrete PSPS events prior to the date of application for SGIP incentives; and
- The community is also eligible for the equity budget. Food banks, homeless shelters, and independent living centers are exempt from this requirement; and
- The Non-Residential customer is one of the following:
    - Police stations; or
    - Fire stations; or
    - Emergency response providers with the addition of tribal government providers; or
    - Emergency operations centers; or
    - 911 call centers (also referred to as Public Safety Answering Points); or
    - Medical facilities including hospitals, skilled nursing facilities, nursing homes, blood banks, health care facilities, dialysis centers, and hospice facilities; or
    - Jails and prisons; or
    - Locations designated by the IOUs to provide assistance during PSPS events (CRCs); or
    - Cooling centers designated by state, local or tribal governments; or
    - Grocery stores, corner stores, markets and supermarkets that have average annual gross receipts of $15 million or less as calculated at the single location applying for SGIP incentives; or
    - Independent living centers; or
    - Food banks

PROJECT DELIVERY METHODS

Various delivery methods and financing options are available for educational institutions to implement renewable energy sources projects at their campuses. A number of factors need to be considered when selecting a financing option for their solar purchase. In addition, the campus will need to evaluate the role of RECs (Renewable Energy Certificates) in their solar procurement strategies as well. While selling RECs to another party can lower the cost of procurement, the procuring campus then cannot legally make a renewable energy claim for that transaction.

The following pages provide summaries of common solar finance models.

Third-Party Ownership Models

Under TPO arrangements, which include PPAs and leases, a third party owns, installs, and operates a solar PV system and either sells the power output (PPA) or leases the system to a solar consumer. Under a PPA, a third-party owner sells electricity generated from a solar PV system, usually on a per kilowatt-hour (kWh) basis, to a solar consumer over a fixed contract period. PPAs are considered off-balance-sheet transactions, an attractive feature to some entities. PPAs can make solar PV (or electricity more generally) accessible to consumers at a known price that parallels (but is sometimes less than) retail electricity rates, depending on the sector, market and contract terms. There are two varieties of solar PPAs: on-site (or “physical”) PPAs, in which the electricity generated from a solar PV facility is directly tied to the consumer’s meter, and off-site (or “financial”) PPAs, under which a consumer still agrees to pay a fixed price per unit of electricity generated from a solar PV installation, but the arrangement is purely financial rather than a physical transfer of electricity. Both types of PPAs are discussed in more detail in subsequent sections.

Under any of the TPO configurations, the third-party owner, not the commercial solar consumer, is investing the upfront capital to develop the system. TPO models offer an attractive risk-return balance for many consumers. Advantages include:

- No upfront costs. There are no upfront costs associated with TPO for the solar consumer.
- Reduced exposure to risk. TPO arrangements incorporate services that historically have not been included under direct ownership, allowing consumers to reduce their exposure to risks related to PV underperformance, O&M costs and delays in receiving incentives or grid-connection approval. However, as the commercial solar market evolves, installers and companies specializing in after-market operations may provide more of these services to solar consumers who elect to directly own their PV system(s).
- Access to technical and market expertise. Consumers can access technical and market expertise of third-party PV owners, which can facilitate more rapid PV deployment. Due to somewhat fragmented nature of current federal, state, and local solar policies, navigating the various tax and incentives programs can be a complex undertaking.
- Potential cost savings. For tax-exempt entities like Colleges and Universities that cannot directly monetize solar tax incentives, working with a third-party owner can facilitate cost savings if the third party takes the tax incentive and integrates the associated cost savings into the PPA or lease prices.
- Ability to have a hybrid model. The TPO provides the option to buy in the system after a specified term (eg, 10years) thus combining the benefits of PPA and owning the system.

The benefits of TPO do come with tradeoffs. The financing mechanism selected can have a significant impact on the overall system costs of the solar investment. TPO options may offer several advantages, but do not provide the same long-term cost benefits associated with direct ownership alternatives. As shown in Figure below, the modeled levelized cost of energy (LCOE) for commercial PV systems under loan configurations are lower than they would be under a TPO PPA arrangement, due to the higher cost of capital required for sponsors and tax-equity providers under PPAs.

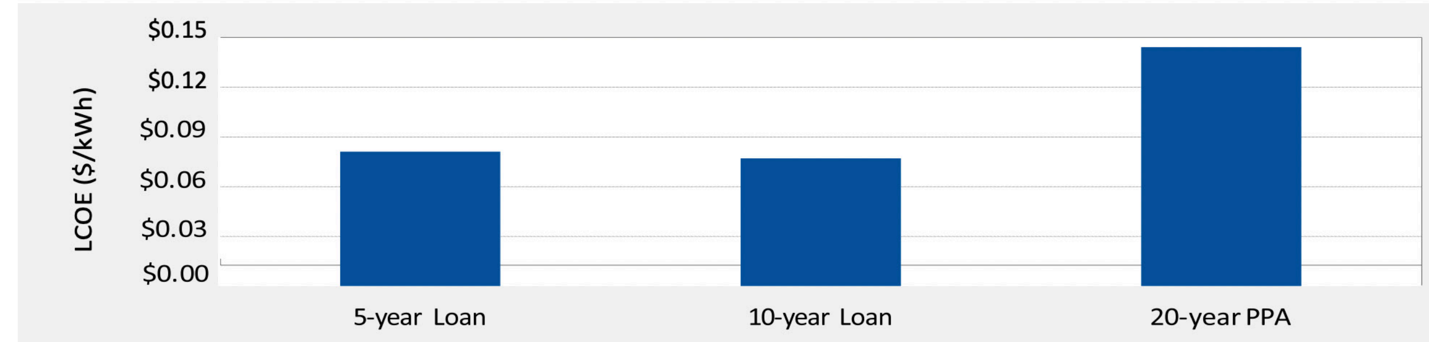


FIGURE 1 - LCOE OF COMMERCIAL PV SYSTEMS, FINANCED UNDER A PPA OR LOAN

REC ownership is another potential tradeoff for solar consumers under a TPO arrangement. TPOs typically retain ownership of and monetize RECs associated with the solar project. Institutions seeking to claim environmental benefits to meet renewable energy or carbon reduction goals need to pay attention to the third-party’s contract terms and ensure these are included as part of the contract.

On-Site Power Purchase Agreement (PPA): Physical PPA

DESCRIPTION

On-site PPAs can be considered "physical" PPAs, because the electricity production is tied to the consumer's meter, directly reducing the amount of electricity purchased from the utility (See Figure 2 below).

Note: Typical term is 15 to 20 years.

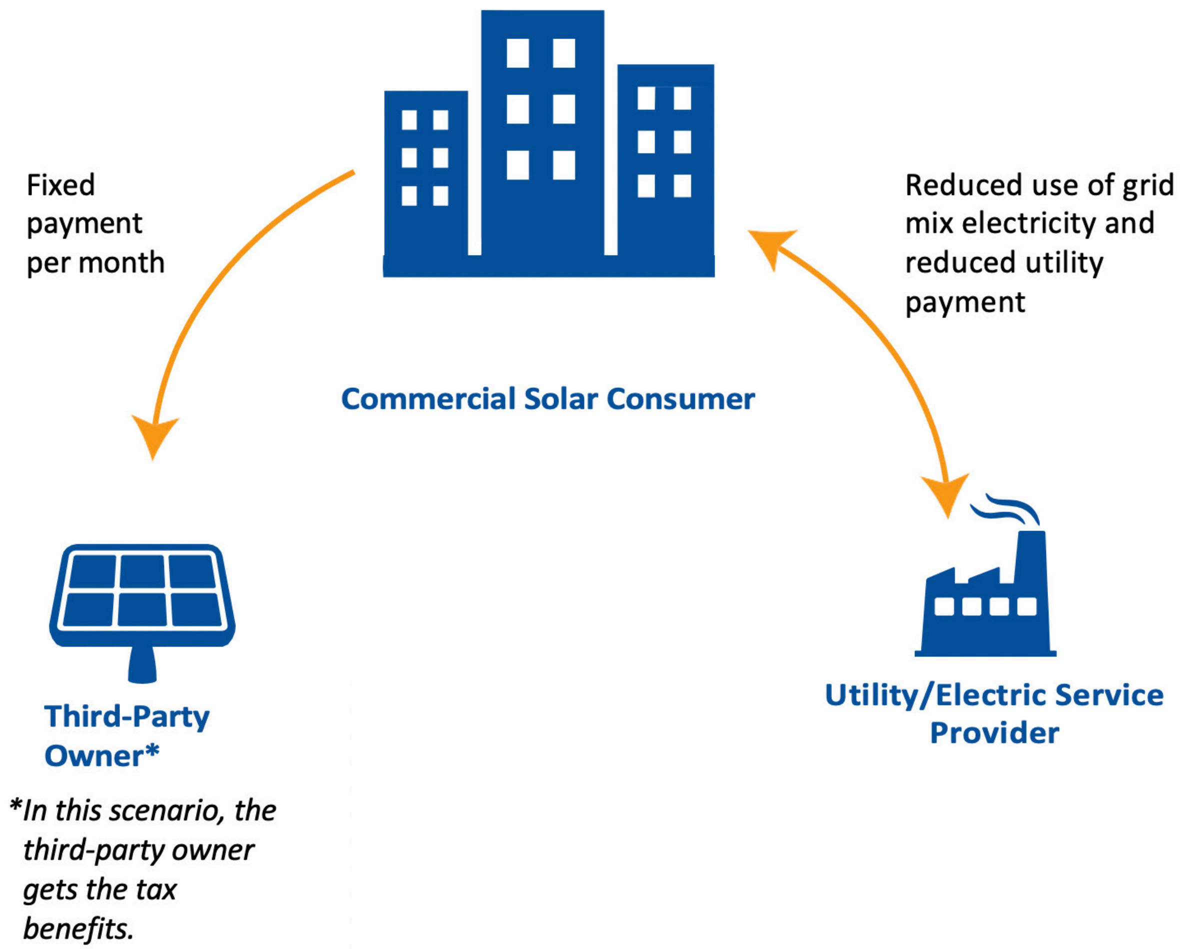


FIGURE 2 OVERVIEW OF ON-SITE PPA

MARKET INSIGHTS

- Third-party owned systems make up almost 70 percent of the nonresidential solar market.

CONTRACT RISKS

- Solar consumer only pays for production of system, thereby eliminating performance risk
- Solar consumer's exposure to electricity price fluctuations is directly reduced

TARGET CONSUMER & EXAMPLE

- Non-taxpaying organizations (e.g., nonprofit organizations, governments) that cannot directly use tax incentives
- Organizations with good credit ratings
- Organizations not wanting or not able to make a capital investment

CONTRACT/COST IMPLICATIONS

- Off-balance sheet
- Typically 15-20 year contracts
- Annual price escalators of around 2 percent

RECS

- RECs should be defined in the PPA and ownership should be assigned to one party. In higher-priced REC markets and in territories where utilities are offering incentives for RECs, commercial consumers typically sell the RECs to the utility or project developer in order to lower the cost of the transaction, but in doing so they relinquish environmental claims.

Off-Site Power Purchase Agreement (PPA): Financial PPA

DESCRIPTION

Under financial PPAs, which are a common arrangement for an off-site generation PPA, the consumer does not take delivery of the electricity. Rather, the consumer agrees to pay a fixed price per unit of electricity generated from the solar facility, and the electricity producer sells the power to the electric grid and is compensated at the market rate. If the market rate the electricity producer receives is different than the negotiated PPA settlement price per unit of electricity, the difference is paid for via a stipulation in the PPA contract referred to as a contract for differences. If the market power rate exceeds the fixed PPA price, then the electricity producer pays the consumer the difference; if the market power rate is less than the PPA price, the consumer pays the electricity producer the difference. This transaction typically occurs monthly. The consumer's on-site electricity consumption is not affected. See Figure 3 to the right.

Note: Typical term is 15 to 20 years.

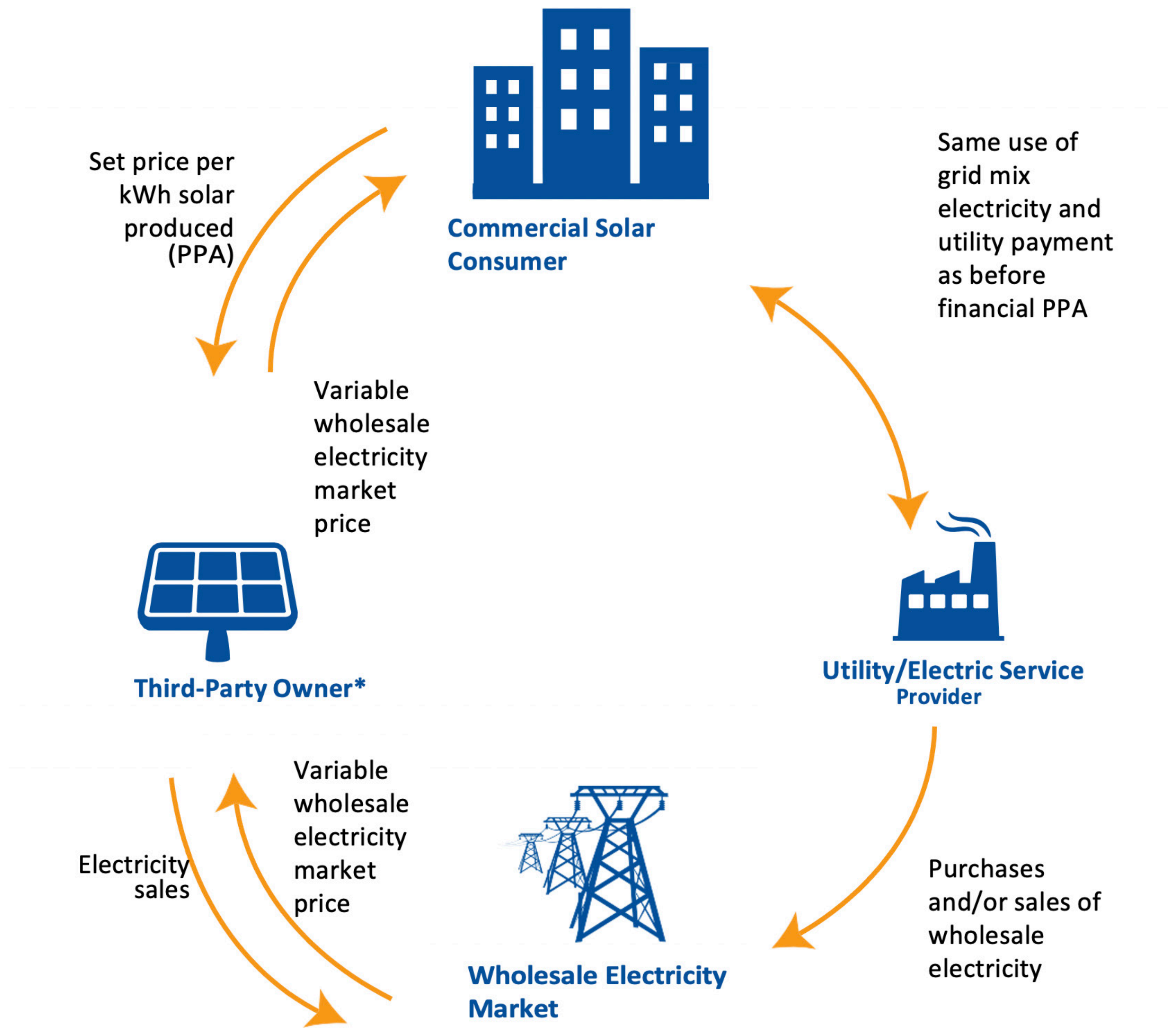


FIGURE 3 OVERVIEW OF OFF-SITE PPA

*IN THIS SCENARIO, THE THIRD-PARTY OWNER GETS THE TAX BENEFITS.

MARKET INSIGHTS

- Financial PPAs represent approximately 50 percent of the total off-site contracts (in terms of cumulative MW of renewable energy contracted) signed by corporate consumers (See Figure 4 below)

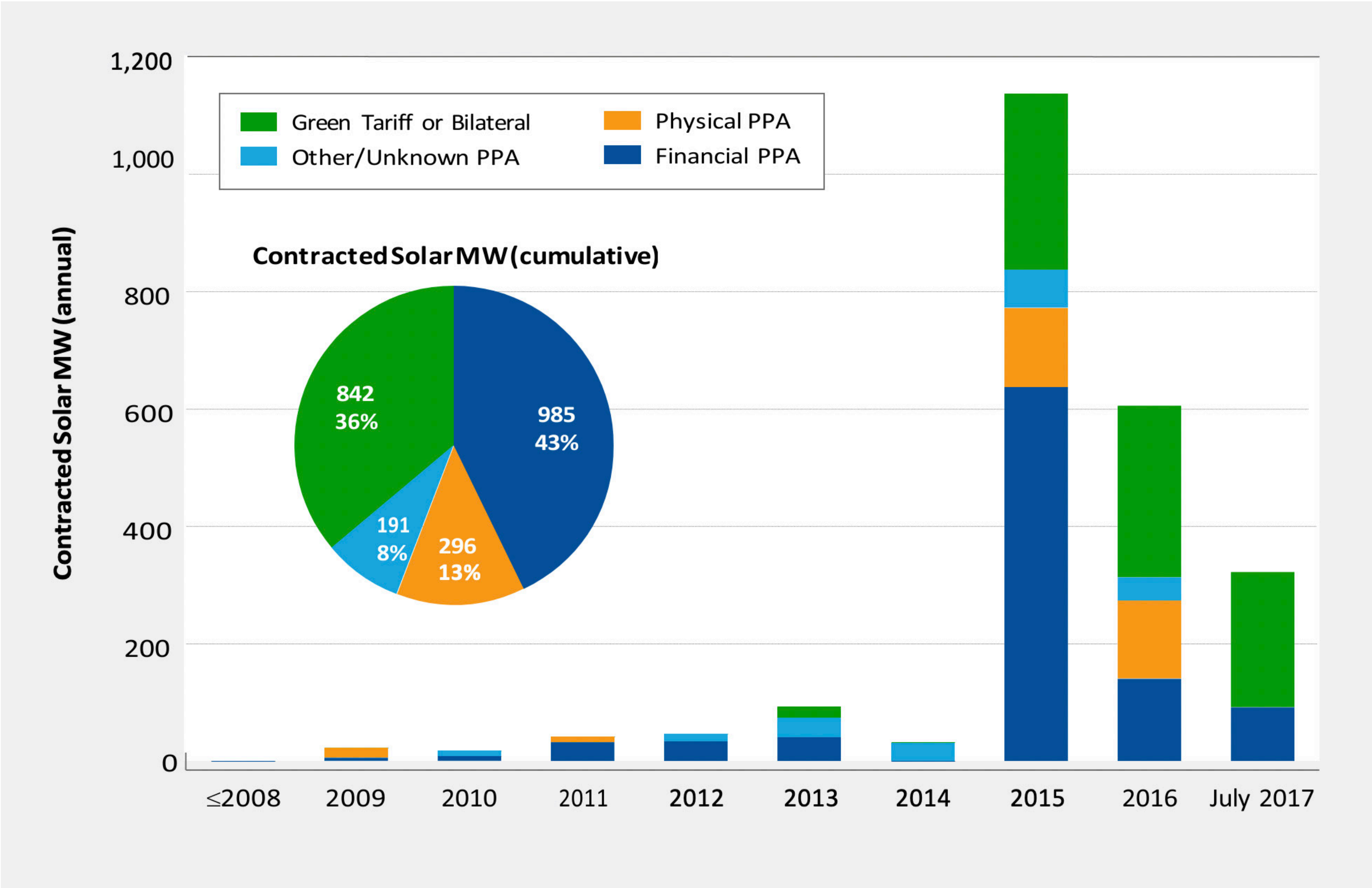


FIGURE 4. CONTRACTED SOLAR MW

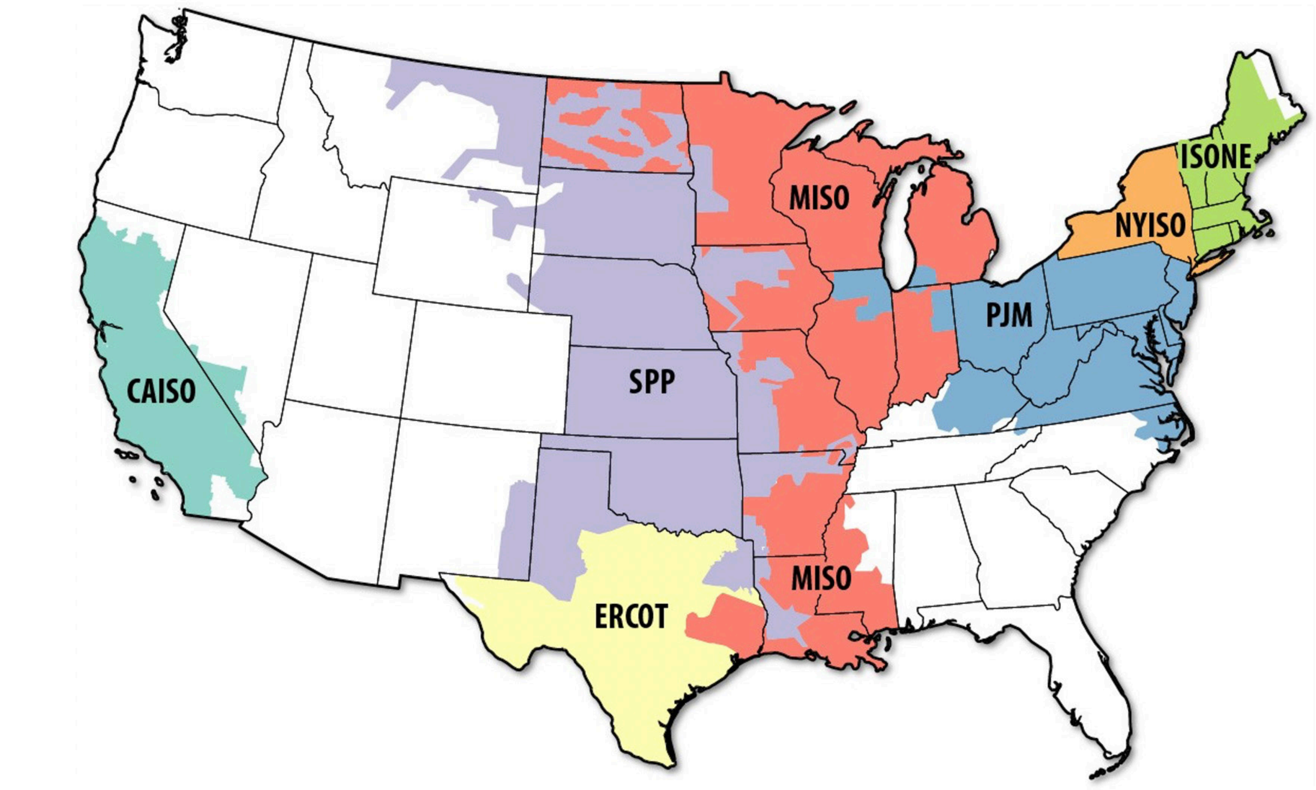


FIGURE 5 MAP OF REGIONAL TRANSMISSION ORGANIZATIONS AND INDEPENDENT SYSTEM OPERATORS

CONTRACT RISKS

- The consumer will assume locational basis risk if the project is being settled at the busbar (point of interconnection) rather than the hub (the average of multiple busbars).
- Setting a price at the busbar may offer greater opportunity for the consumer to earn greater returns than setting a price at the hub because of the minimized transmission congestion costs, but it comes with more risk.

TARGET CONSUMER & EXAMPLE

- Organizations with finance and legal expertise, or interest in working with partners to understand complex transactions
- Organizations with limited space available for on-site generation
- Organizations with large electrical loads
- Organizations with good credit ratings
- Organizations not wanting or not able to make a capital investment

CONTRACT/COST IMPLICATIONS

- Off-balance sheet
- Typically 10-15 year contracts
- May have annual escalator payment to electricity producer

RECS

- RECs should be defined in the financial PPA and ownership should be assigned to one party. In many cases, financial PPAs are being signed where the commercial solar consumer is keeping the RECs to make a renewable energy claim, however, there are cases where the consumer sells the RECs or engages in a REC swap.

Lease

DESCRIPTION

Solar leases also fall under the TPO model and mirror other common lease arrangements, such as an automobile lease. Generally, a solar consumer leases a solar PV system from a third party for a monthly rate over a pre-determined contract period (typically 10-20 years) (See figure 6 below). The defining characteristic of a solar lease that distinguishes it from a PPA is the fixed monthly payment—consumers are making fixed payments every month rather than paying for the power generated. Because monthly costs are fixed, leases typically include production guarantees. Lease terms and prices vary depending on a number of factors, including physical location, PV system size, roof specifications (for rooftop installations), and the consumer's credit score, among others. Depending on how the lease is structured, consumers may also have the option of pre-paying a portion of the lease to reduce monthly payments.

Note: Typical term is 15 to 20 years.

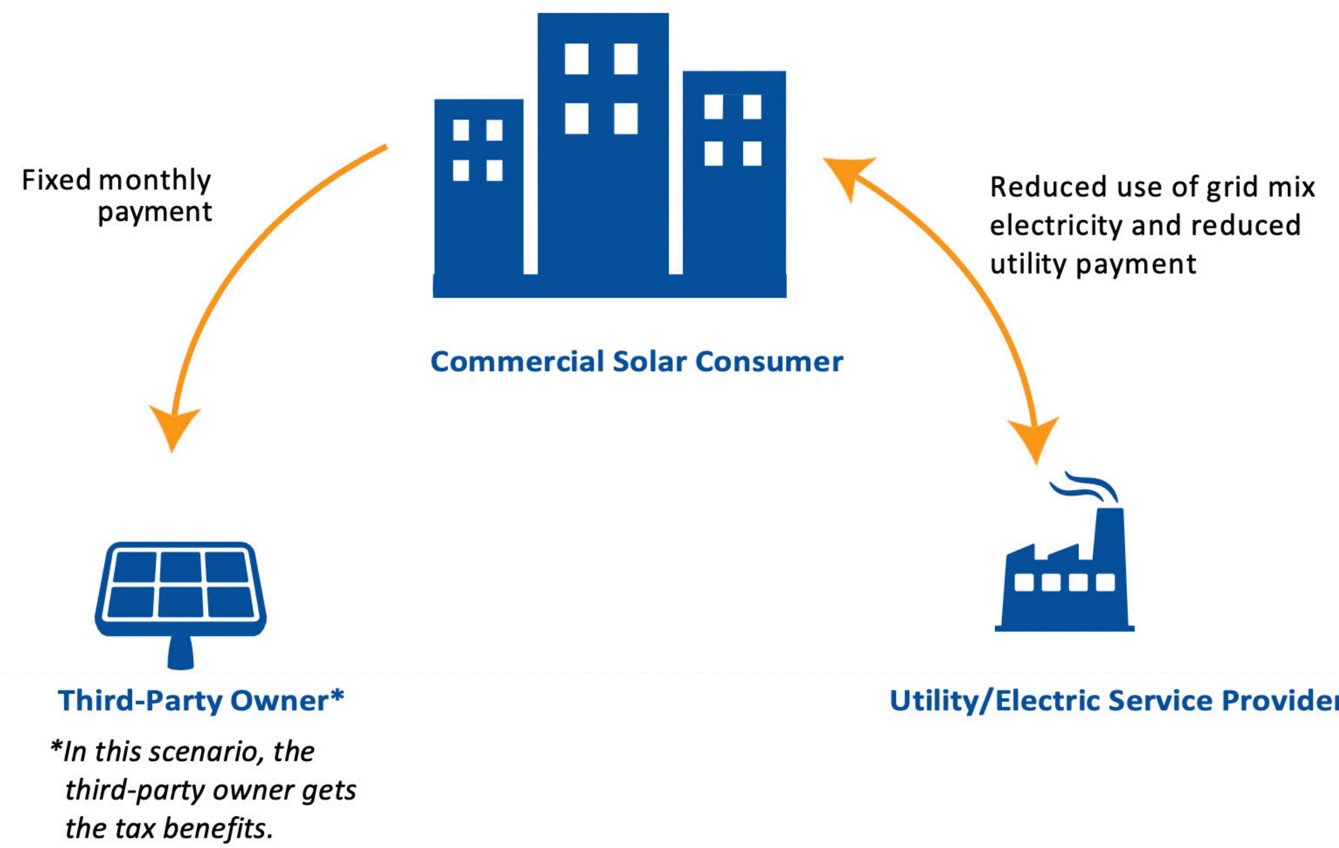


FIGURE 6 OVERVIEW OF LEASE

MARKET INSIGHTS

- Third-party owned systems, including commercial leases, make up approximately70 percent of the nonresidential solar market.

POLICY DRIVERS

- The TPO model of solar leases allows tax-exempt organizations to partner with other entities to monetize tax benefits but is currently not available in all states.

CONTRACT RISKS

- The solar lessee assumes performance risk, which is typically mitigated by including a performance guarantee.

TARGET CONSUMER & EXAMPLE

- Non-taxpaying organizations (e.g., nonprofit organizations, governments) that cannot directly take advantage of tax incentives
- Organizations already using equipment leases
- Organizations with good credit ratings
- Organizations not wanting or not able to make a capital investment or that take a long time to make capital budgeting decisions

CONTRACT/COST IMPLICATIONS

- Typically includes an annual escalator
- In order for a solar lease to qualify for the federal investment tax credit (ITC), both parties (e.g., the third-party owner and the lessee) must be taxpaying entities. Non-taxpaying entities may also enter into solar leases with a third-party owner but risk losing the ITC in that scenario. Taxpaying entities can use operating and capital leases to monetize tax credits directly.
  - An operating lease ("tax lease") is an off-balance sheet transaction which, for accounting purposes, closely resembles a traditional lease or rental. Under an operating lease, the lessor remains the owner of the asset and takes the tax credit. Operating leases are more common and are structured assuming the lessee will not necessarily assume direct ownership of the system in the future.
  - Conversely, a capital lease is an on-balance-sheet transaction that shares many characteristics of a rent-to- own or direct ownership arrangement and assumes the lessee will eventually own the system outright; the lessee is the owner for tax purposes.

RECS

- RECs should be defined, in the lease and ownership should be assigned to one party. In higher-priced REC markets and in territories where utilities are offering incentives for RECs, commercial consumers typically sell the RECs to the utility or project developer in order to lower the cost of the transaction, but in doing so they relinquish environmental claims.

Loan

DESCRIPTION

Solar-specific loans provide a pathway to direct ownership, which offers the benefit of free or low-cost electricity after the loan is paid off, and spreads the system cost out over a number of years (usually 5-15, depending on the loan terms), reducing upfront costs (Figure B-8). Solar loans are an ownership model—the consumer is paying for the PV panels, not for the electricity production, thus the risk of poor performance falls to the commercial solar consumer. As these loan packages have evolved, some now also include service packages, often covering the same O&M coverage historically associated with TPO models.

Note: Typical term is 15 to 20 years.

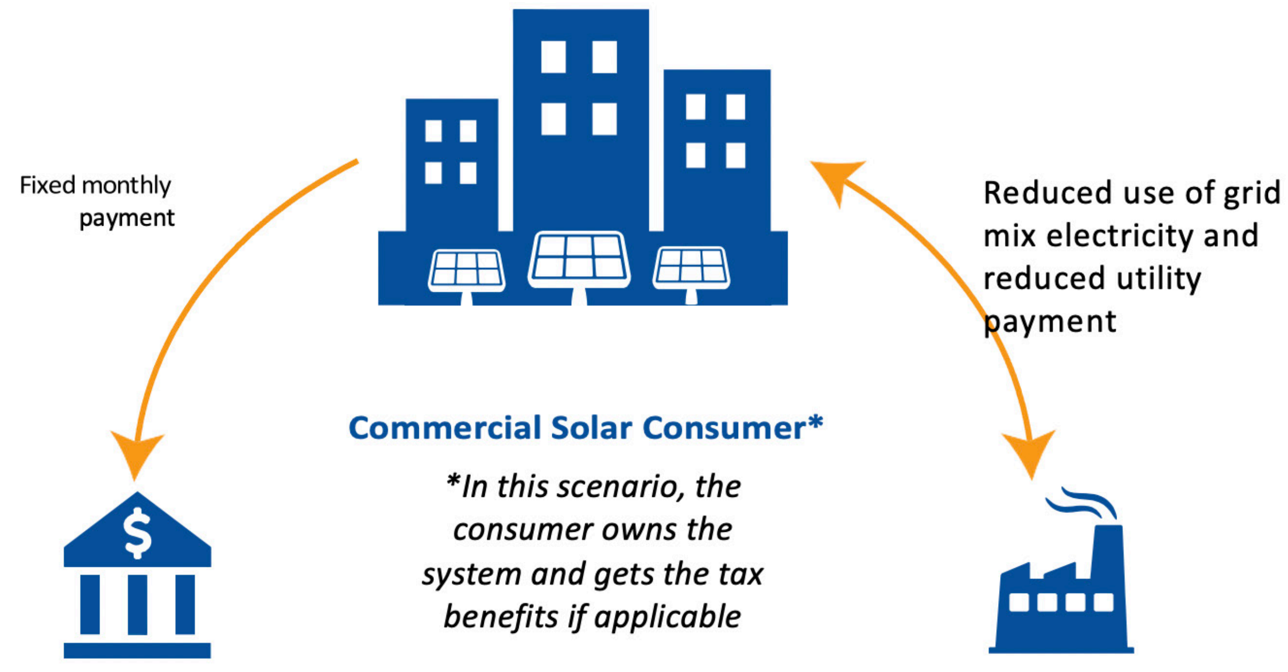


FIGURE 7 - OVERVIEW OF LOAN

MARKET INSIGHTS

- Owned systems (including those where a consumer took out a loan to finance the system) makeup approximately 2 percent of the nonresidential solar market.
- Solar-specific loan offerings for which the underwriting loan terms, lender security, interest, and other programmatic aspects are designed for financing solar installations exclusively—started emerging as a prominent financing tool in late 2013, partially supplanting the use of more standardized home or commercial loans to finance solar.

POLICY DRIVERS

- Loans are a way for solar consumers to finance and directly own a PV system. Loans are used in states that have not authorized third-party ownership or where the status of third-party ownership is unclear.

CONTRACT RISKS

- Purchaser assumes performance risk, including risk of delayed interconnection

TARGET CONSUMER & EXAMPLE

- Smaller organizations, which PPA providers may not serve or require an interest rate of the organization that is unfeasible, may be able to get a loan through their banks or credit unions.
- Organizations not wanting or not able to make a capital investment
- Organizations able to take on operations and maintenance responsibilities or to contract for those services
- Solar loans are used by small commercial consumers; the products are similar to those used by residential households installing solar. Many large solar developers offer solar loan products in addition to PPA or lease options.

CONTRACT/COST IMPLICATIONS

- Interest rates vary depending on factors like the borrower's credit score, length of the loan, and the loan provider, but generally fall in the 2.99 to 6 percent range.
- On-balance sheet; may limit organization's borrowing potential

RECS

- Banks and financial institutions may examine potential revenue from selling RECs; commercial solar consumers may monetize their RECs to make the loan terms more favorable, but they relinquish environmental claims if they do so.

Cash Purchase

FINANCING OPTION DESCRIPTION

Cash purchases are the most straightforward solar financing option: the solar consumer directly purchases, owns and is responsible for maintaining the solar installation (See Figure 8 below). Although PV system costs have fallen in recent years, purchasing a solar PV system outright requires significant upfront capital outlay, making this option unrealistic for many consumers, but appealing to others. Cash purchases also represent the most direct procurement type when selling or transferring an asset because it is already paid off. Owners typically assume all O&M costs and related expenses, but also maintain control over a long-term, high-quality asset. Because cash purchase is a direct sale, there are fewer entities involved in the transaction than there are with loan or TPO options and the solar consumer does not incur financing costs (e.g., interest on a loan or the cost of capital). This generally results in a higher rate of return over the lifetime of the PV system, although consumers typically will not see immediate economic benefits under a cash purchase—depending on the configuration, commercial solar consumers may see a negative cash flow for the first 5-11 years of system ownership.

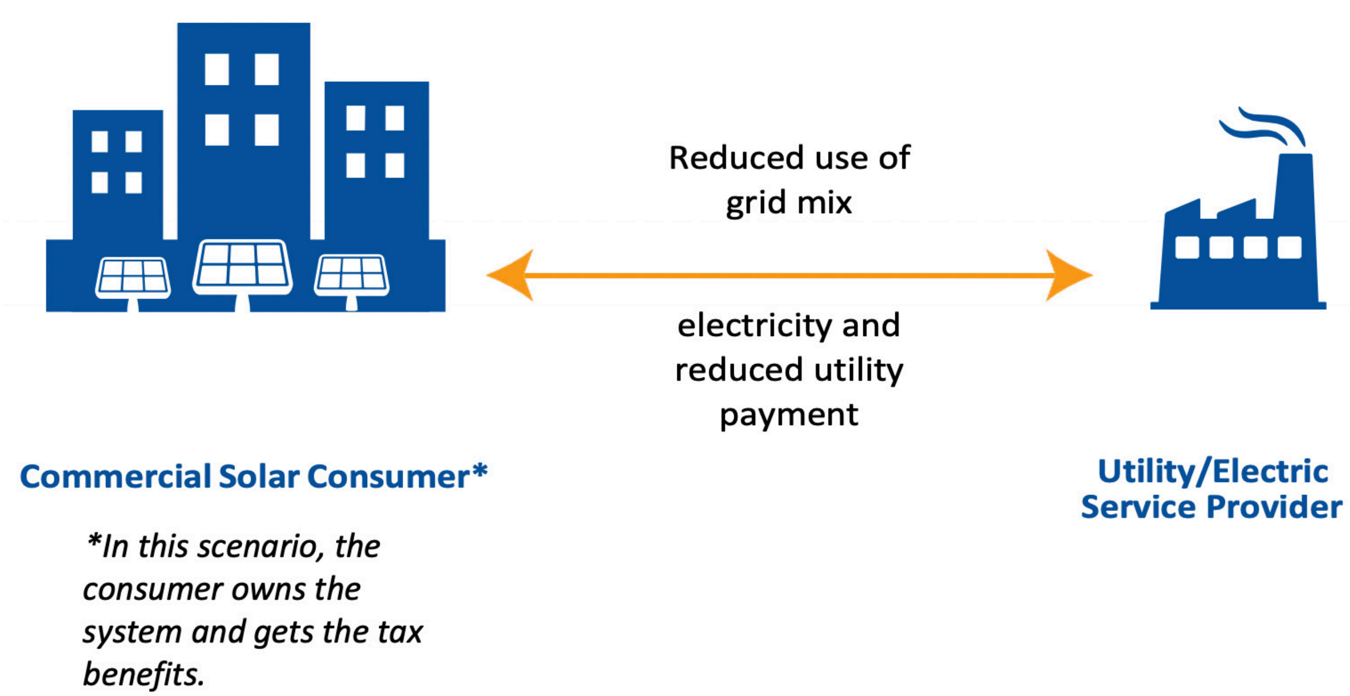


FIGURE - OVERVIEW OF CASH PURCHASE

MARKET INSIGHTS

- Consumer-owned systems account for 25 percent of the commercial solar market.

POLICY DRIVERS

- Some institutions (colleges and universities, for example) may be able to utilize internal funding, bond financing including donor funding, as potential revenue streams for cash purchases. However, tax-exempt entities may not be able to take advantage of tax benefit incentives if opting for direct financing, which could impact the economic viability of solar projects.

CONTRACT RISKS

- Purchaser assumes performance risk, including risk of delayed interconnection

TARGET CONSUMER & EXAMPLE

- Organizations with available capital
- Organizations with access to grants, bond financing or donor funding (e.g., universities, nonprofit organizations)
- Organizations with tax liability

CONTRACT/COST IMPLICATIONS

- On-balance sheet

RECS

- Organizations may examine potential revenue from selling RECs; they may monetize their RECs to ensure shorter payback periods, but they relinquish environmental claims if they do so.

Other Financing and Solar Purchasing Options

There are several additional solar financing or purchasing options that may be available in certain markets, some of which can be used in conjunction with the mechanisms presented in the previous section.

BOND FINANCING.

- Public institutions, governments and corporations have the option of issuing bonds to raise revenue to finance solar purchases. Green bonds are an emerging subset of bonds specifically dedicated to financing environment-related projects, such as energy efficiency, renewable energy, water conservation and similar measures.

DIRECT INVESTMENTS.

- In limited cases, direct investments such as bond funding, donor funding, endowments or internal capital funds may be available to facilitate solar cash purchases, particularly for larger institutions. Dedicated sustainability or renewable energy funds, such as those collected through student fees at some colleges and universities, represent another potential funding stream.

ENERGY PERFORMANCE CONTRACTING.

- Energy performance contracting mechanisms are structured to allow government agencies and commercial institutions to pay for renewable energy upgrades over time using money saved on energy bills resulting from energy-saving measures. Energy performance contracting structures are used extensively by federal agencies and are also open to the private and public sector. They include ESPCs and UESCs. Under both types of agreements, the company providing the energy efficiency or renewable energy service upgrades—an energy service company (ESCO) under ESPCs or the utility in the case of UESCs—guarantees reduced energy expenditures resulting from energy-saving projects. The ESCO or utility typically conducts a building energy audit, identifying specific energy conservation measures. Once the ESCO or utility and the building owner agree on the course of action, the ESCO or utility arranges project financing and makes the upgrades. The building owner then repays the ESCO or utility using its normal operating budget and the freed-up money from reduced energy costs stemming from the energy conservation measures. ESPCs and UESCs are discussed further in Appendix A, Green Power Considerations for Federal Agencies.46

GREEN TARIFFS.

- Green tariff programs are an emerging product among utilities that allow consumers (usually larger commercial and industrial entities) to purchase renewable power directly from the utility, typically under a long-term contract. Consumers opting into these programs may purchase electricity at the green tariff rate, which typically replaces the standard electricity rate and may result in cost savings to the consumer over the contract term. Typically, the utility's green tariff will specify key terms and conditions, then consumers will sign an individual contract with the utility specifying the costs. As of April 2017, five utilities had a subscribed green tariff, with 900 MW of renewable capacity committed.

Conclusion

The solar PV financing landscape continues to evolve and expand, with new products and configurations affording solar consumers a variety of potential options. Specific financing mechanisms offer different combinations of advantages and challenges. A consumer's tax profile, location, and access to upfront capital, among other factors, will impact the viability and relative attractiveness of the different approaches. Individual solar consumers will need to carefully consider solar financing options within their specific contexts. Table summarizes the overarching advantages and challenges associated with the different financing mechanisms and identifies the types of end users that may benefit most from the respective financing options.

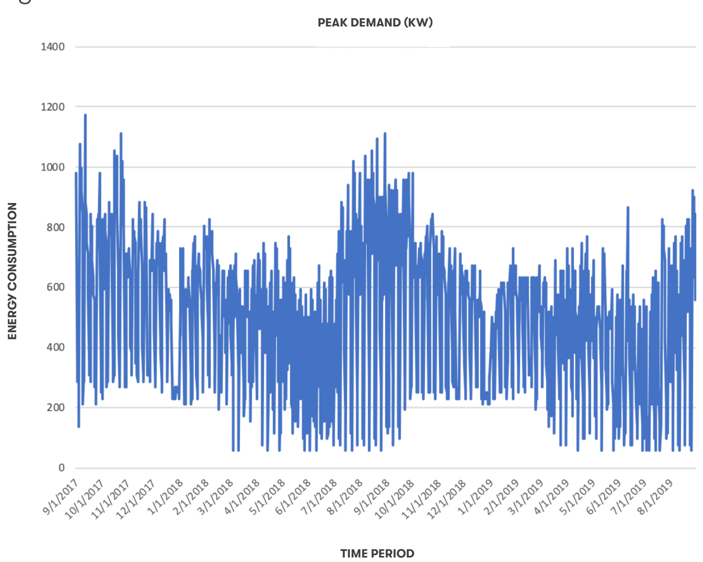
Table 2 - Summary of Solar Financing Mechanisms

Financing Mechanism	Existing Design	Challenges	Which end users benefit most?
On-site, Physical PPAs	• Little or no upfront capital investment • Tax-exempt consumers can take advantage of tax benefits, including MACRS • Consumer only pays for production • Reduces consumer exposure to electricity price fluctuations • O&M responsibilities covered by TPO • Utility bills reduced by amount the PPA covers • Off-balance sheet	• Requires long-term contract for power • Consumer must have good credit • Potential transfer issues at property sale • RECs must be assigned to one party; selling RECs may lower transaction costs, but consumer then cannot claim environmental benefits	• Consumers with little or no tax appetite • Consumers with limited access or interest in spending upfront capital • Organizations with good credit
Off-site, Financial PPAs	• Same advantages as on-site PPAs, plus: • Option for consumers where physical PPAs are not allowed • Often issued for shorter contract terms (10 years) than on-site PPAs	• Complex financial arrangement; consumers may experience steep learning curve in executing contracts • Consumer continues to pay exist- ing electricity bill; may not provide perfect hedge against rising utility rates • Electricity producer must be located in restructured markets • Consumer must have good credit • Dodd-Frank Wall Street Reform and Consumer Protection Act may have recordkeeping, reporting and other implications • RECs must be assigned to one party; selling RECs may lower transaction costs, but consumer then cannot claim environmental benefits	• Consumers in restructured electricity markets • Consumers with distributed loads • Consumers with interest and ability to learn about new financial products • Large electricity users • Consumers with limited space available for on-site solar development • Consumers in restructured electricity markets • Consumers with distributed loads • Consumers with interest and ability to learn about new financial products • Large electricity users • Consumers with limited space available for on-site solar development • Organizations with good credit rating • Consumers with little or no tax appetite • Consumers with limited access to or interest in spending upfront capital
Lease	• Little or no upfront capital investment • Can work with existing equipment lease financial partners • Fixed payments monthly	• Lease may impact balance sheet, depending on the structure • Consumer assumes performance risk • RECs must be assigned to one party; selling RECs may lower transaction costs, but the consumer then cannot claim environmental benefit	• Non-taxpaying organizations (e.g. nonprofit organizations, governments) • Organizations already using equipment leases • Organizations with good credit ratings • Large corporations with aversion to debt • Organizations not wanting or not able to make a capital investment or that take a long time to make capital budgeting decisions
Solar Loan	• Reduced upfront costs • Consumer enjoys benefits of ownership after loan is paid off • Typically lower cost to consumer than TPO models	• Consumer must have good credit • Consumer assumes risk of nonproduction • On-balance sheet	• Organizations not wanting or not able to make a capital investment • Organizations able to take on operations and maintenance responsibilities, or contract for those services
Cash Purchase	• Owner avoids financing charges and interest payments • May expedite the solar installation process • May expedite property sale or transfer	• Competing uses for organizations' funds • No accelerated depreciation benefits (residential consumers) • Tax-exempt entities may not be able to monetize tax benefits • Owner responsible for O&M (or contract out for those services)	• Consumers with available upfront capital • Organizations with access to grants, bond financing, or donor funding (e.g., universities, nonprofit organizations) • Organizations with tax liability

RENEWABLE ENERGY ANALYSIS, INTEGRATION AND RECOMMENDATIONS

An analysis of the various in site generation sources revealed that PV system would be the most economical and the right renewable energy source to achieve net zero energy status.

An analysis of the existing and future electrical demand at the campus was undertaken to determine the capacity and viability of providing photovoltaic systems at the campus to achieve net zero energy status. A graph showing existing demand of the campus in kWh and kW is provided in figures below.



The campus already has a solar farm installed on the north east side of the campus. A total of six areas on the north east side are populated with ground mount concentrator PV system and integrated with the campus 4160V system. A total of 1.21MW and 1,561,545 kWh is currently being generated by the existing solar farm. Discussions with campus and an evaluation report undertaken in 2019 reveal that almost 15-20% of the concentrator PV system do not function as designed and intended and are awaiting parts to enable them track the sun and optimize their production.

A review of the campus buildings rooftops, ground areas around the campus and the parking lots and discussions had with the District and campus personnel revealed that the most optimum location for the campus to provide PV systems in phase 1 would be at the following areas as depicted in the proposed solar system exhibit. Consideration was given to aesthetics, costs, existing roof condition, effective utilization of the areas to maximize production and its proximity to the campus infrastructure.

Area 2, 4, & 6 (Solar Farm area on the north east side of the campus)

The replacement of the existing solar farm Area 4 with ground mount stationary PV systems and the indicated parking lots will produce approximately 95% of the overall source energy utilized by the campus annually in kBtus

As the rest of the concentrator PV solar farm areas experience failures and the overall production degrades, we recommend the same be replaced in phases to not only effectively utilize the current area but also maximize overall kW and kWh production to achieve net zero energy status. A total of 1154 kW can be replaced with 2,120 kW thus not only increasing the overall efficiency of utilization of the current areas but also increasing overall kW and kWh production. The replacement of the existing solar farm areas with ground mount stationary PV systems will produce approximately 95% of the overall source energy utilized by the campus annually in kBtus. The campus can evaluate the second phase comprising of Parking lots, and new building rooftops to enhance PV production in the future as the demand increases and offset the remaining energy use at the campus.

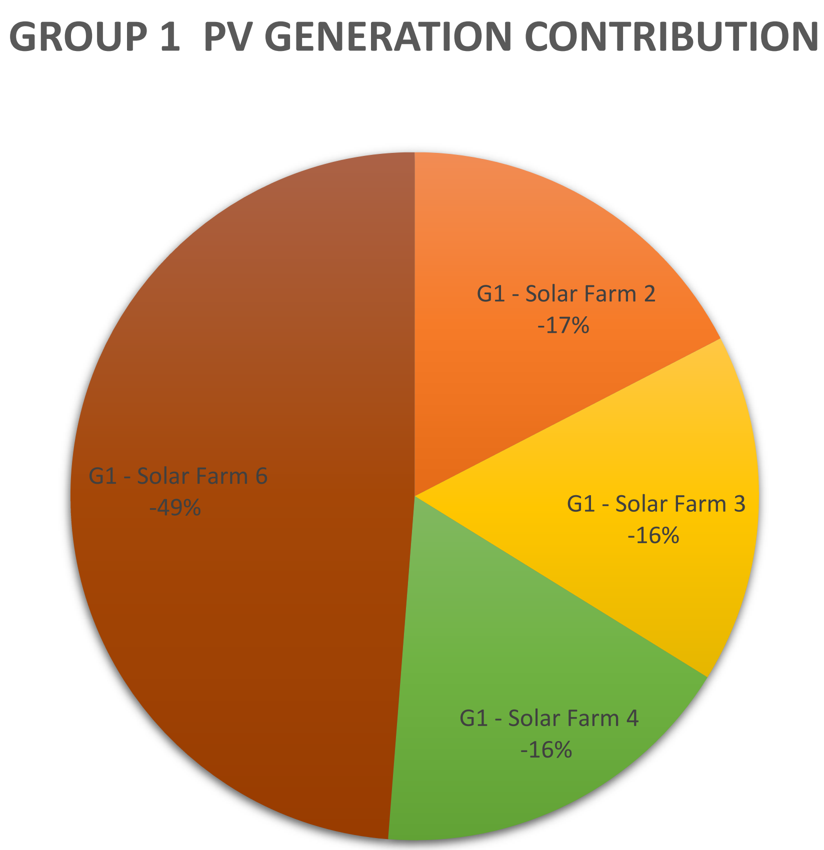
A review and analysis of the battery storage system integrated with proposed solar system was also conducted. Considering the electric utilities migrating to a 4-9pm peak Time-of-Use rates, Campus shall plan to add battery energy storage system to store the excess on site generation during daytime and utilize the stored energy to offset the demand during the 4-9pm period. Based on the existing demand and PV systems installed under phase 1, 740kW/2960kWh Battery Energy Storage System shall be integrated into the campus distribution system. The availability of enhanced self generation incentives due to location of the campus (Equity Incentives), the paybacks are really attractive to combine the solar system with the battery storage to not only offset the overall peak demand charges but also offset overall peak energy consumption charges and save overall operational costs. Payback analysis and associated costs for integrating the solar system with battery storage is included at the end of the section.

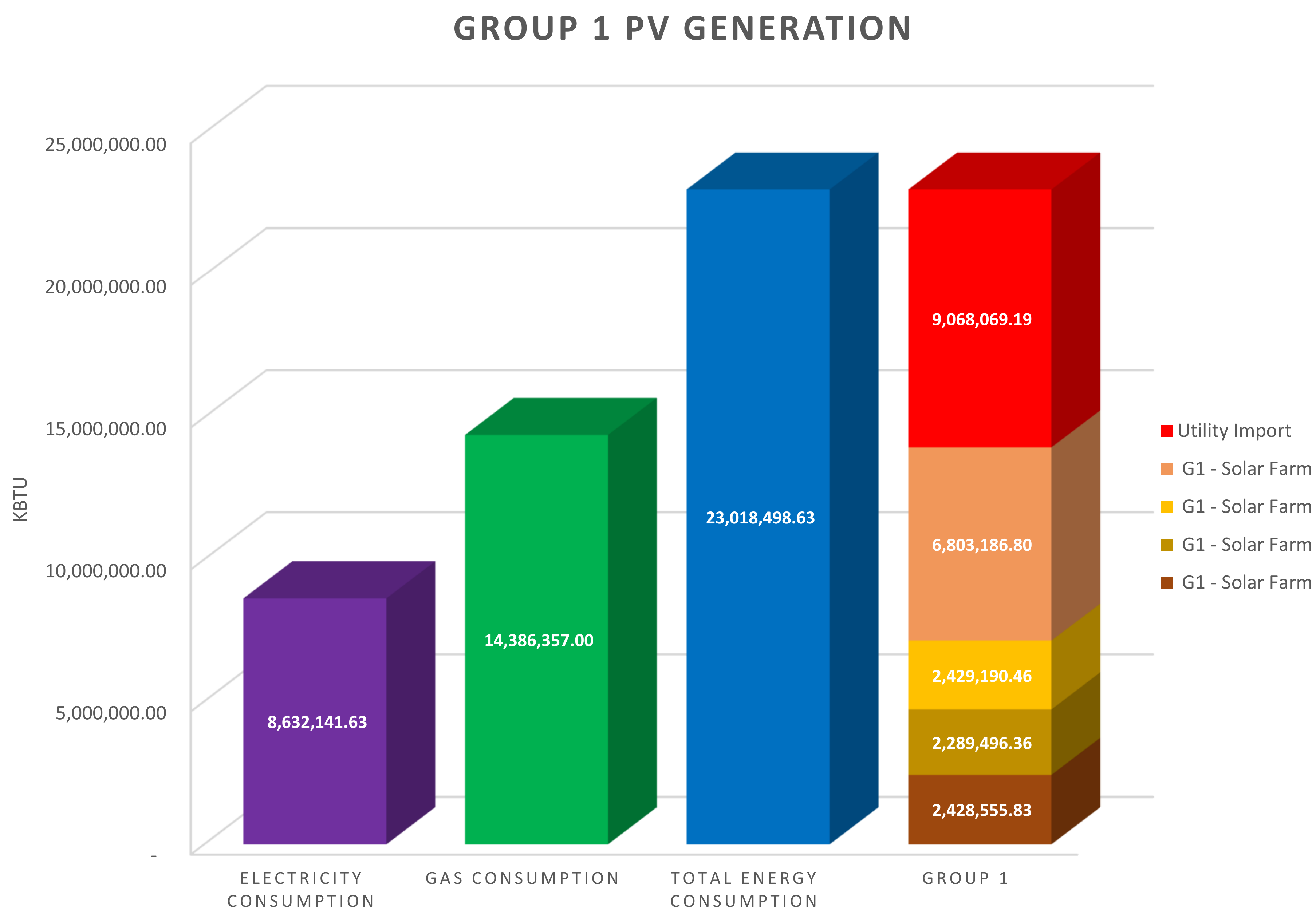
A financial analysis of the various delivery methods for deploying renewable energy sources was also undertaken and outright purchase was found to be the most optimum and economical to deploy these systems at the campus. So we recommend that the campus utilize their own available funds to deploy the recommended systems.

The campus can also evaluate the provision of solar charging stations to not only demonstrate their commitment towards green power and towards fulfilling the campus goal of reducing carbon emissions but also providing a clean and renewable source of energy for charging the multitude of mobile devices typically found on campus while offering much needed shade.

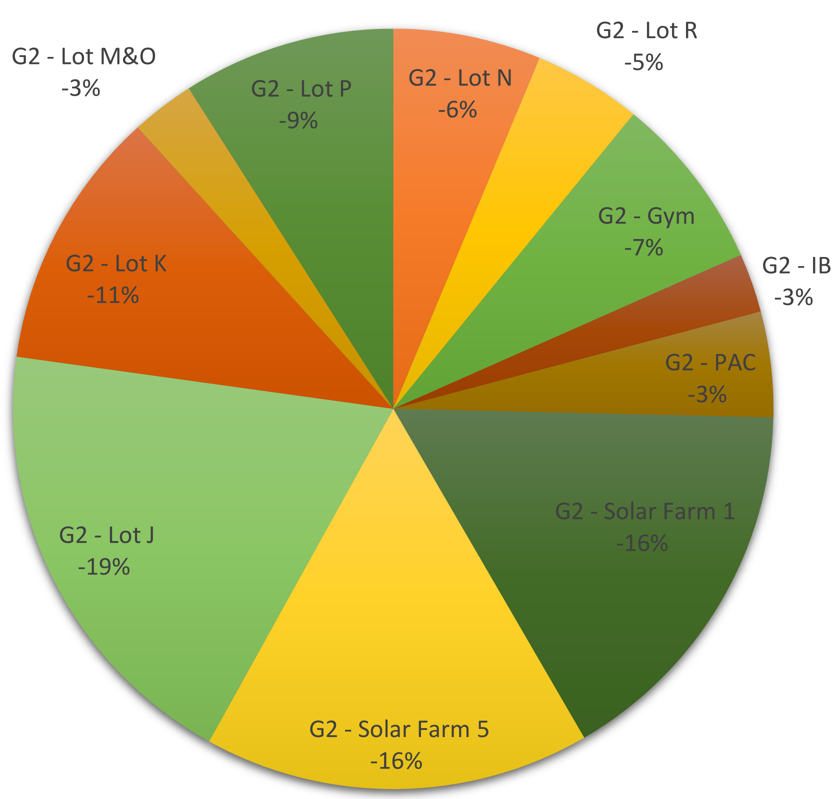
The provision of the subject PV systems will limit dependence of the campus on non-renewable power sources, reduce greenhouse gas emissions and eliminate the impact of fluctuation of energy prices in the future.

The overall PV system installations comprising of solar farm areas, indicated parking lots and new building rooftops would offset 100% of the current energy consumption in kBtu's comprising of both electric and gas consumption and reduce campus carbon emissions by 1,695 metric tons per year. Graphs showing current energy consumption in KBtu's and the offset provided by the provision of PV systems in phase 1 and 2 at the campus is provided below for reference.

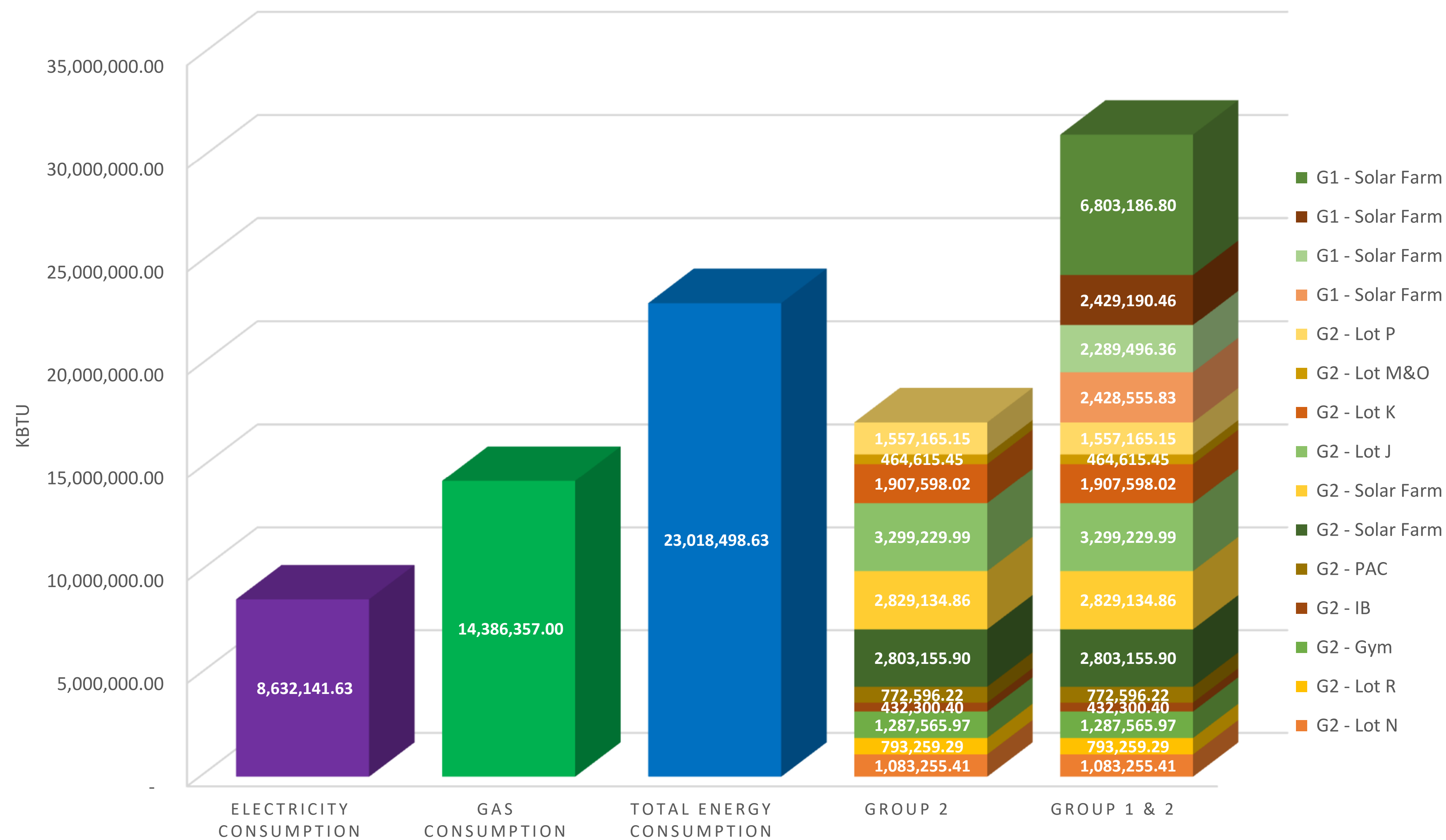




GROUP 2 PV GENERATION CONTRIBUTION



GROUP 2 PV GENERATION



Based on our above projected costs/watt and review of campus available areas, below are our proposed locations, costs and paybacks for proposed PV systems at the campus.

Costs, Payback and Proposed Locations

Area	PV Size [kW]	Mounting Type	Energy Generated [kWh]	Energy Generation [kBtu]	Campus Demand %	GHG Offset [lb]	System Cost ($)*	Payback Period	Electric Bill Savings	TIRR %
Group 1	2,117.8	MULTIPLE	4,056,468	13,840,669	100%	632,253	$4,452,000	10.2	$14,356,322	31%
Group 1 + 740kW/2960kWh Ba	2,117.8	MULTIPLE	4,056,468	13,840,669	100%	632,253	$7,550,763	7.8	$20,370,363	20%
Solar Farm Area 2	366.6	GROUND MOUNT	711,770	2,428,559	30%	320,297	$1,308,480	18.6	$2,787,590	4%
Solar Farm Area 3	355.3	GROUND MOUNT	671,014	2,289,500	29%	301,956	$1,299,456	18.8	$2,137,228	3%
Solar Farm Area 4	366.6	GROUND MOUNT	711,956	2,429,194	27%	320,380	$1,140,000	17.7	$2,007,948	4%
Solar Farm Area 6	1,070.0	GROUND MOUNT	1,993,901	6,803,190	75%	360,101	$3,429,120	20.7	$4,969,215	2%

Area	PV Size [kW]	Mounting Type	Energy Generated [kWh]	Energy Generation [kBtu]	Campus Demand %	GHG Offset [lb]	System Cost ($)*	Payback Period	Electric Bill Savings	TIRR %
Lot N	188.9	CARPORT	317,484	1,083,255	12%	142,868	$604,608	20.2	$1,175,285	4%
Lot R	124.1	CARPORT	232,490	793,256	9%	104,621	$397,056	18.5	$862,474	5%
Gym	237.8	ROOFTOP	377,364	1,287,566	14%	169,814	$761,024	21.3	$1,398,196	3%
IB	67.2	ROOFTOP	126,701	432,304	5%	57,015	$215,072	17.2	$503,940	5%
PAC	126.0	ROOFTOP	226,436	772,600	8%	101,896	$403,072	19.3	$829,759	4%
Lot J	614.8	CARPORT	1,142,635	3,898,671	42%	514,186	$2,067,232	20.5	$3,850,562	3%
Lot K	391.04	CARPORT	559,086	1,907,601	21%	251,589	$1,251,328	23.1	$2,058,311	2%
Lot M&O	74.26	CARPORT	136,170	464,612	5%	61,277	$237,632	18	$524,307	5%
Lot P	243.93	CARPORT	456,379	1,557,165	17%	205,371	$780,576	18.8	$1,658,975	4%
Solar Farm Area 1	423.0	GROUND MOUNT	821,556	2,803,149	30%	369,700	$1,353,600	18.7	$2,855,770	4%
Solar Farm Area 5	428.6	GROUND MOUNT	829,171	2,829,131	31%	373,127	$1,371,648	18.8	$2,878,532	4%

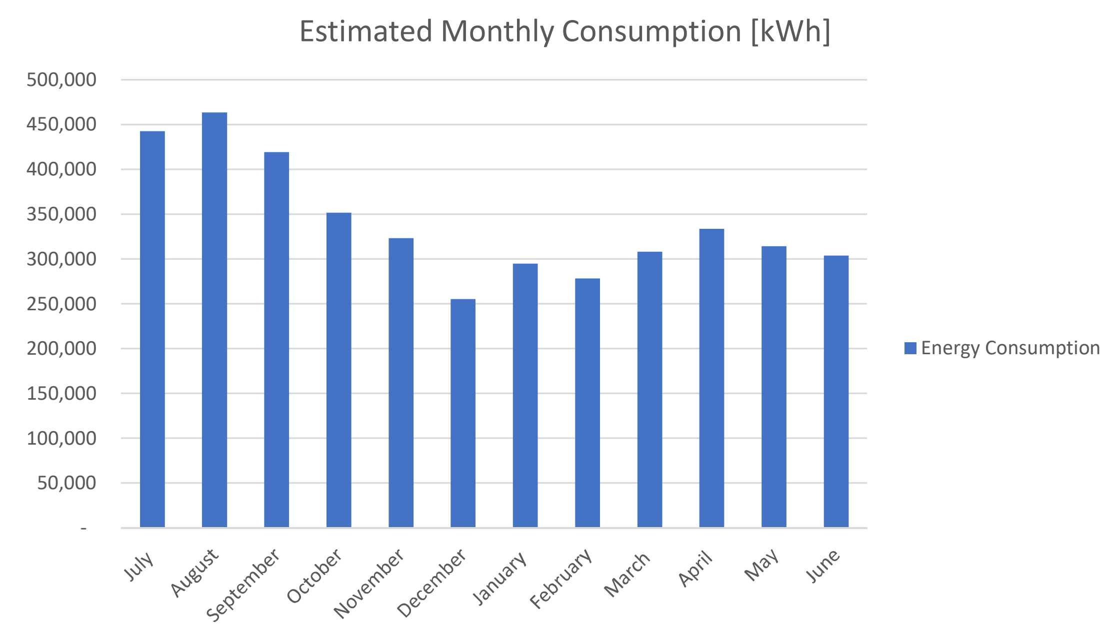
* Note: Cost includes PV panel, Balance of System (BOS), and cost of all structures

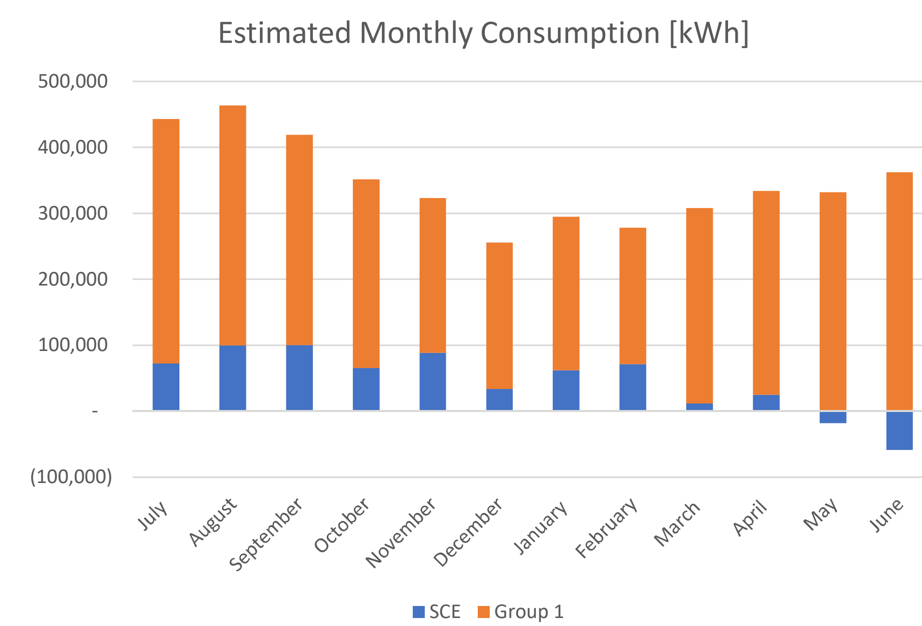
Considering the electric utilities migrating to a 4-9pm peak Time-of-Use rates, Campus shall plan to add battery energy storage system to store the excess on site generation during daytime and utilize the stored energy to offset the demand during the 4-9pm period. Based on the existing demand and PV systems installed under phase 1, 740kW/2960kWh Battery Energy Storage System shall be integrated into the campus distribution system.

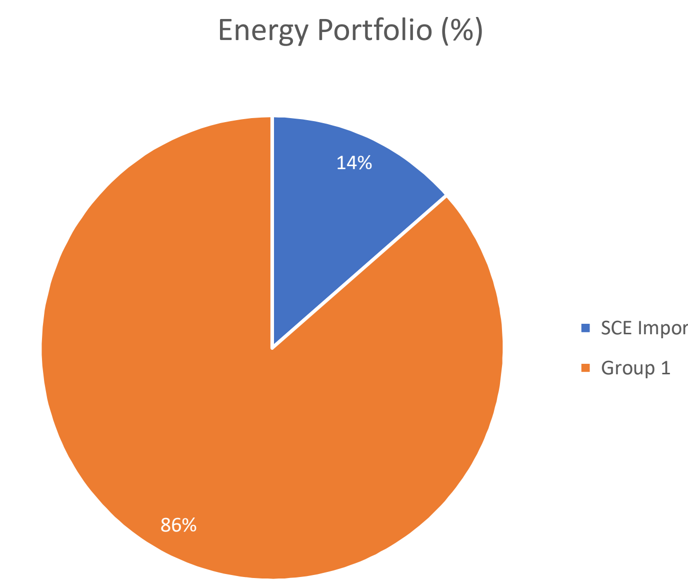
Exhibit showing Phase 1 and 2 areas along with enlarged plans of each area is included at the end of this section. Associated paybacks for each of the areas grouped together is provided in Appendix.

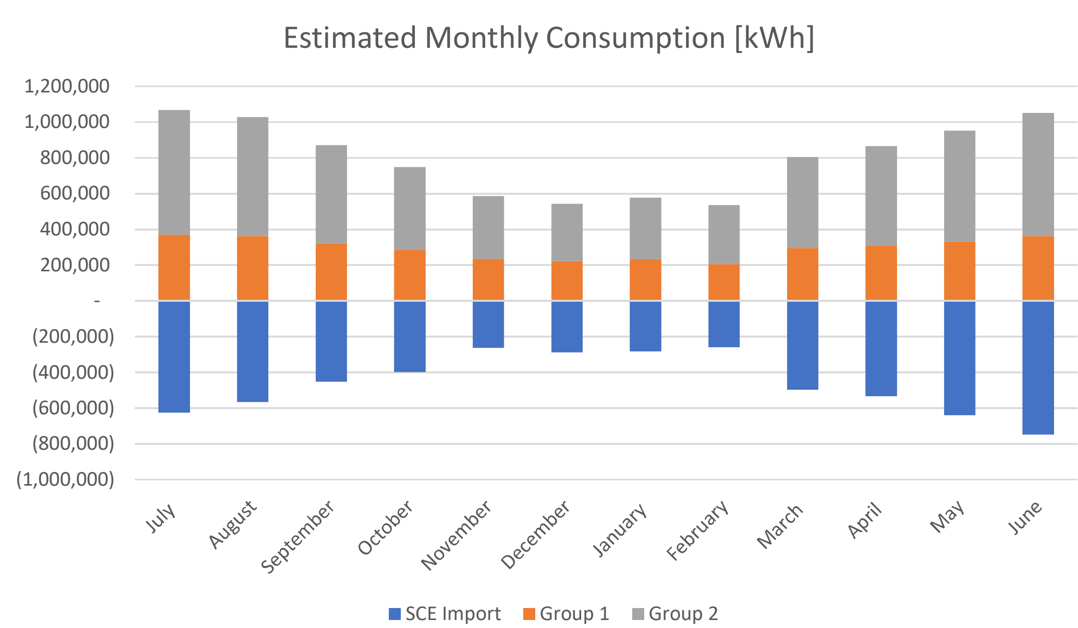
Crafton Hills College Group 1			
Energy Type	Consumption KWH	Consumption Kbtu	Source Energy Factor (KBTU)
Electricity Purchase	2,529,936.00	8,632,141.63	23,112,559.22
G1 - Solar Farm 2	(711,769.00)	(2,428,555.83)	(7,649,950.86)
G1 - Solar Farm 3	(671,013.00)	(2,289,496.36)	(7,211,913.52)
G1 - Solar Farm 4	(711,955.00)	(2,429,190.46)	(7,651,949.95)
G1 - Solar Farm 6	(1,993,900.00)	(6,803,186.80)	(21,430,038.42)
TOTAL PRODUCTION	4,088,637.00	13,950,429.44	43,943,852.75

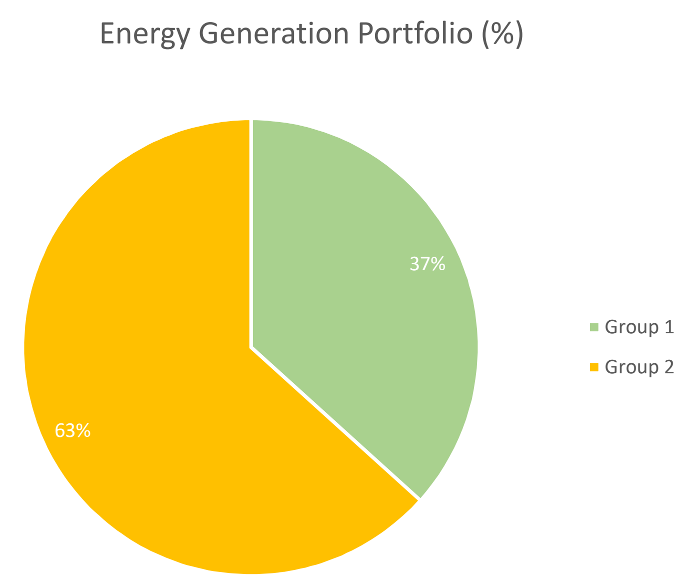
Crafton Hills College Group 2			
Energy Type	Consumption KWH	Consumption Kbtu	Source Energy Factor (KBTU)
Electricity Purchase	4,311,736.69	14,711,645.59	39,390,431.06
G2 - Lot N	(317,484.00)	(1,083,255.41)	(3,412,254.54)
G2 - Lot R	(232,491.00)	(793,259.29)	(2,498,766.77)
G2 - Gym	(377,364.00)	(1,287,565.97)	(4,055,832.80)
G2 - IB	(126,700.00)	(432,300.40)	(1,361,746.26)
G2 - PAC	(226,435.00)	(772,596.22)	(2,433,678.09)
G2 - SOLAR FARM 1	(821,558.00)	(2,803,155.90)	(8,829,941.07)
G2 - SOLAR FARM 5	(829,172.00)	(2,829,134.86)	(8,911,774.82)
G2 - LOT J	(966,949.00)	(3,299,229.99)	(10,392,574.46)
G2 - LOT K	(559,085.00)	(1,907,598.02)	(6,008,933.76)
G2 - LOT M&O	(136,171.00)	(464,615.45)	(1,463,538.67)
G2 - LOT P	(456,379.00)	(1,557,165.15)	(4,905,070.22)
TOTAL PRODUCTION	5,049,788.00	17,229,876.66	54,274,111.47

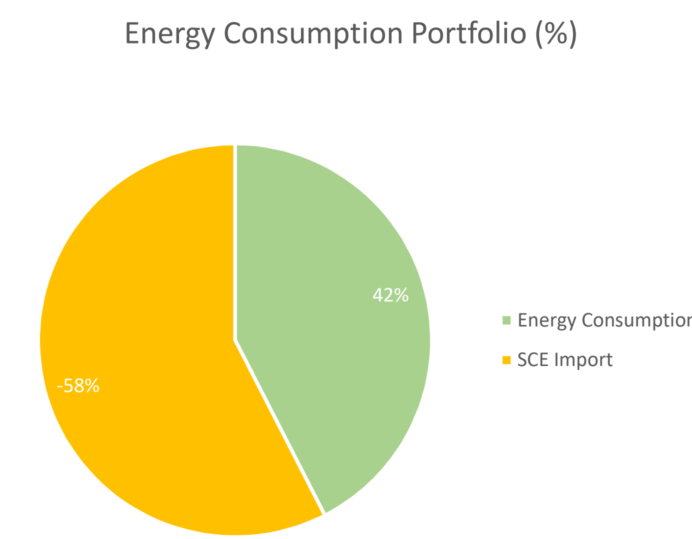

Estimated Monthly Consumption [kWh]
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
-
July
August
September
October
November
December
January
February
March
April
May
June
Energy Consumption


Estimated Monthly Consumption [kWh]
500,000
400,000
300,000
200,000
100,000
-
(100,000)
July
August
September
October
November
December
January
February
March
April
May
June
SCE
Group 1


Energy Portfolio (%)
14%
86%
SCE Import
Group 1


Estimated Monthly Consumption [kWh]
1,200,000
1,000,000
800,000
600,000
400,000
200,000
-
(200,000)
(400,000)
(600,000)
(800,000)
(1,000,000)
July
August
September
October
November
December
January
February
March
April
May
June
SCE Import
Group 1
Group 2


Energy Generation Portfolio (%)
37%
63%
Group 1
Group 2


Energy Consumption Portfolio (%)
42%
-58%
Energy Consumption
SCE Import

PHASE 1 PV EXHIBIT

BUILDING LEGEND

- EXISTING BUILDING
- UNDER CONSTRUCTION
- FUTURE BUILDING
- BUILDING RENOVATION/EXPANSION

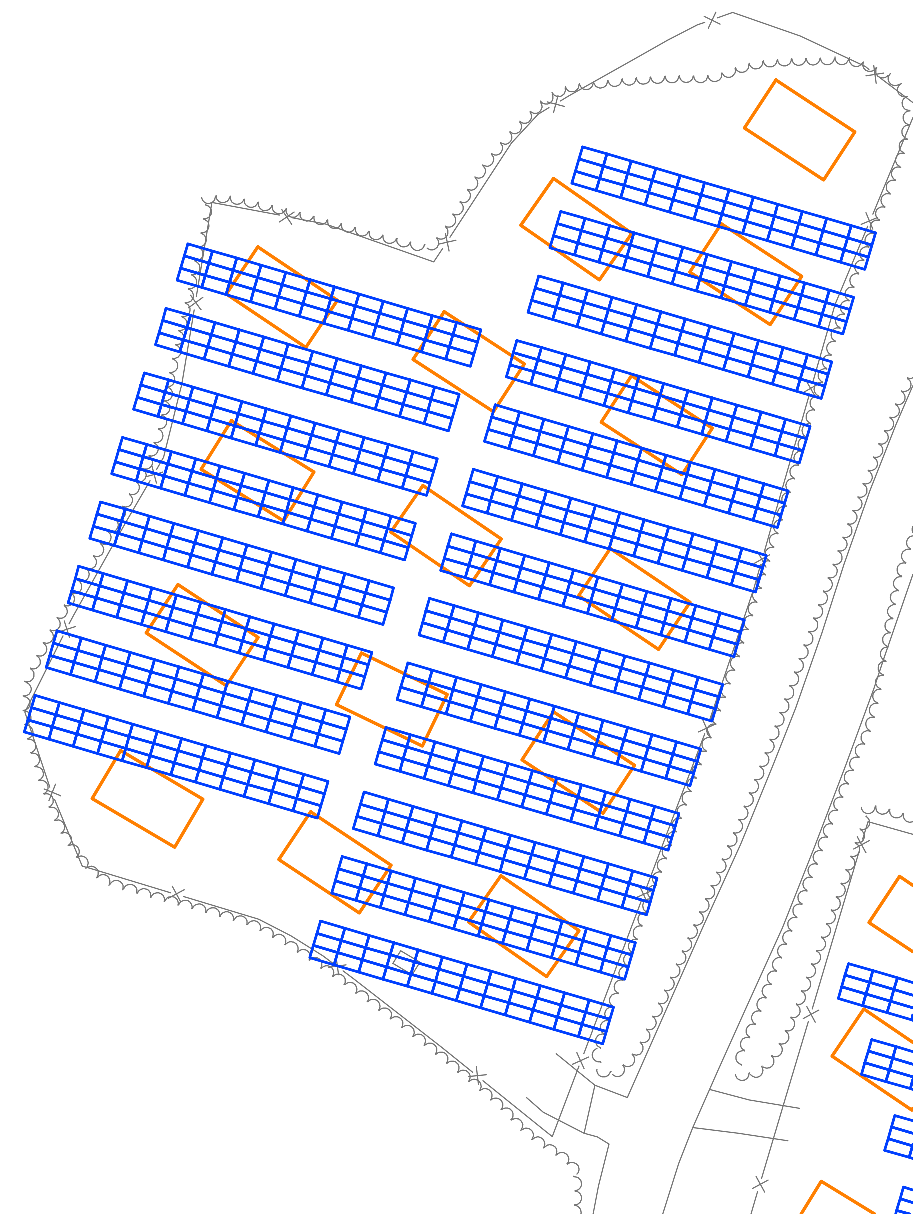
SYMBOL LEGEND

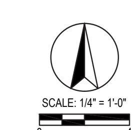
- GROUP 1
- EXISTING PV

FACILITY LEGEND

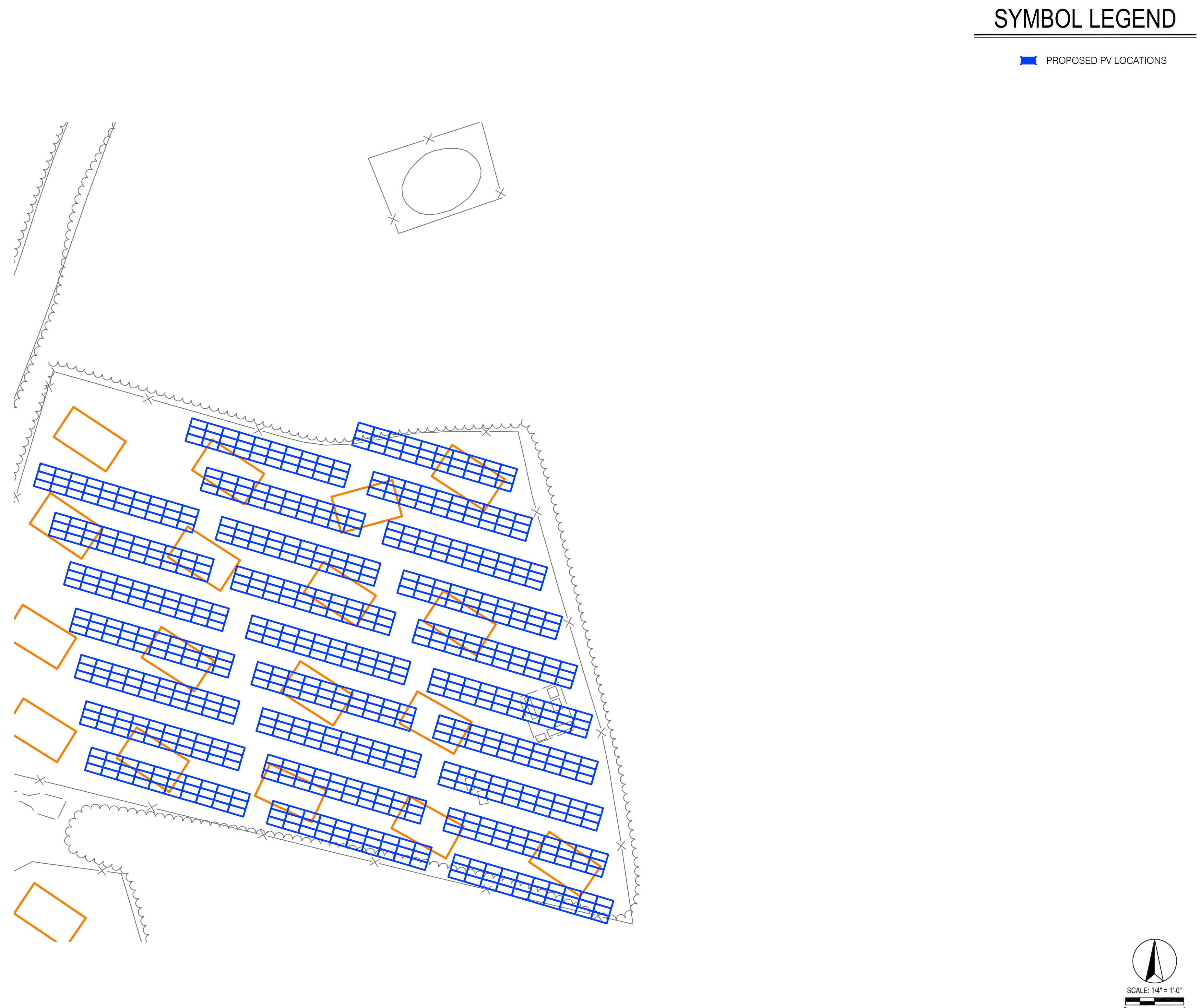
ART	VISUAL ARTS
CYN	CANYON HALL
CNTL1	CENTRAL COMPLEX
CNTL2	CENTRAL COMPLEX 2
CDC	CHILD DEVELOPMENT CENTER
CTB	CLOCK TOWER BUILDING
CCR	CRAFTON CENTER
CHL	CRAFTON HALL
EAST	EAST COMPLEX
EIB	EAST INSTRUCTIONAL BUILDING
EVPSTC	EAST VALLEY PUBLIC SAFELY TRAINING CENTER
GYM	GYMNASIUM
IB	INSTRUCTIONAL BUILDING
KHA	KINESIOLOGY, HEALTH EDUCATION, AQUATIC COMPLEX
LRC	LEARNING RESOURCES CENTER
M&O	MAINTENANCE AND OPERATIONS
M&O ADD	MAINTENANCE AND OPERATIONS ADDITION
NRTH	NORTH COMPLEX
PAC	PERFORMING ARTS CENTER
PSAH	PUBLIC SAFETY AND ALLIED HEALTH
SSB	STUDENT SUPPORT BUILDING
WEST	WEST COMPLEX

PROPOSED SITE PLAN: AREA 3

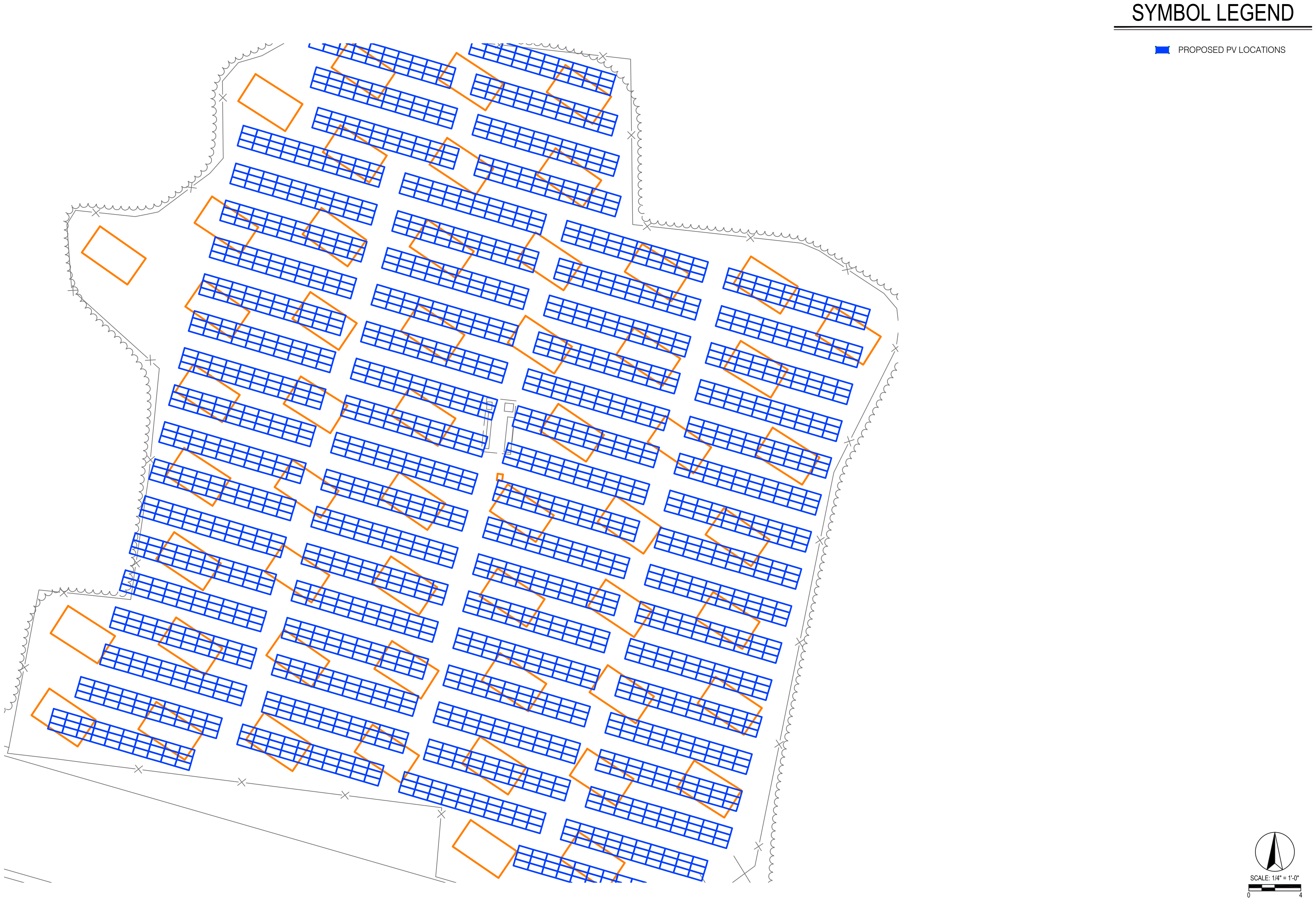




PROPOSED SITE PLAN: AREA 4



PROPOSED SITE PLAN: AREA 6



PHASE 2 PV EXHIBIT

BUILDING LEGEND

- EXISTING BUILDING
- UNDER CONSTRUCTION
- FUTURE BUILDING
- BUILDING RENOVATION/EXPANSION

SYMBOL LEGEND

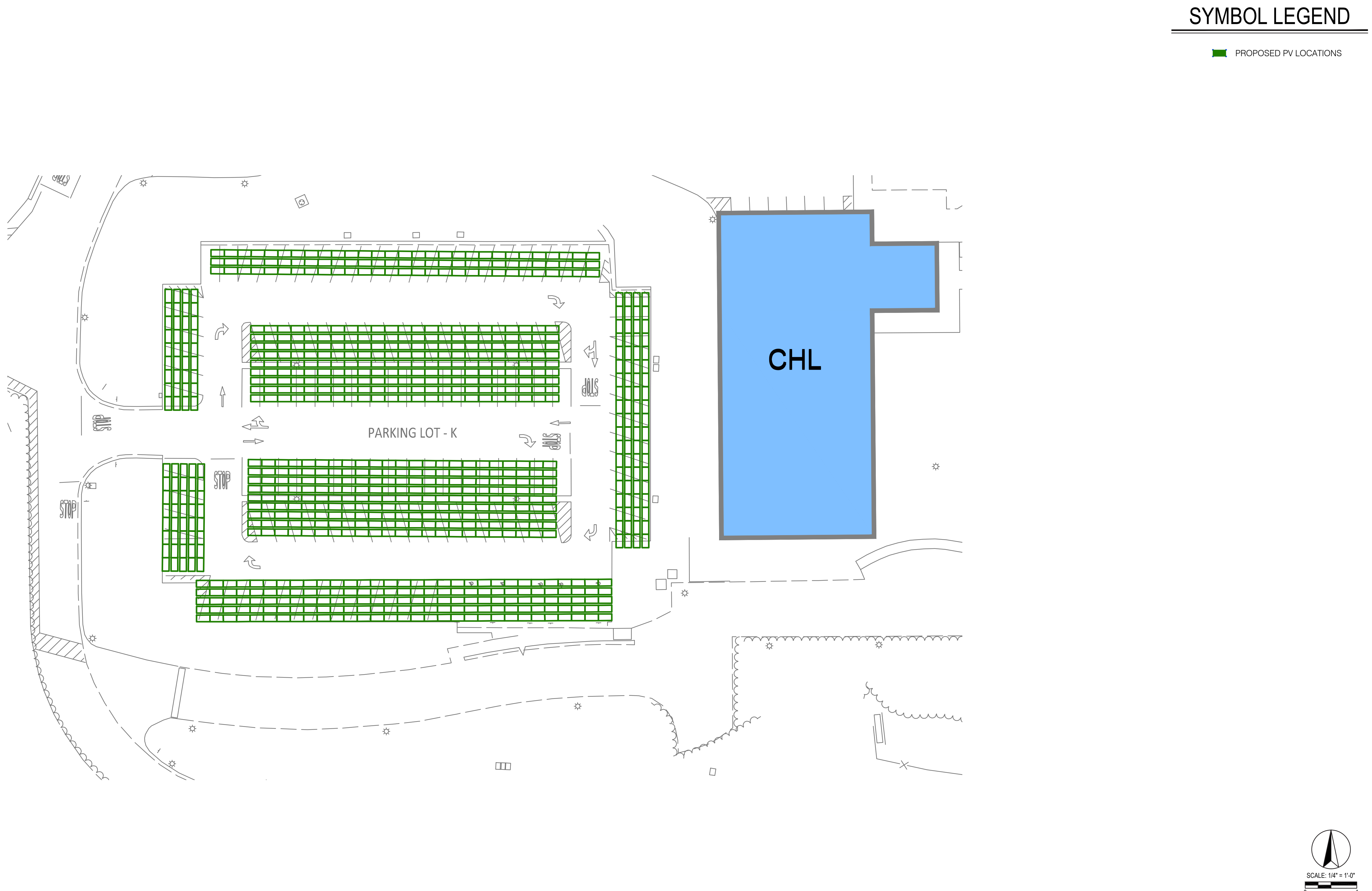
- GROUP 2
- EXISTING PV

FACILITY LEGEND

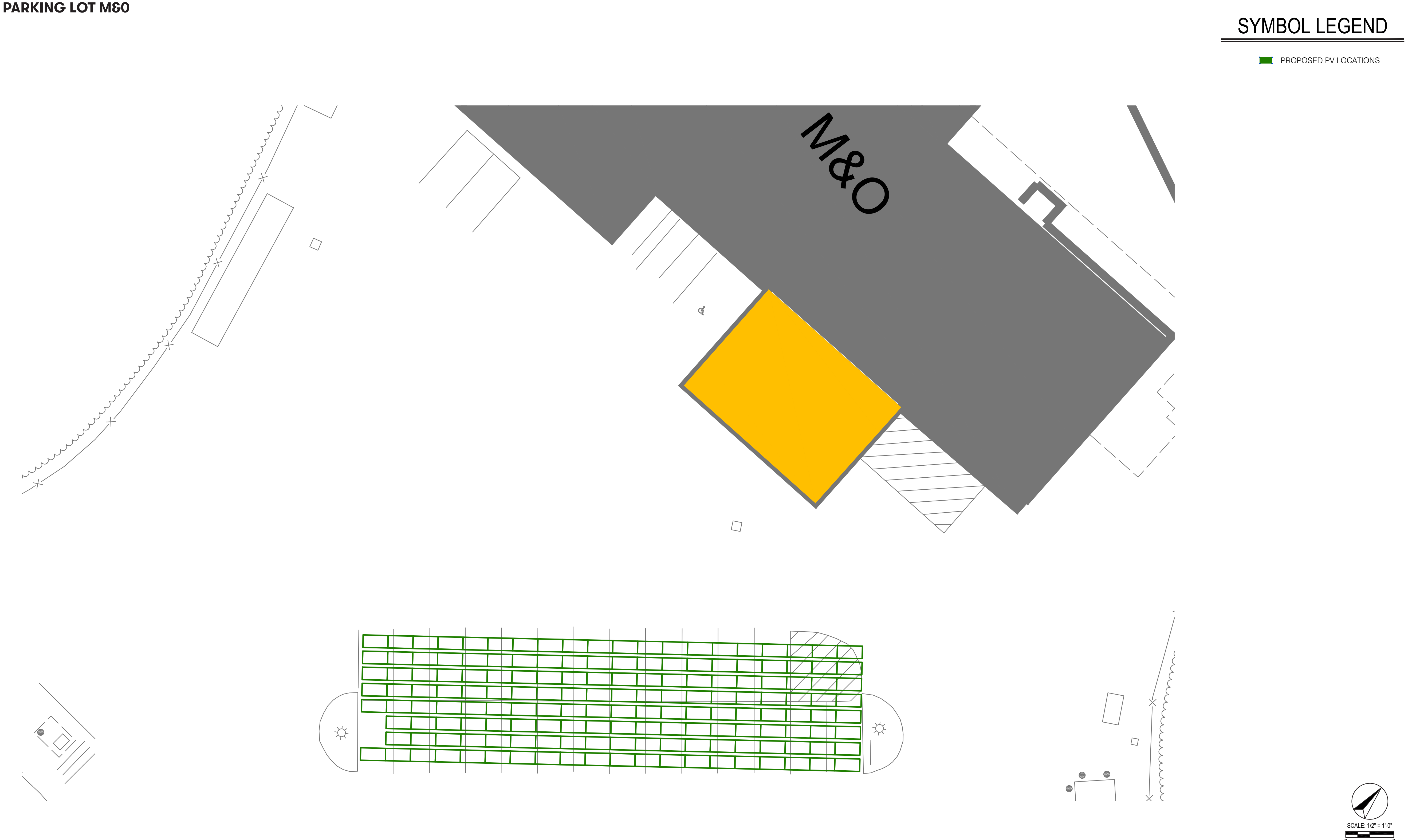
ART	VISUAL ARTS
CYN	CANYON HALL
CNTL1	CENTRAL COMPLEX
CNTL2	CENTRAL COMPLEX 2
CDC	CHILD DEVELOPMENT CENTER
CTB	CLOCK TOWER BUILDING
CCR	CRAFTON CENTER
CHL	CRAFTON HALL
EAST	EAST COMPLEX
EIB	EAST INSTRUCTIONAL BUILDING
EVPSTC	EAST VALLEY PUBLIC SAFELY TRAINING CENTER
GYM	GYMNASIUM
IB	INSTRUCTIONAL BUILDING
KHA	KINESIOLOGY, HEALTH EDUCATION, AQUATIC COMPLEX
LRC	LEARNING RESOURCES CENTER
M&O	MAINTENANCE AND OPERATIONS
M&O ADD	MAINTENANCE AND OPERATIONS ADDITION
NRTH	NORTH COMPLEX
PAC	PERFORMING ARTS CENTER
PSAH	PUBLIC SAFETY AND ALLIED HEALTH
SSB	STUDENT SUPPORT BUILDING
WEST	WEST COMPLEX

PROPOSED SITE PLAN: PARKING LOT J

PROPOSED SITE PLAN: PARKING LOT K



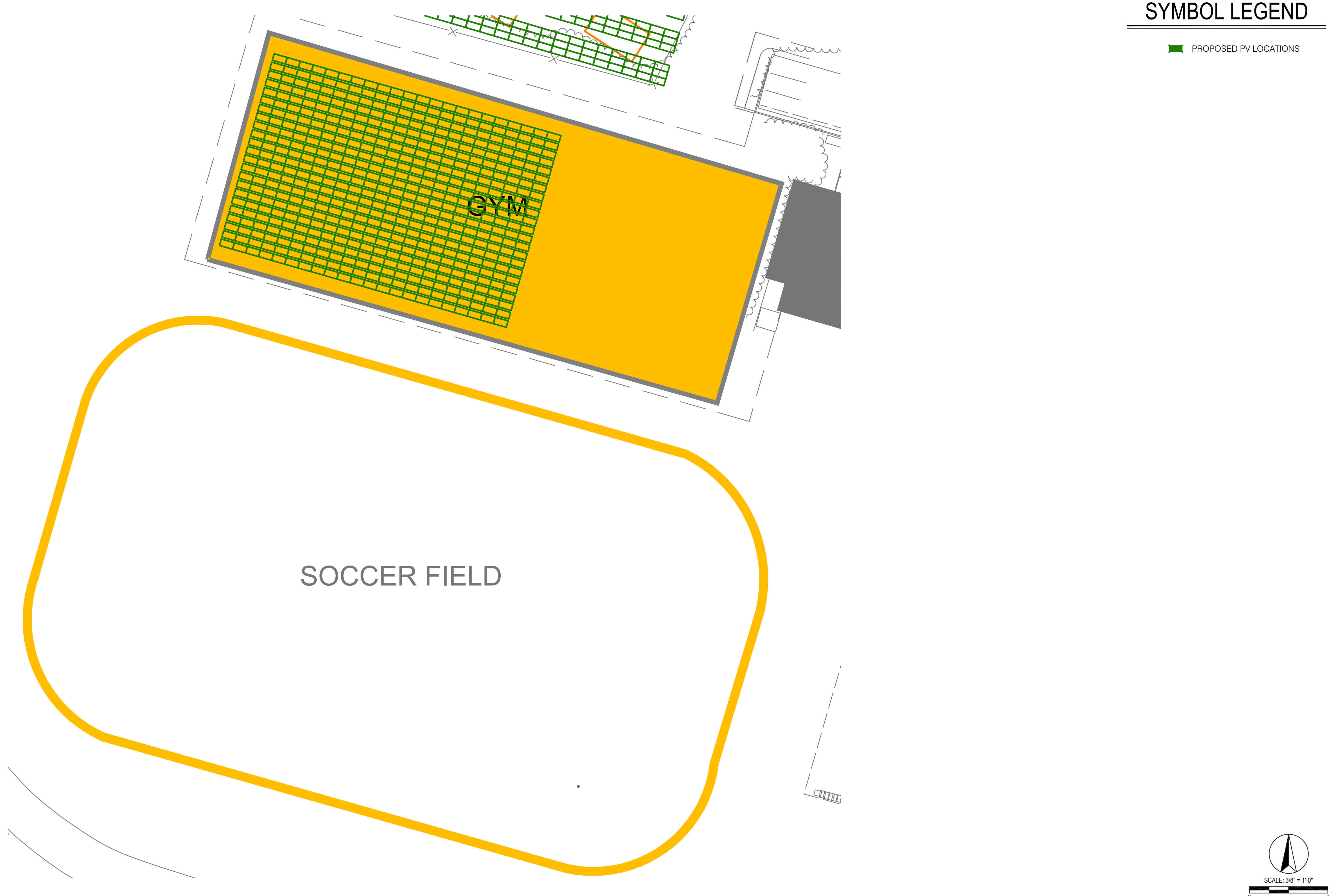
PROPOSED SITE PLAN: PARKING LOT M&O



PROPOSED SITE PLAN: PARKING LOT N

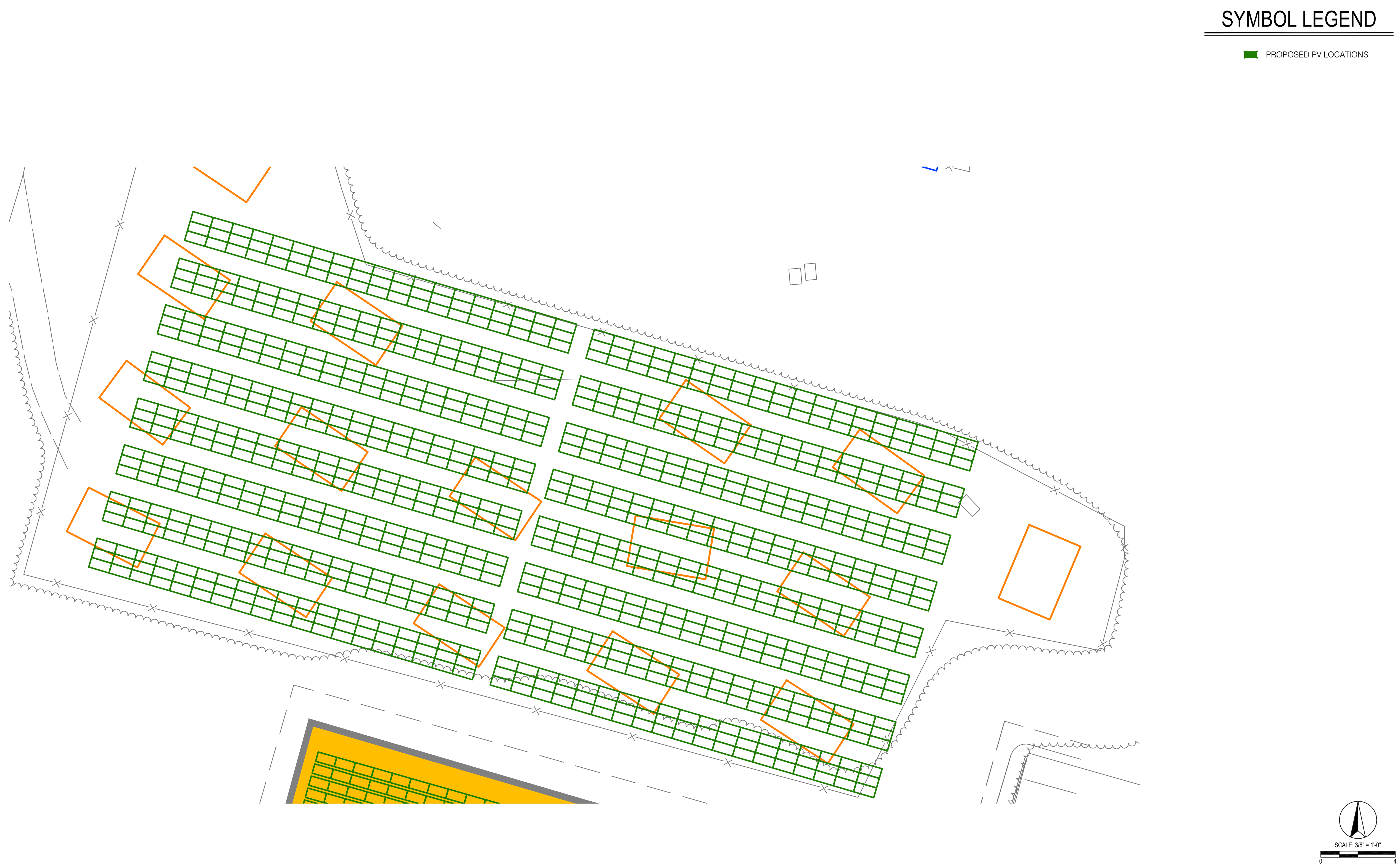
PROPOSED SITE PLAN: PARKING LOT R

PROPOSED SITE PLAN: GYM



PROPOSED SITE PLAN: AREA 1 & 2

PROPOSED SITE PLAN: AREA 5



CHAPTER 5
Roadmap for ZNE Implementation Plan

OVERVIEW OF FINDINGS AND ANALYSIS

Greenhouse gas emissions, typically caused from the burning of fossil fuels such as coal, natural gas, and oil, are generally recognized as contributing factor to the climate change experienced over the years. It is thus important to be good stewards and minimize the use of these fuels by promoting energy conservation, providing clean renewable sources to offset overall energy use and minimizing natural gas consumption by promoting electrification. Several legislations and programs have been implemented into action to track and encourage Educational Institutions to minimize their greenhouse gas emissions while promoting the research and educational efforts of higher education to equip society to-stabilize the earth's climate Consistent with these legislations and programs, the campus is adopting an aggressive role to promote an NZE campus. To meet this campus objective, P2S was contracted by the District to develop an NZE implementation plan for the campus that not only provides a clear roadmap of achieving an NZE status but is practical and identifies clear measures to be adopted along with their source of funding.

Following approach was adopted in developing the subject implementation plan:

- Identifying and prioritizing energy conservation measures to minimize overall energy consumption and associated greenhouse gas emissions at the campus
- Evaluating renewable energy sources, identifying locations of providing these at the campus and analyzing their v and delivery methods
- Promoting the provision of electric vehicle charging stations to minimize overall green house gas emissions
- Setting standards for future facilities to be NZE facilities

Following is an overview of our findings and analysis in achieving an NZE status for the campus:

P2S conducted an audit of the existing MEP systems currently serving each of the facilities at the campus and identified energy conservation measures and associated costs and paybacks for each of the measures. The implementation of the recommended measures will not only reduce overall energy consumption but also reduce associated greenhouse gas emissions and bring the campus closer to becoming an NZE campus. Following is a table providing a list of recommended energy conservation measures along with associated reduction in greenhouse gas emissions, cost savings and paybacks. The savings are primarily in the retrofit of existing light fixtures, retro commissioning and mechanical upgrades.

An analysis of the various in site generation sources revealed that PV system would be the most economical and the right renewable energy source to achieve net zero energy status.

An analysis of the existing and future electrical demand at the campus was undertaken to determine the capacity and viability of providing photovoltaic systems at the campus to achieve net zero energy status. A graph showing existing demand of the campus in kWh and kW is provided in figures below.

The campus already has a solar farm installed on the north east side of the campus. A total of six areas on the north east side are populated with ground mount concentrator PV system and integrated with the campus 4160V system. A total of 1.21MW and 1,561,545 kWh is currently being generated annually by the existing solar farm. Discussions with campus and an evaluation report undertaken in 2019 reveal that almost 15-20% of the concentrator PV system do not function as designed and intended and are awaiting parts to enable them track the sun and optimize their production.

A review of the campus buildings rooftops, ground areas around the campus and the parking lots and discussions had with the District and campus personnel revealed that the most optimum location for the campus to provide PV systems in phase 1 would be at the following areas as depicted in the proposed solar system exhibit. Consideration was given to aesthetics, costs, existing roof condition, effective utilization of the areas to maximize production and its proximity to the campus infrastructure.

- Area 2, 3, 4, & 6 (Solar Farm area on the north east side of the campus)

The replacement of the existing solar farm area with ground mount stationary PV systems and the indicated parking lots will produce approximately 100% of the overall source energy utilized by the campus annually in kBtus

As the rest of the concentrator PV solar farm areas experience failures and the overall production degrades, we recommend the same be replaced in phases to not only effectively utilize the current area but also maximize overall kW and kWh production to achieve net zero energy status. A total of 1154 kW can be replaced with 2,120 kW thus not only increasing the overall efficiency of utilization of the current areas but also increasing overall kW and kWh production. The replacement of the existing solar farm areas with ground mount stationary PV systems will produce approximately 95% of the overall source energy utilized by the campus annually in kBtus. The campus can evaluate the second phase comprising of Parking lots, and new building rooftops to enhance PV production in the future as the demand increases and offset the remaining energy use at the campus.

The campus can also evaluate the provision of solar charging stations to not only demonstrate their commitment towards green power and towards fulfilling the campus goal of reducing carbon emissions but also providing a clean and renewable source of energy for charging the multitude of mobile devices typically found on campus while offering much needed shade.

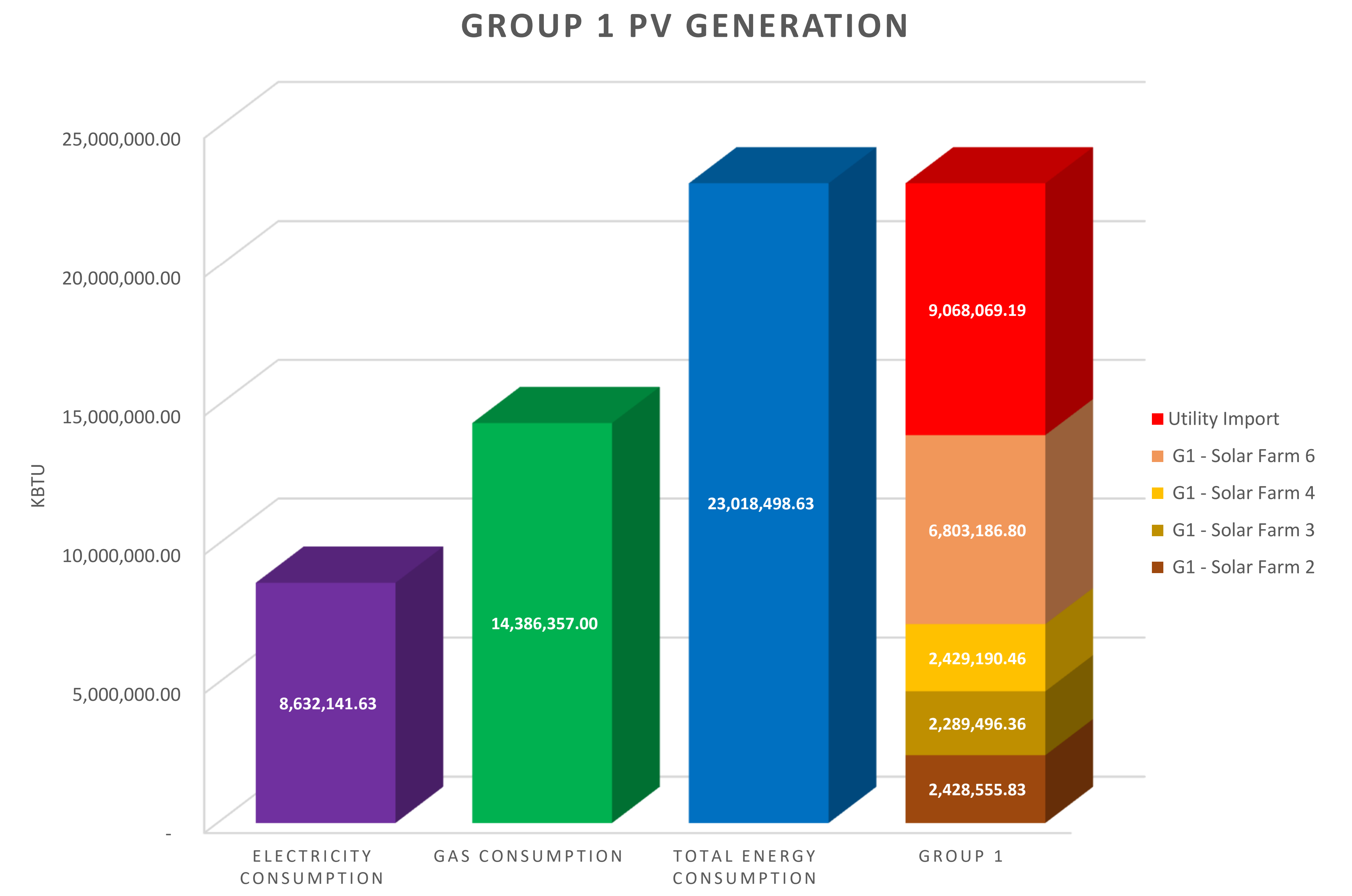
The provision of the subject PV systems will limit dependence of the campus on non-renewable power sources, reduce greenhouse gas emissions and eliminate the impact of fluctuation of energy prices in the future.

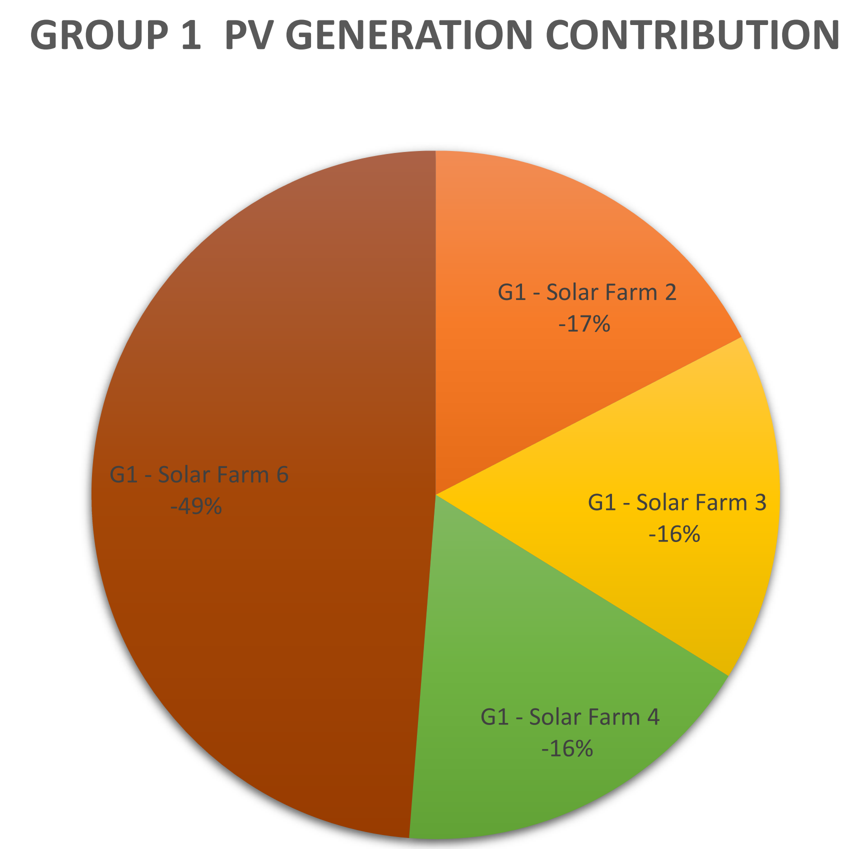
The overall PV system installations comprising of solar farm areas, indicated parking lots and new building rooftops would offset 100% of the current energy consumption in kBtu's comprising of both electric and gas consumption and reduce campus carbon emissions by 1,695 metric tons per year. Graphs showing current energy consumption in KBtu's and the offset provided by the provision of PV systems in phase 1 and 2 at the campus is provided below for reference.

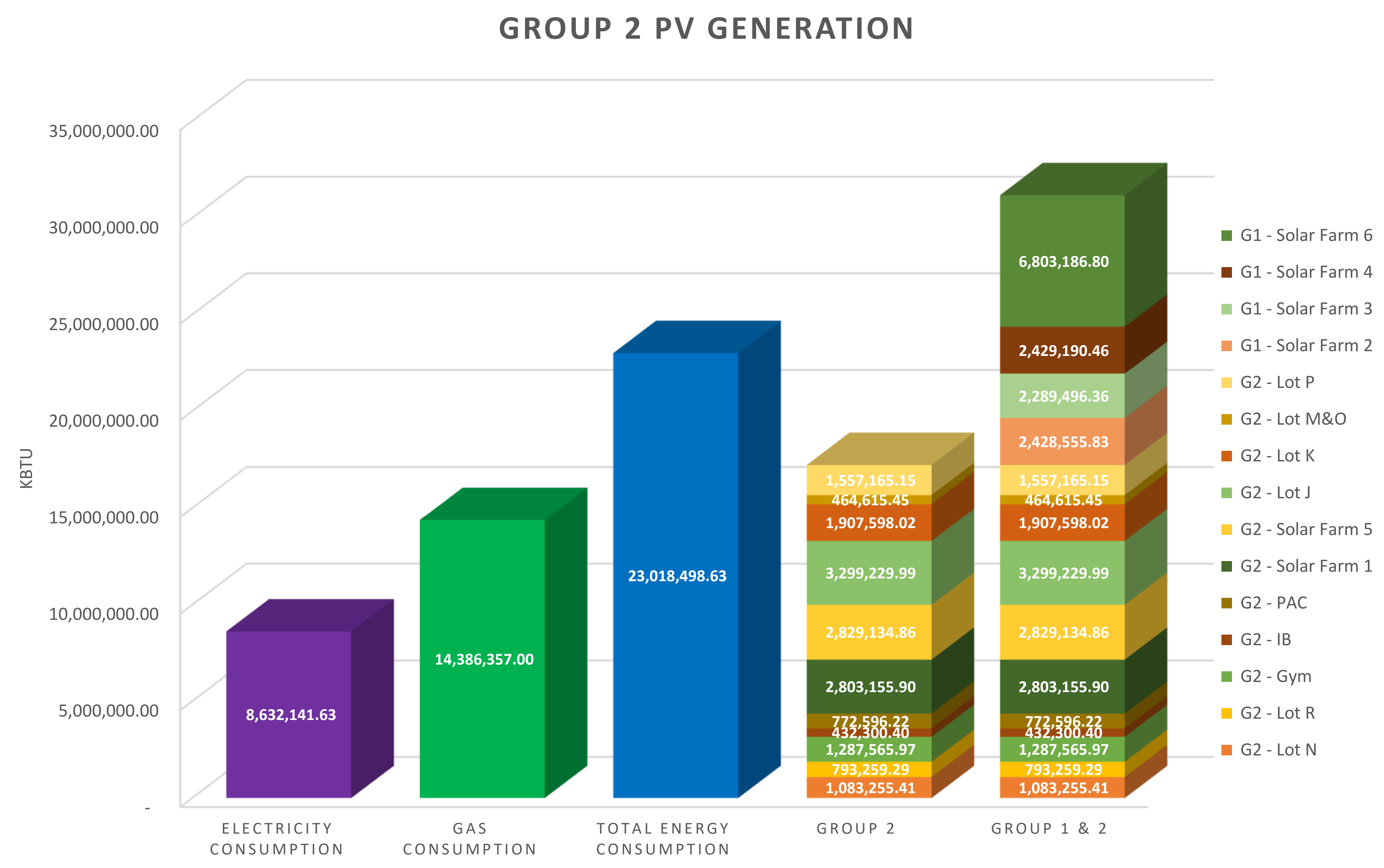
A review and analysis of the battery storage system integrated with proposed solar system was also conducted. Considering the electric utilities migrating to a 4-9pm peak Time-of-Use rates, we recommend the Campus add battery storage system to store the excess on site generation during daytime and utilize the stored energy to offset the demand during the 4-9pm period.

Based on the existing demand and PV systems installed under phase 1, 740kW/2960kWh Battery Energy Storage System shall be integrated into the campus distribution system. The availability of enhanced self generation incentives due to location of the campus (Equity Incentives), the paybacks are really attractive to combine the solar system with the battery storage to not only offset the overall peak demand charges but also offset overall peak energy consumption charges and save overall operational costs. Payback analysis and associated costs for integrating the solar system with battery storage is included at the end of this section.

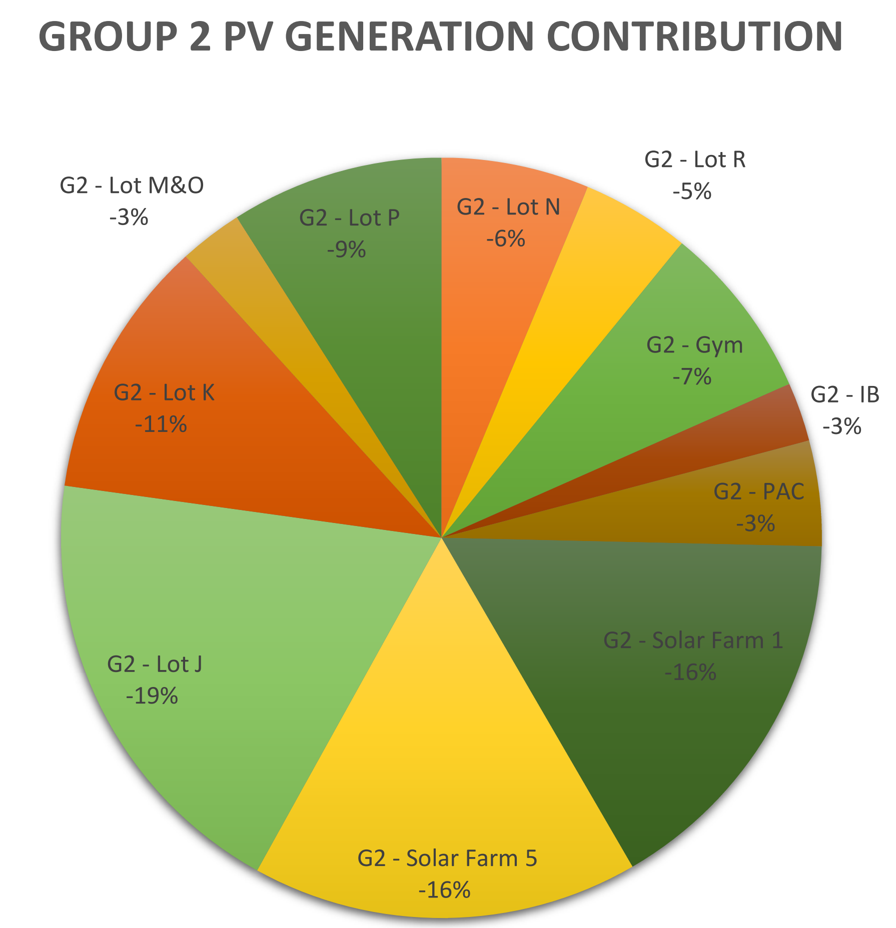
A financial analysis of the various delivery methods for deploying renewable energy sources was also undertaken and outright purchase was found to be the most optimum and economical to deploy these systems at the campus. So we recommend that the campus utilize their own available funds to deploy the recommended systems.


GROUP 1 PV GENERATION
25,000,000.00
20,000,000.00
15,000,000.00
10,000,000.00
5,000,000.00
-
KBTU
8,632,141.63
14,386,357.00
23,018,498.63
9,068,069.19
6,803,186.80
2,429,190.46
2,289,496.36
2,428,555.83
ELECTRICITY CONSUMPTION
GAS CONSUMPTION
TOTAL ENERGY CONSUMPTION
GROUP 1
Utility Import
G1 - Solar Farm 6
G1 - Solar Farm 4
G1 - Solar Farm 3
G1 - Solar Farm 2


GROUP 1 PV GENERATION CONTRIBUTION
G1 - Solar Farm 2
-17%
G1 - Solar Farm 3
-16%
G1 - Solar Farm 4
-16%
G1 - Solar Farm 6
-49%



GROUP 2 PV GENERATION
35,000,000.00
30,000,000.00
25,000,000.00
20,000,000.00
15,000,000.00
10,000,000.00
5,000,000.00
-
KBTU
8,632,141.63
14,386,357.00
23,018,498.63
1,557,165.15
464,615.45
1,907,598.02
3,299,229.99
2,829,134.86
2,803,155.90
772,596.22
432,300.40
1,287,565.97
793,259.29
1,083,255.41
6,803,186.80
2,429,190.46
2,289,496.36
2,428,555.83
ELECTRICITY CONSUMPTION
GAS CONSUMPTION
TOTAL ENERGY CONSUMPTION
GROUP 2
GROUP 1 & 2
G1 - Solar Farm 6
G1 - Solar Farm 4
G1 - Solar Farm 3
G1 - Solar Farm 2
G2 - Lot P
G2 - Lot M&O
G2 - Lot K
G2 - Lot J
G2 - Solar Farm 5
G2 - Solar Farm 1
G2 - PAC
G2 - IB
G2 - Gym
G2 - Lot R
G2 - Lot N



GROUP 2 PV GENERATION CONTRIBUTION
G2 - Lot M&O -3%
G2 - Lot P -9%
G2 - Lot N -6%
G2 - Lot R -5%
G2 - Gym -7%
G2 - IB -3%
G2 - PAC -3%
G2 - Lot K -11%
G2 - Solar Farm 1 -16%
G2 - Lot J -19%
G2 - Solar Farm 5 -16%

Based on the projected costs/watt and review of campus available areas, below are our proposed locations, costs and paybacks for proposed PV systems at the campus.

Area	PV Size [kW]	Mounting Type	Energy Generated [kWh]	Energy Generation [kBtu]	Campus Demand %	GHG Offset [lb]	System Cost ($)*	Payback Period	Electric Bill Savings	TIRR %
Group 1	2,117.8	MULTIPLE	4,056,468	13,840,669	100%	632,253	$4,452,000	10.2	$14,356,322	31%
Group 1 + 740kW/2960kWh Ba	2,117.8	MULTIPLE	4,056,468	13,840,669	100%	632,253	$7,550,763	7.8	$20,370,363	20%
Solar Farm Area 2	366.6	GROUND MOUNT	711,770	2,428,559	30%	320,297	$1,308,480	18.6	$2,787,590	4%
Solar Farm Area 3	355.3	GROUND MOUNT	671,014	2,289,500	29%	301,956	$1,299,456	18.8	$2,137,228	3%
Solar Farm Area 4	366.6	GROUND MOUNT	711,956	2,429,194	27%	320,380	$1,140,000	17.7	$2,007,948	4%
Solar Farm Area 6	1,070.0	GROUND MOUNT	1,993,901	6,803,190	75%	360,101	$3,429,120	20.7	$4,969,215	2%

Area	PV Size [kW]	Mounting Type	Energy Generated [kWh]	Energy Generation [kBtu]	Campus Demand %	GHG Offset [lb]	System Cost ($)*	Payback Period	Electric Bill Savings	TIRR %
Lot N	188.9	CARPORT	317,484	1,083,255	12%	142,868	$604,608	20.2	$1,175,285	4%
Lot R	124.1	CARPORT	232,490	793,256	9%	104,621	$397,056	18.5	$862,474	5%
Gym	237.8	ROOFTOP	377,364	1,287,566	14%	169,814	$761,024	21.3	$1,398,196	3%
IB	67.2	ROOFTOP	126,701	432,304	5%	57,015	$215,072	17.2	$503,940	5%
PAC	126.0	ROOFTOP	226,436	772,600	8%	101,896	$403,072	19.3	$829,759	4%
Lot J	614.8	CARPORT	1,142,635	3,898,671	42%	514,186	$2,067,232	20.5	$3,850,562	3%
Lot K	391.04	CARPORT	559,086	1,907,601	21%	251,589	$1,251,328	23.1	$2,058,311	2%
Lot M&O	74.26	CARPORT	136,170	464,612	5%	61,277	$237,632	18	$524,307	5%
Lot P	243.93	CARPORT	456,379	1,557,165	17%	205,371	$780,576	18.8	$1,658,975	4%
Solar Farm Area 1	423.0	GROUND MOUNT	821,556	2,803,149	30%	369,700	$1,353,600	18.7	$2,855,770	4%
Solar Farm Area 5	428.6	GROUND MOUNT	829,171	2,829,131	31%	373,127	$1,371,648	18.8	$2,878,532	4%

* Note: Cost includes PV panel, Balance of System (BOS), and cost of all structures

Crafton Hills College Group 1			
Energy Type	Consumption KWH	Consumption Kbtu	Source Energy Factor (KBTU)
Electricity Purchase	2,529,936.00	8,632,141.63	23,112,559.22
G1 - Solar Farm 2	(711,769.00)	(2,428,555.83)	(7,649,950.86)
G1 - Solar Farm 3	(671,013.00)	(2,289,496.36)	(7,211,913.52)
G1 - Solar Farm 4	(711,955.00)	(2,429,190.46)	(7,651,949.95)
G1 - Solar Farm 6	(1,993,900.00)	(6,803,186.80)	(21,430,038.42)
Total Production	4,088,637.00	13,950,429.44	43,943,852.75

Costs, Payback and Proposed Locations

Considering the electric utilities migrating to a 4-9pm peak Time-of-Use rates, Campus shall plan to add battery energy storage system to store the excess on site generation during daytime and utilize the stored energy to offset the demand during the 4-9pm period. Based on the existing demand and PV systems installed under phase 1, 740kW/2960kWh Battery Energy Storage System.

Exhibit showing Phase 1 and 2 areas along with enlarged plans of each area is included at the end of this section. Associated paybacks for each of the areas grouped together is provided in Appendix.

A review of the existing parking lots at the campus revealed that the campus currently does not have any electric vehicle charging at their parking lots.

To promote and support electric vehicle charging at the campus consistent with the current and future legislations and in absence of any standard or legislation governing the number of EV chargers, the current CA Green Code requirements for number of EV chargers required were utilized in joint consultation with the campus. CA green code stipulates EV infrastructure for the proposed chargers based on the number of parking spaces in each of the parking lots. This number was used as a basis for specifying the number of EV chargers in each of the parking lots at the campus. The number of parking spaces in each of the parking lots were based on the campus wide ADA study conducted in 2013.

Table to the right provides the number of EV chargers infrastructure required in parking lots based on the current CA Green Code.

The Campus Lighting Reduction and 2011 Solar Photovoltaic System decreased the campus greenhouse gas emissions. In total the planned facilities reduced the campus greenhouse gas emissions by 3,551 metric tons per year (9.3% of 2020 goal).

Crafton Hills College Group 2			
Energy Type	Consumption KWH	Consumption Kbtu	Source Energy Factor (KBTU)
Electricity Purchase	4,311,736.69	14,711,645.59	39,390,431.06
G2 - Lot N	(317,484.00)	(1,083,255.41)	(3,412,254.54)
G2 - Lot R	(232,491.00)	(793,259.29)	(2,498,766.77)
G2 - Gym	(377,364.00)	(1,287,565.97)	(4,055,832.80)
G2 - IB	(126,700.00)	(432,300.40)	(1,361,746.26)
G2 - PAC	(226,435.00)	(772,596.22)	(2,433,678.09)
G2 - SOLAR FARM 1	(821,558.00)	(2,803,155.90)	(8,829,941.07)
G2 - SOLAR FARM 5	(829,172.00)	(2,829,134.86)	(8,911,774.82)
G2 - LOT J	(966,949.00)	(3,299,229.99)	(10,392,574.46)
G2 - LOT K	(559,085.00)	(1,907,598.02)	(6,008,933.76)
G2 - LOT M&O	(136,171.00)	(464,615.45)	(1,463,538.67)
G2 - LOT P	(456,379.00)	(1,557,165.15)	(4,905,070.22)
TOTAL PRODUCTION	5,049,788.00	17,229,876.66	54,274,111.47

TOTAL NUMBER OF ACTUAL PARKING SPACES	NUMBER OF REQUIRED EV CHARGING SPACES
0-9	0
10-25	1
26-50	2
51-75	4
76-100	5
101-150	7
151-200	10
201 AND OVER	6 PERCENT OF TOTAL

***Calculation for spaces are rounded up to the nearest whole number.**

Based on the previous table, tables below provides the number of recommended Level 2 and DC Fast EV chargers at each of the parking lots at the campus.

CHC - Level 2 Charging

Parking Lot	Parking Spaces	EV Spaces	Electrical POC	Electrical POC Capacity	Electrical POC Existing Load (kW)	Proposed Load Addition (kW)	Proposed Electrical POC Estimated Load (kW)
A	74	5	Parking Lot A, Switchboard DBA	500	200	41.44	385.36
B	137	10	Parking Lot A, Switchboard DBA			76.72	
C	120	8	Parking Lot A, Switchboard DBA			67.2	
D	23	2	Central Complex, Main Switchboard	500	200	12.88	254.32
E	74	5	Central Complex, Main Switchboard			41.44	
F	80	6	Proposed EIB Building, Main Switchboard	500	200	44.8	291.28
G	83	6	Proposed EIB Building, Main Switchboard			46.48	
H	79	6	PSAH Building, Main Switchboard	500	200	44.24	385.36
I	252	18	PSAH Building, Main Switchboard			141.12	
J	173	12	Gym Building, Main Switchboard	750	300	96.88	396.88
K	128	9	Crafton Hall, Main Switchboard	500	200	71.68	271.68
L	85	6	Proposed CDC Building, Main Switchboard	300	120	47.6	212.4
M	80	6	Proposed CDC Building, Main Switchboard			44.8	
N	62	4	LRC Building, Main Switchboard	1500	600	34.72	634.72
P	57	5	Proposed PAC Building, Main Switchboard	500	200	40	240
R	46	3	Proposed IB Building, Main Switchboard	500	200	25.76	225.76
M&O	35	2	M&O Building, Main Switchboard	750	300	19.6	319.6
TOTAL	1588	112					

CHC - DC Fast Charging

Parking Lot	Parking Spaces	EV Spaces	Electrical POC	Electrical POC Capacity	Electrical POC Existing Load (kW)	Proposed Load Addition (kW)	Proposed Electrical POC Estimated Load (kW)
D	23	2	Central Complex, Main Switchboard	500	200	120.75	320.75
F	80	6	Proposed EIB Building, Main Switchboard	1500	200	420	1055.75
G	83	6	Proposed EIB Building, Main Switchboard	0	0	435.75	
L	85	6	Proposed CDC Building, Main Switchboard	1000	120	446.25	986.25
M	80	6	Proposed CDC Building, Main Switchboard	0	0	420	
N	62	4	LRC Building, Main Switchboard	1500	600	325.5	925.5
P	57	5	Proposed PAC Building, Main Switchboard	750	200	375	575
R	46	3	Proposed IB Building, Main Switchboard	500	200	241.5	441.5
M&O	35	2	M&O Building, Main Switchboard	750	300	183.75	483.75
TOTAL	551	40					

An overall exhibit providing the number of EV chargers in each of the parking lots and enlarged plans showing location of each of these chargers is provided at the end of this section.

Impacts on Current Infrastructure and Demand

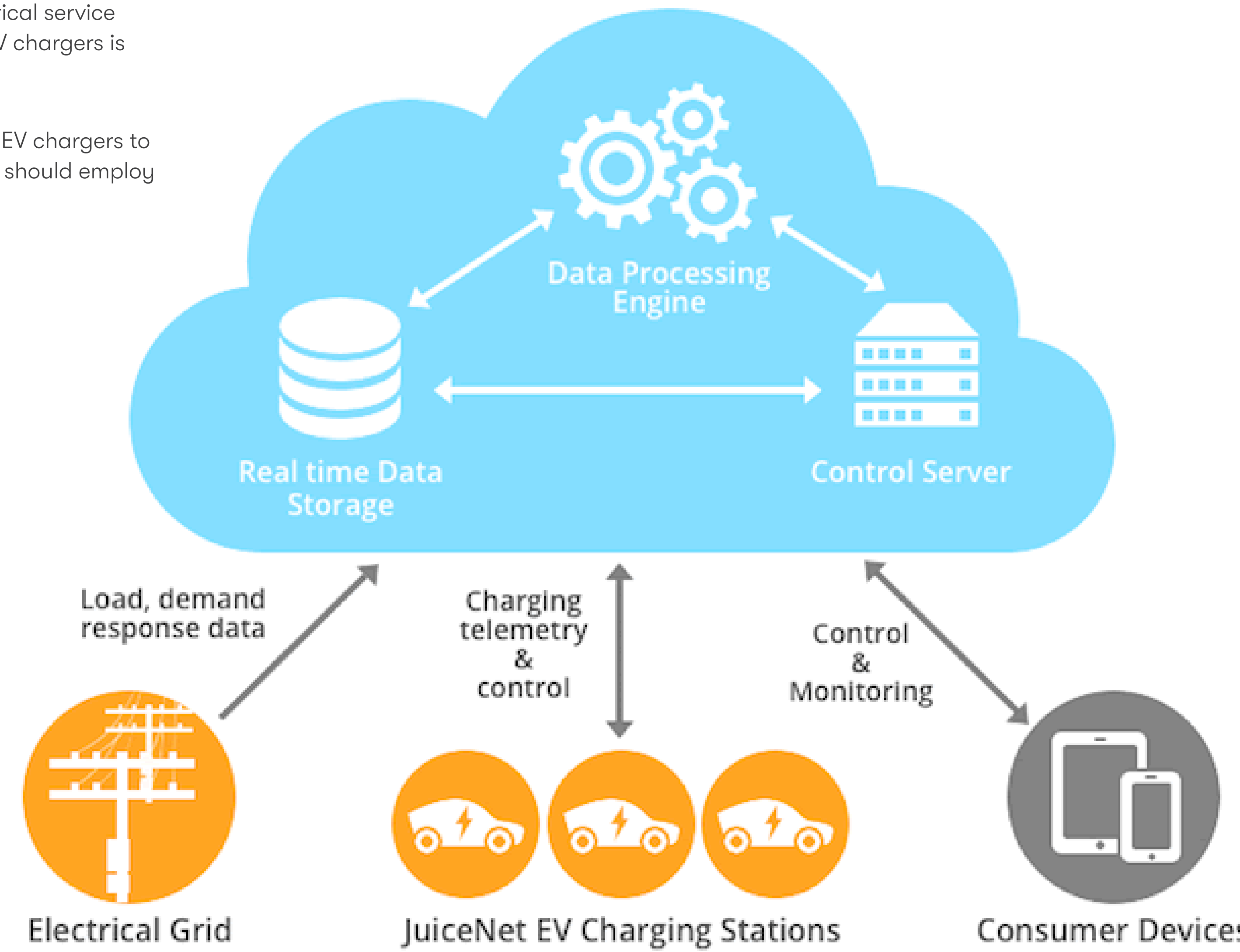
An evaluation of the current infrastructure to support the proposed EV chargers recommended in each of the parking lots was undertaken. Majority of the chargers can be connected to the existing infrastructure available in close proximity to the parking lots as shown in the exhibit with no major upgrades required to the existing infrastructure. Efforts should also focus to implement smart energy-efficient future mobility demands and management systems controllers to monitor, adjust and control the electric demands from electric vehicle charging rather than solely focus on upgrading infrastructure to support electric vehicle charger loads at all times. Controller should monitor the real time demand and guide charging network design, with solutions that go beyond simply adding more stations and even include potentially maintaining some slow-charging locations in contrast to switching over all charging stations to faster rates. Monitoring shall be implemented to effectively monetize the charging stations and maintain the demand profiles and integrate with controllers as required. Monitoring programs commercially available offer end-to-end distributed energy solutions, combining advanced analytics, software technology, and hardware systems.

Alternatively, the campus should await the roll out of utility program for Light Vehicle EV Chargers in fall of this year and utilize the SCE infrastructure available along the main campus drive to support the demands of the proposed EV chargers. This will have no impact on the current infrastructure and will not require any extension of existing infrastructure to support these EV chargers. In addition, optimal rates combined with both incentives and grants will be available to support the installation of these chargers which will help offset majority of the costs of these chargers.

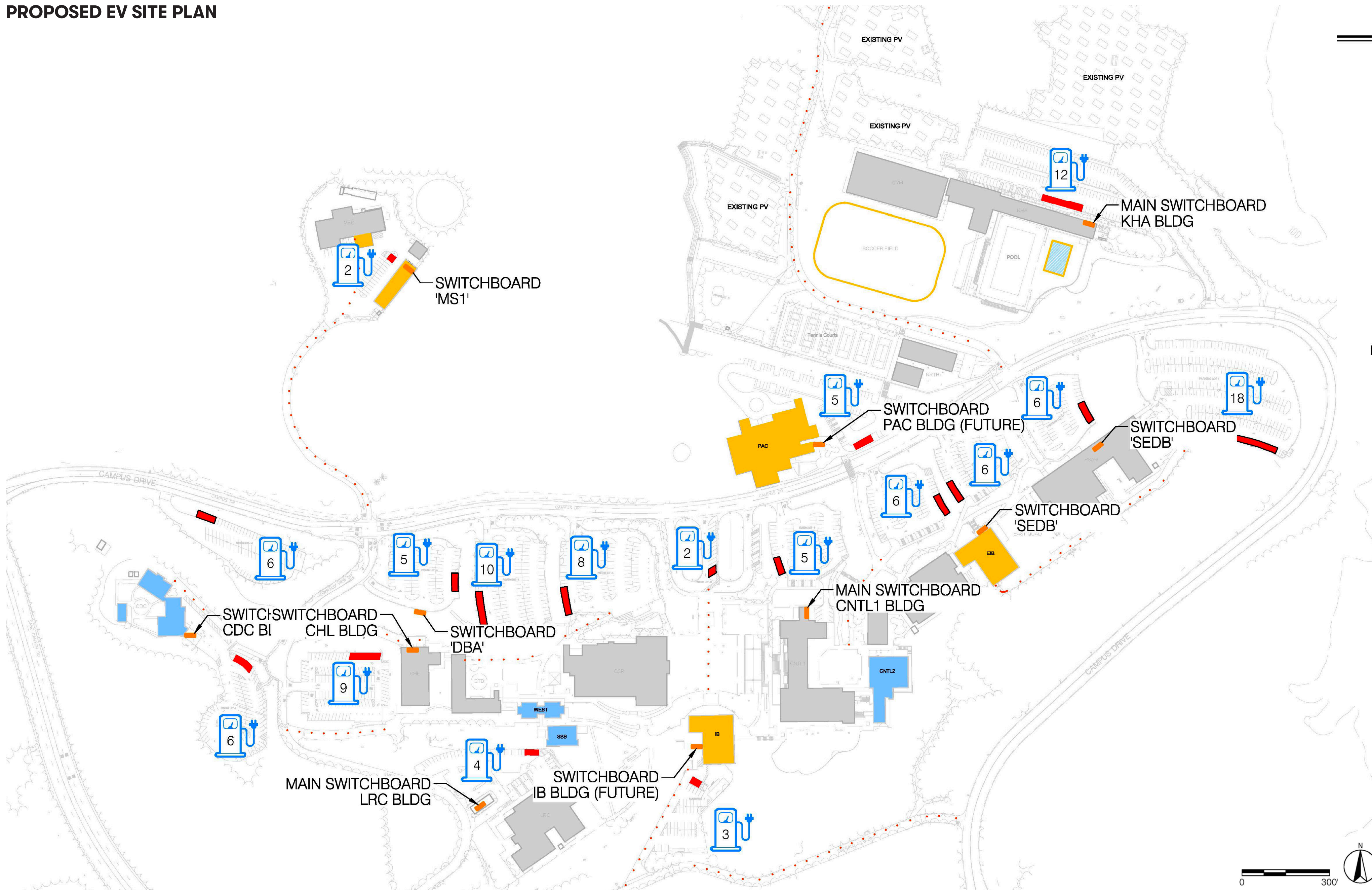
A review of the current campus infrastructure revealed that the addition of the recommended EV chargers will have minimal or no impact to the current electrical infrastructure.

The campus has plenty of electrical capacity to support the proposed EV chargers at each of the parking lots. An exhibit providing description of the proposed electrical service to each of the parking lots to support the EV chargers is included at the end of the section.

In addition, as the campus adds additional EV chargers to support the electrical vehicles, the campus should employ



PROPOSED EV SITE PLAN



FACILITY LEGEND

ART	VISUAL ARTS
CYN	CANYON HALL
CNTL1	CENTRAL COMPLEX
CNTL2	CENTRAL COMPLEX 2
CDC	CHILD DEVELOPMENT CENTER
CTB	CLOCK TOWER BUILDING
CCR	CRAFTON CENTER
CHL	CRAFTON HALL
EAST	EAST COMPLEX
EIB	EAST INSTRUCTIONAL BUILDING
EVPSTC	EAST VALLEY PUBLIC SAFELY TRAINING CENTER
GYM	GYMNASIUM
IB	INSTRUCTIONAL BUILDING
KHA	KINESIOLOGY, HEALTH EDUCATION, AQUATIC COMPLEX
LRC	LEARNING RESOURCES CENTER
M&O	MAINTENANCE AND OPERATIONS
M&O ADD	MAINTENANCE AND OPERATIONS ADDITION
NRTH	NORTH COMPLEX
PAC	PERFORMING ARTS CENTER
PSAH	PUBLIC SAFETY AND ALLIED HEALTH
SSB	STUDENT SUPPORT BUILDING
WEST	WEST COMPLEX

BUILDING LEGEND

- EXISTING BUILDING
- UNDER CONSTRUCTION
- FUTURE BUILDING
- BUILDING RENOVATION/EXPANSION

SYMBOL LEGEND

- EV CAR CHARGER
- EV CHARGING SPACES
- SELECTOR SWITCH
- EC CHARGER POC
- SWITCHBOARD

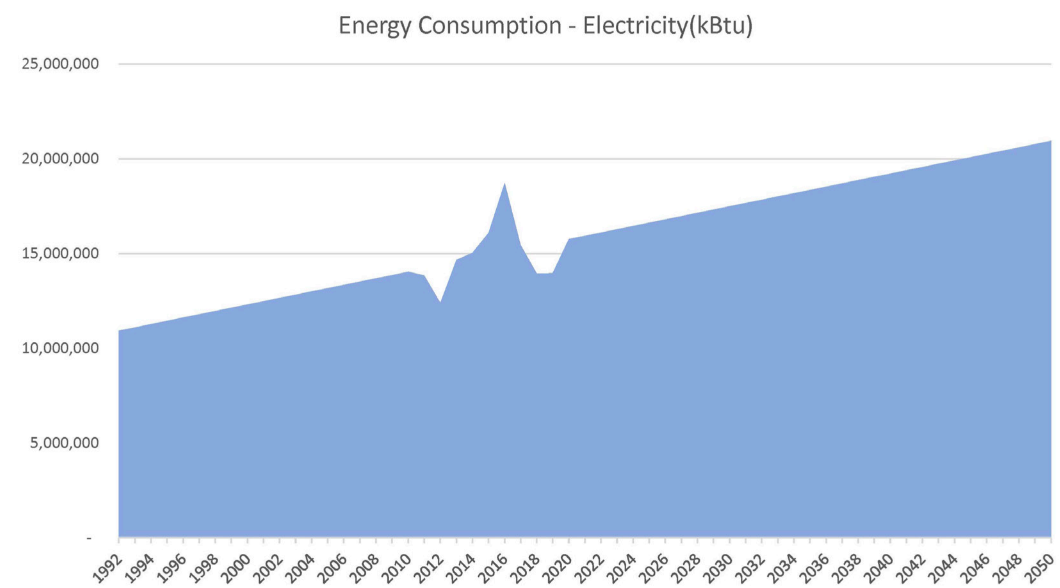
available X software to program and charge the chargers during periods of low demands to minimize the impact on the current electrical infrastructure serving existing facilities at the campus or seek direct service from SCE to serve the proposed chargers.

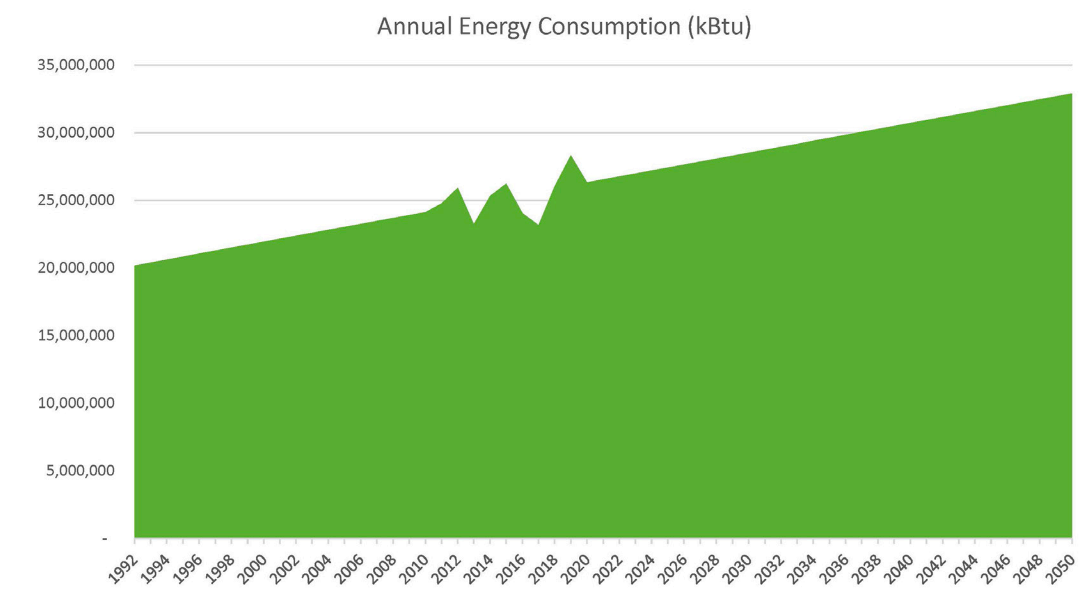
BASELINE AND TARGETS

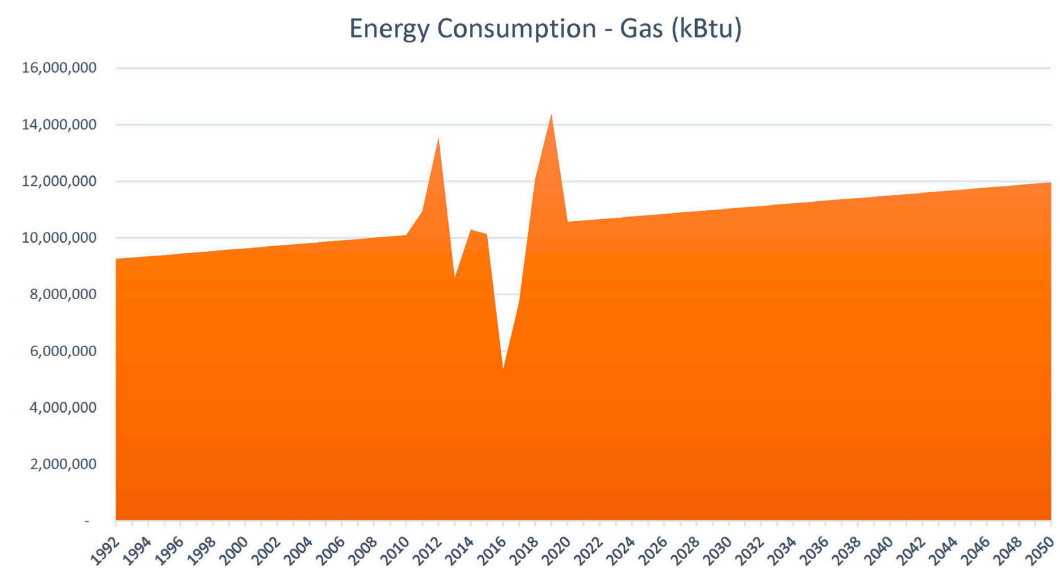
The College accounted for a total of 26,614MTeCO2 of emissions in 1990. An 80% reduction from 1990 levels to comply with AB 32 would be 5,322.8 MTeCO2. The 1990 emissions data assumes that the percentage of student, staff, and faculty members commuters have remained constant over the years.

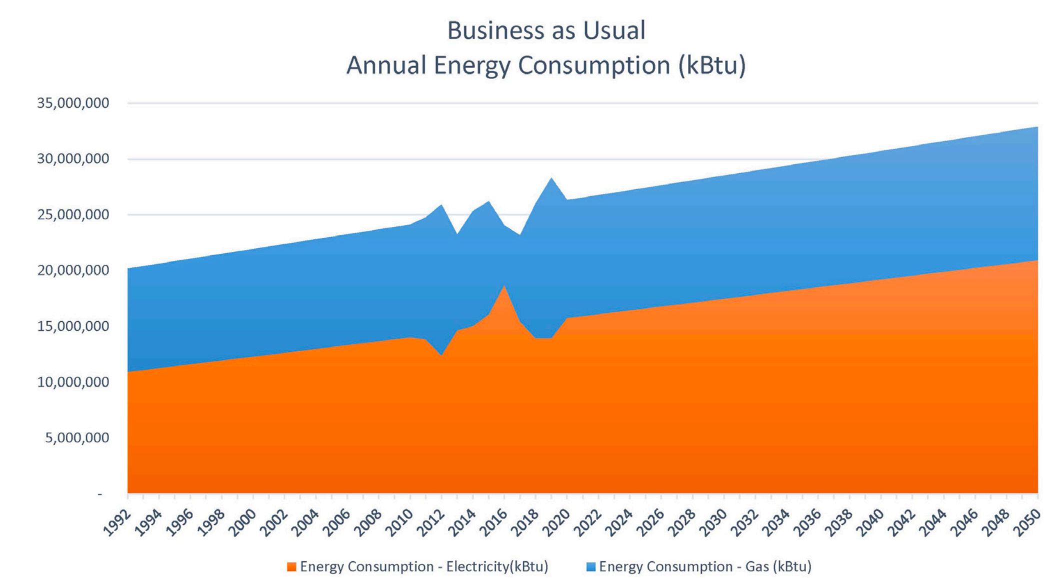
In 2008, the University accounted for 32668 MTeCO2. By 2030, it is estimated that the College needs to reduce their annual greenhouse gas emission by 26,985 metric tons to meet 40% below 1990 emissions.

If College trends were to continue, it is projected that emissions would plateau by 2033.



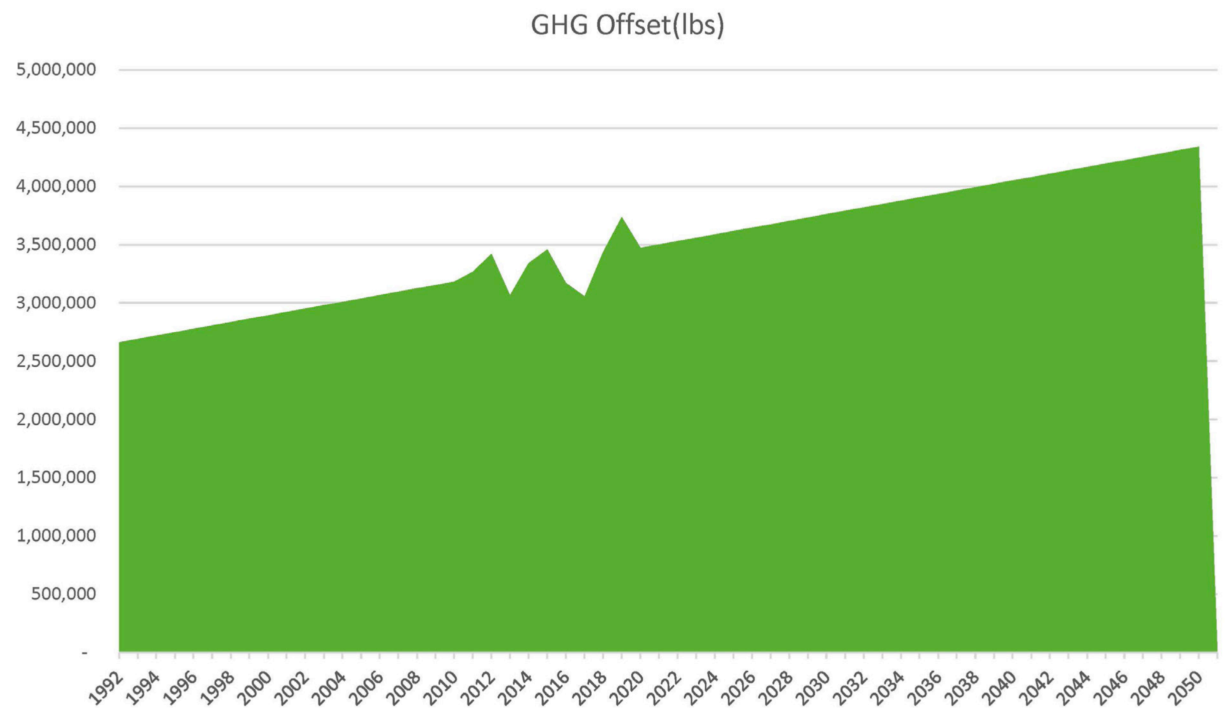


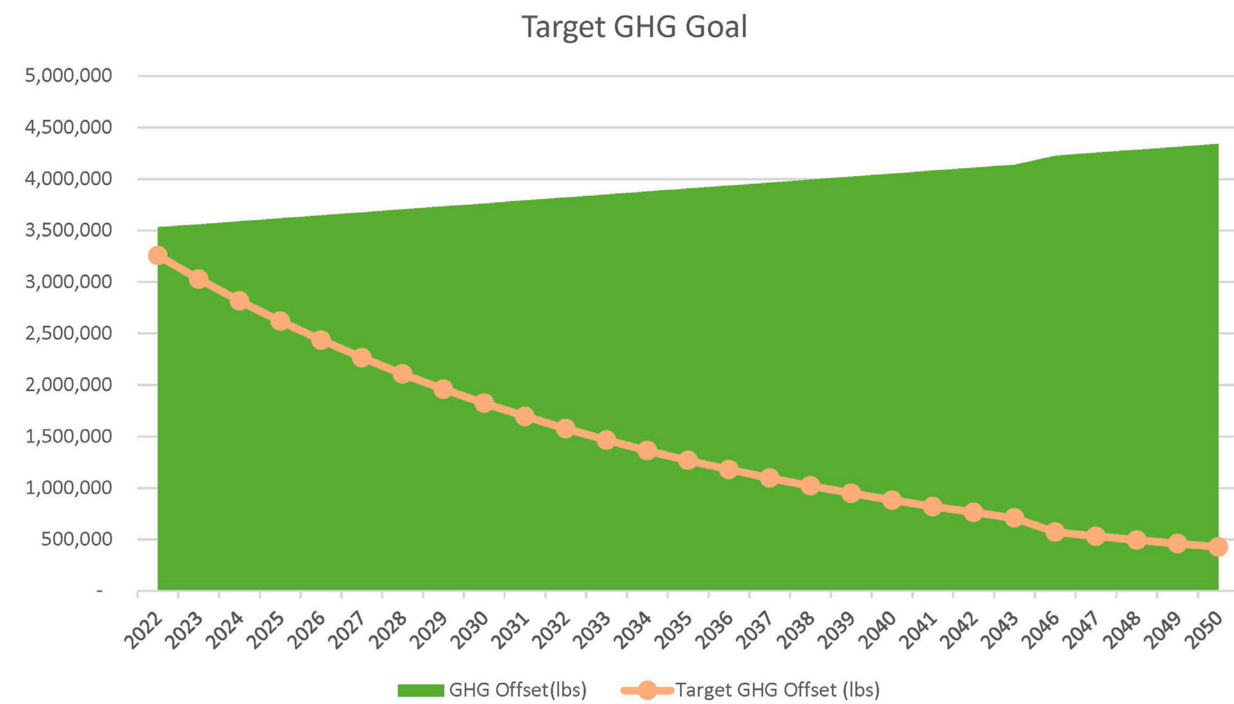


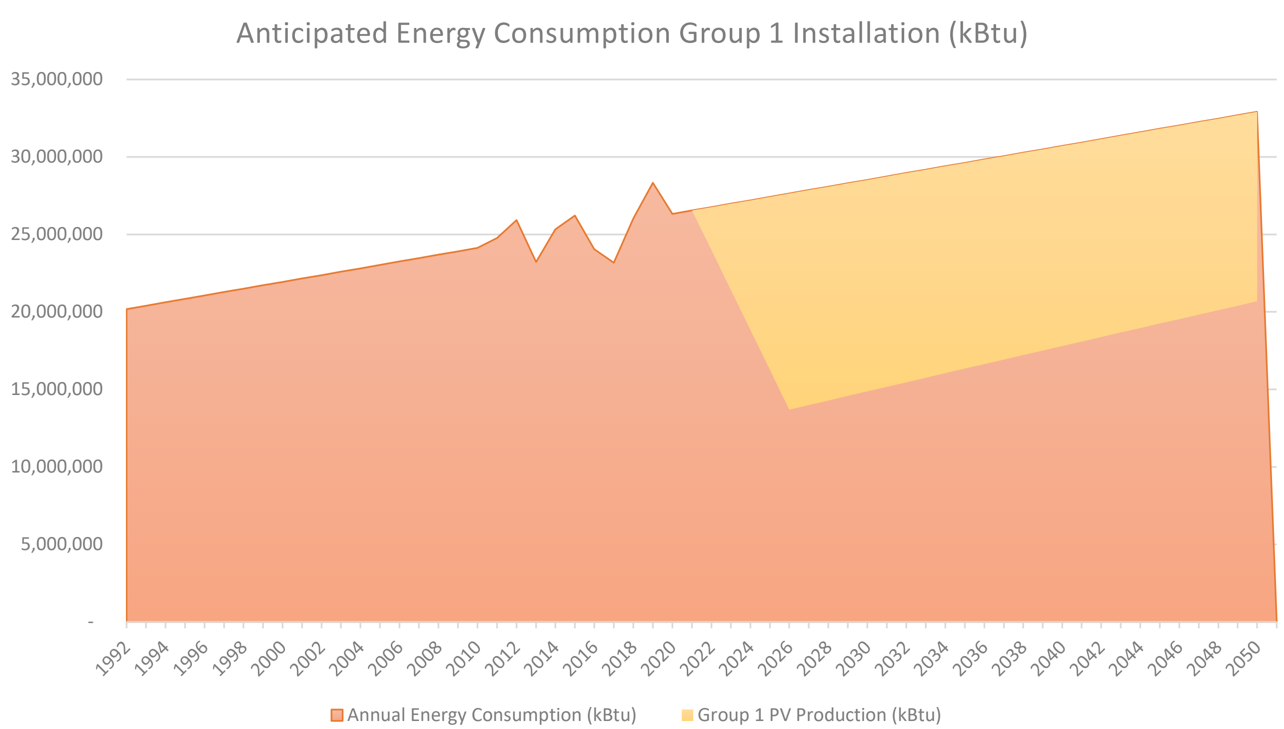


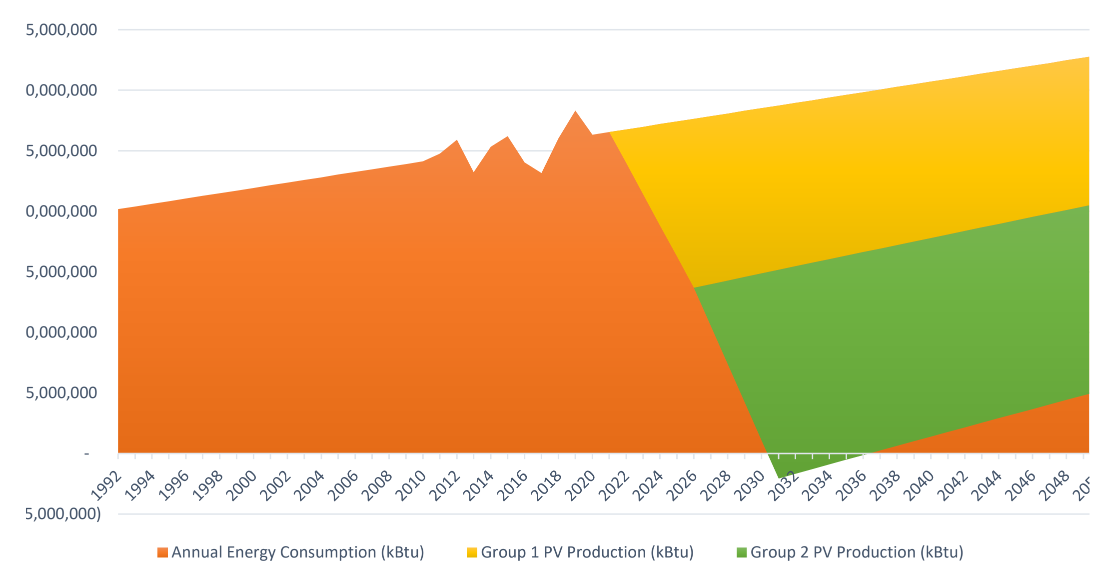
By 2050, it is estimated that the College needs to reduce their annual greenhouse gas emission by 38,067 metric tons to meet 80% of 1990 emissions. The last graph to the right shows increase in greenhouse gas emissions from various elements with business as usual approach.

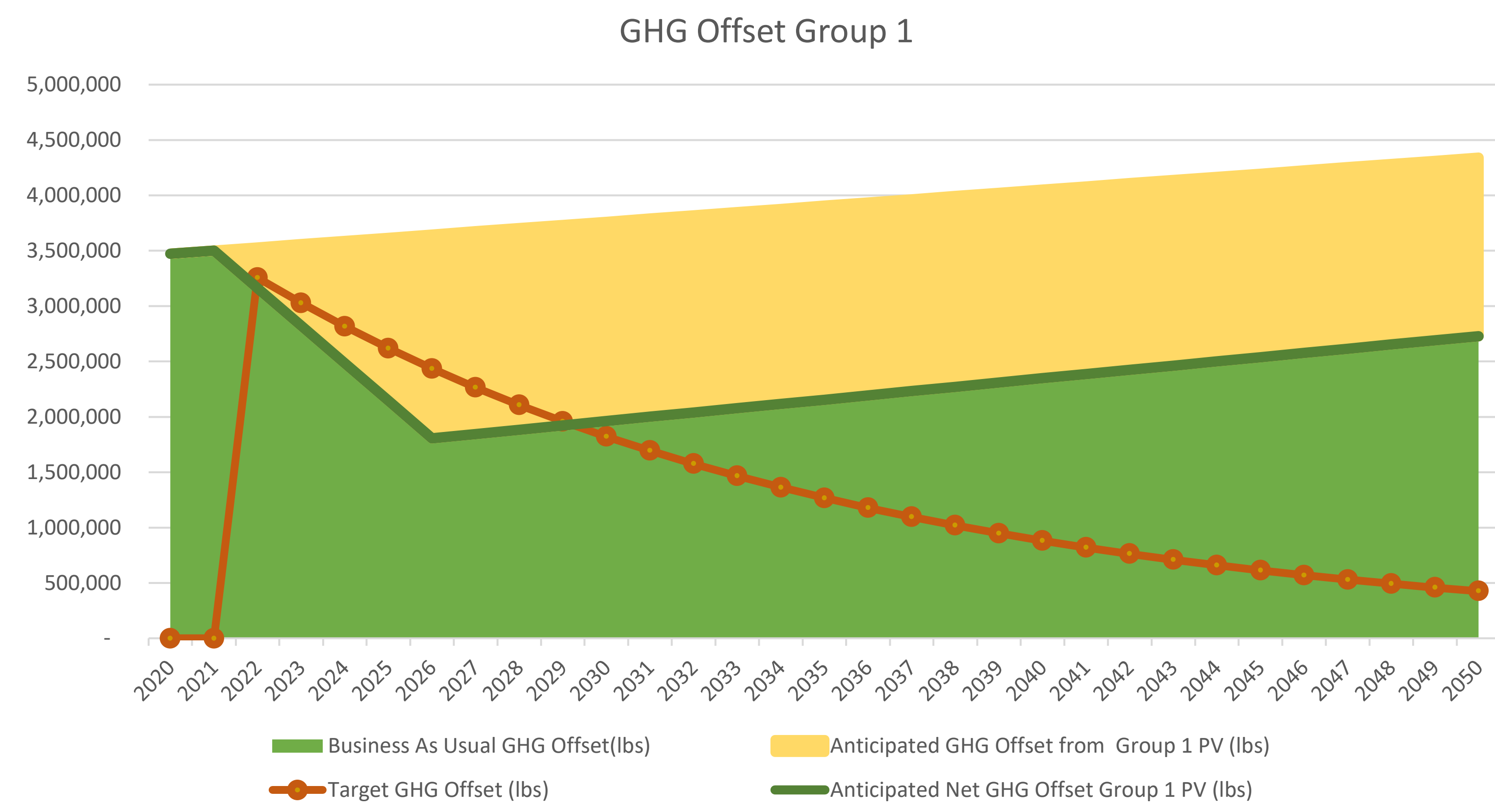
Our recommended strategies will help reduce the campus' overall greenhouse gas emissions. All strategies shown are directed towards reducing the greenhouse gas emissions of campus facilities and are show in the second graph to the right.

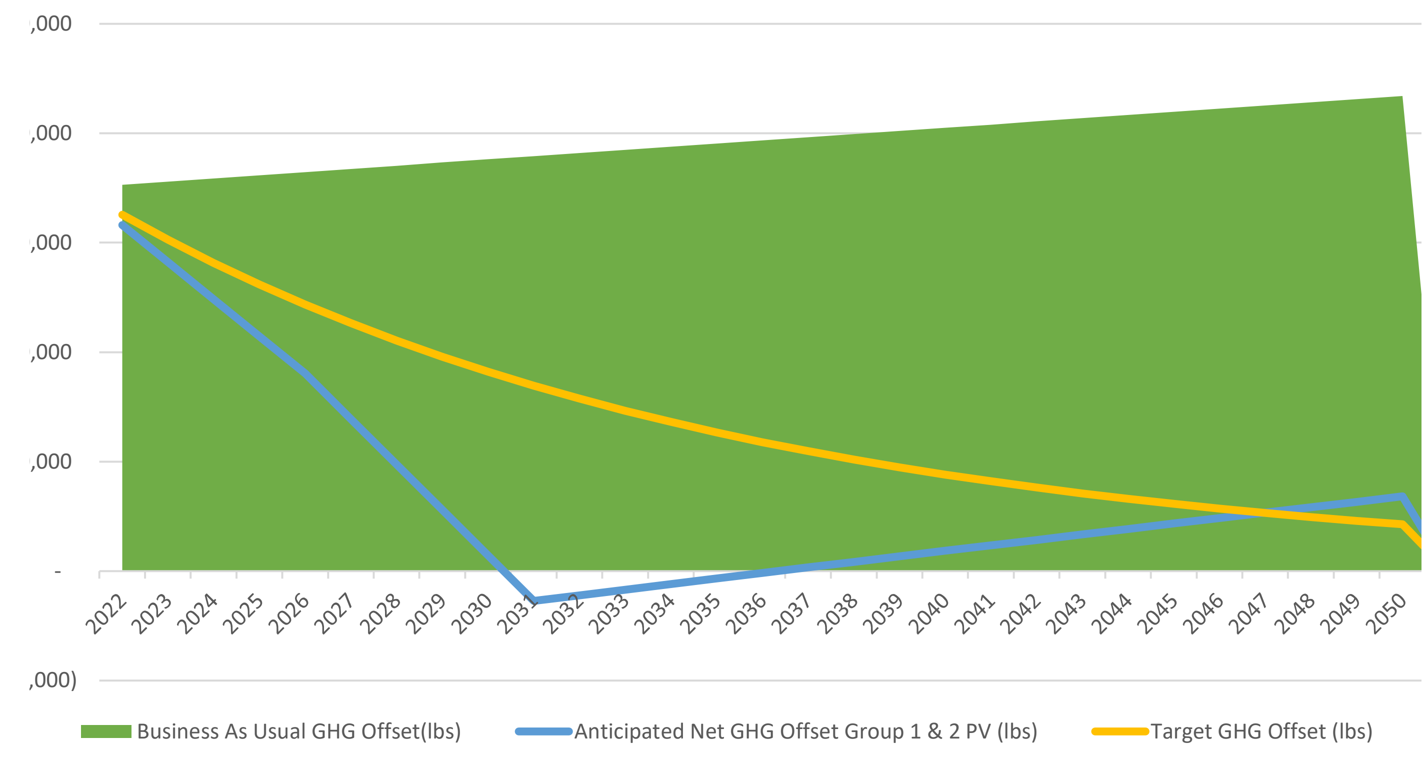









GHG Offset Group 1
5,000,000
4,500,000
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
-
2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050
Business As Usual GHG Offset(lbs)
Anticipated GHG Offset from Group 1 PV (lbs)
Target GHG Offset (lbs)
Anticipated Net GHG Offset Group 1 PV (lbs)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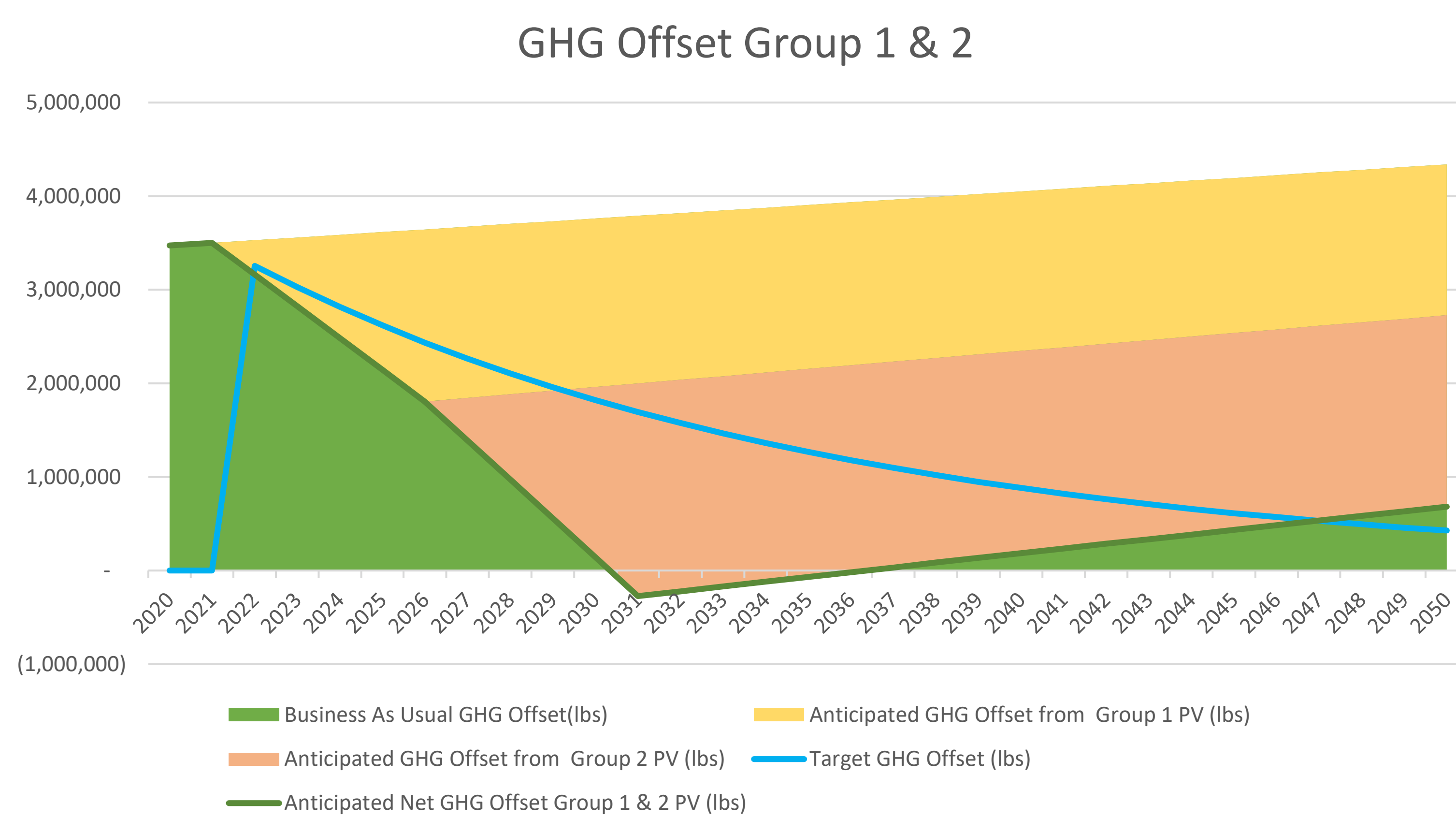
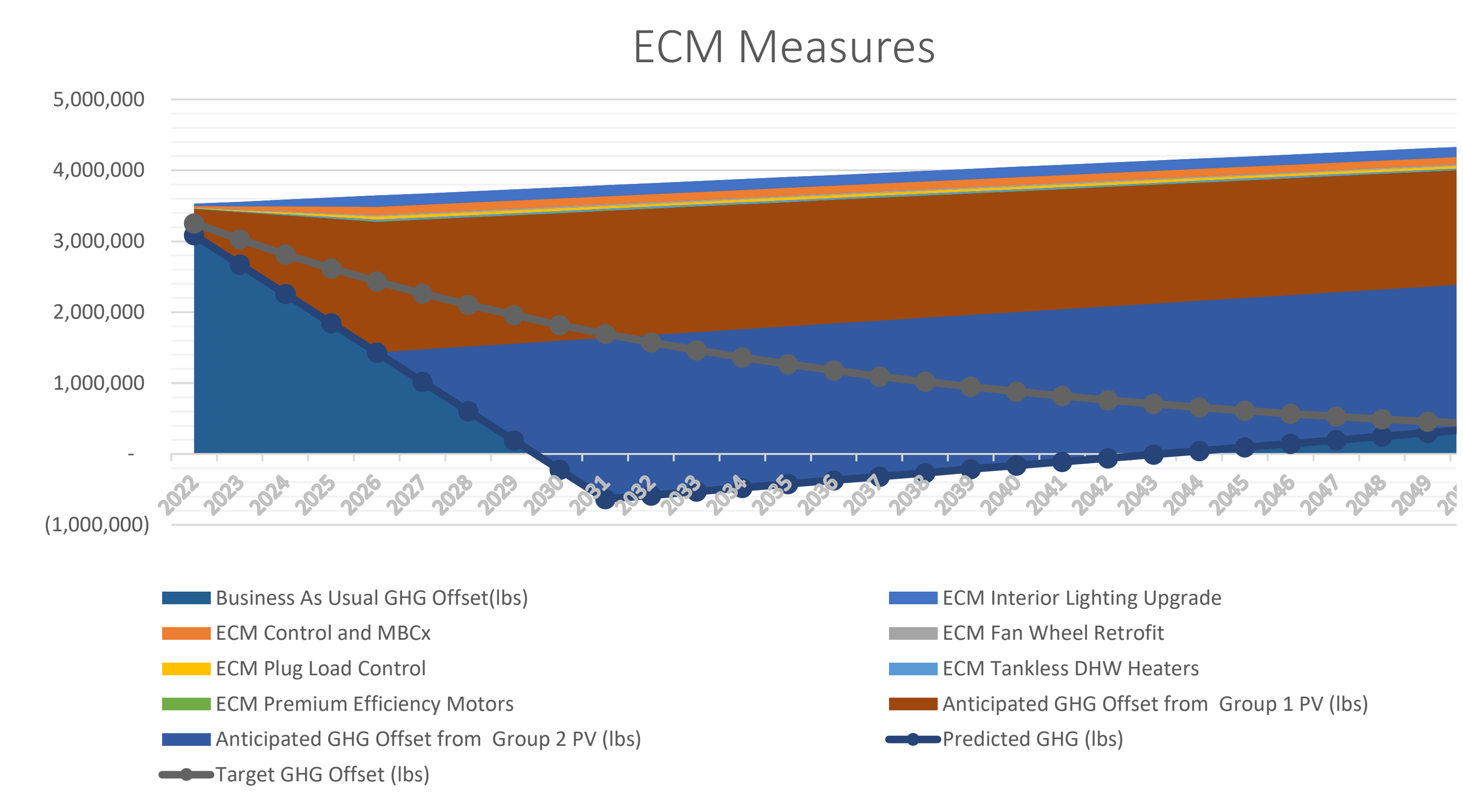
2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050
Business As Usual GHG Offset(lbs)
Anticipated Net GHG Offset Group 1 & 2 PV (lbs)
Target GHG Offset (lbs)


GHG Offset Group 1 & 2
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
-
(1,000,000)
2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050
Business As Usual GHG Offset(lbs)
Anticipated GHG Offset from Group 1 PV (lbs)
Anticipated GHG Offset from Group 2 PV (lbs)
Target GHG Offset (lbs)
Anticipated Net GHG Offset Group 1 & 2 PV (lbs)


ECM Measures
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
-
(1,000,000)
Business As Usual GHG Offset(lbs)
ECM Interior Lighting Upgrade
ECM Control and MBCx
ECM Fan Wheel Retrofit
ECM Plug Load Control
ECM Tankless DHW Heaters
ECM Premium Efficiency Motors
Anticipated GHG Offset from Group 1 PV (lbs)
Anticipated GHG Offset from Group 2 PV (lbs)
Predicted GHG (lbs)
Target GHG Offset (lbs)

Our recommended strategies will help reduce the campus' overall greenhouse gas emissions. All strategies shown are directed towards reducing the greenhouse gas emissions of campus facilities and are shown in the bottom graphs.

The Campus Lighting Reduction and 2011 Solar Photovoltaic System decreased the campus greenhouse gas emissions. In total the planned facilities reduced the campus greenhouse gas emissions by 3,551 metric tons per year (9.3% of 2020 goal).

In order to meet the ambitious goals of AB32 (80% below 1990 levels by 2050) and achieve an NZE status, the College will have to come up with a strategic plan to reduce greenhouse gas emissions. The graph below provides campus emissions and overall campus goals to reduce the same.

The following objectives, targets, metrics and action plans will be used for a roadmap to managing the climate change at the campus and mitigate the effects of greenhouse gas emissions.

IMPLEMENTATION ROADMAP

P2S conducted an analysis of the existing energy usage (both gas and electric usage), existing campus mechanical, electrical and plumbing systems serving each of the facilities at the campus, conducted an ASHRAE level 1 audit of existing facilities to reduce overall energy usage and evaluated the provision of renewable sources to offset the overall energy usage to achieve net zero energy status.

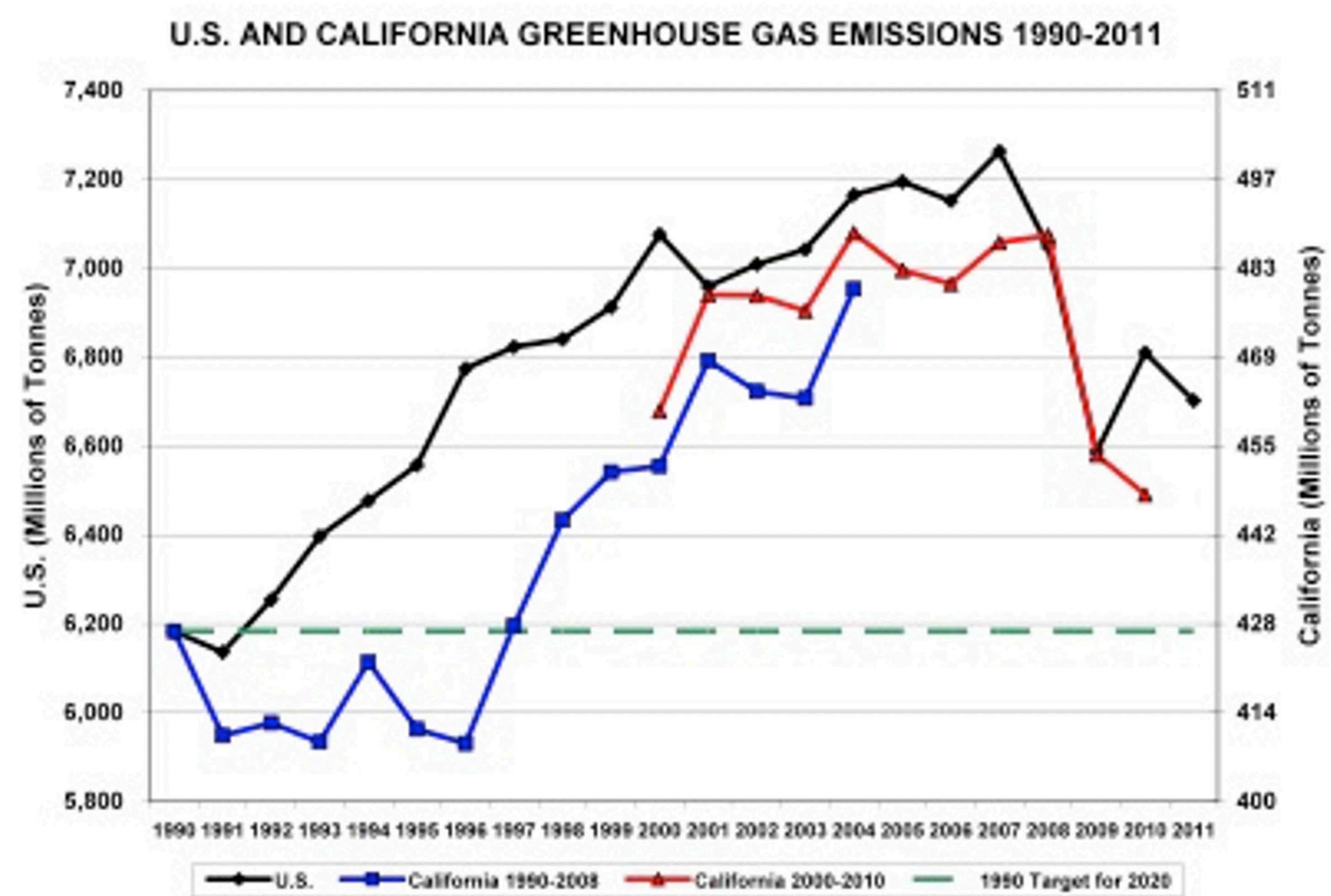
The primary objective or target is to promote electrification and offset overall energy usage in kBtu's by implementing overall energy reduction measures at each of the buildings and providing renewable energy sources to achieve overall net zero energy (NZE) status on a source basis.

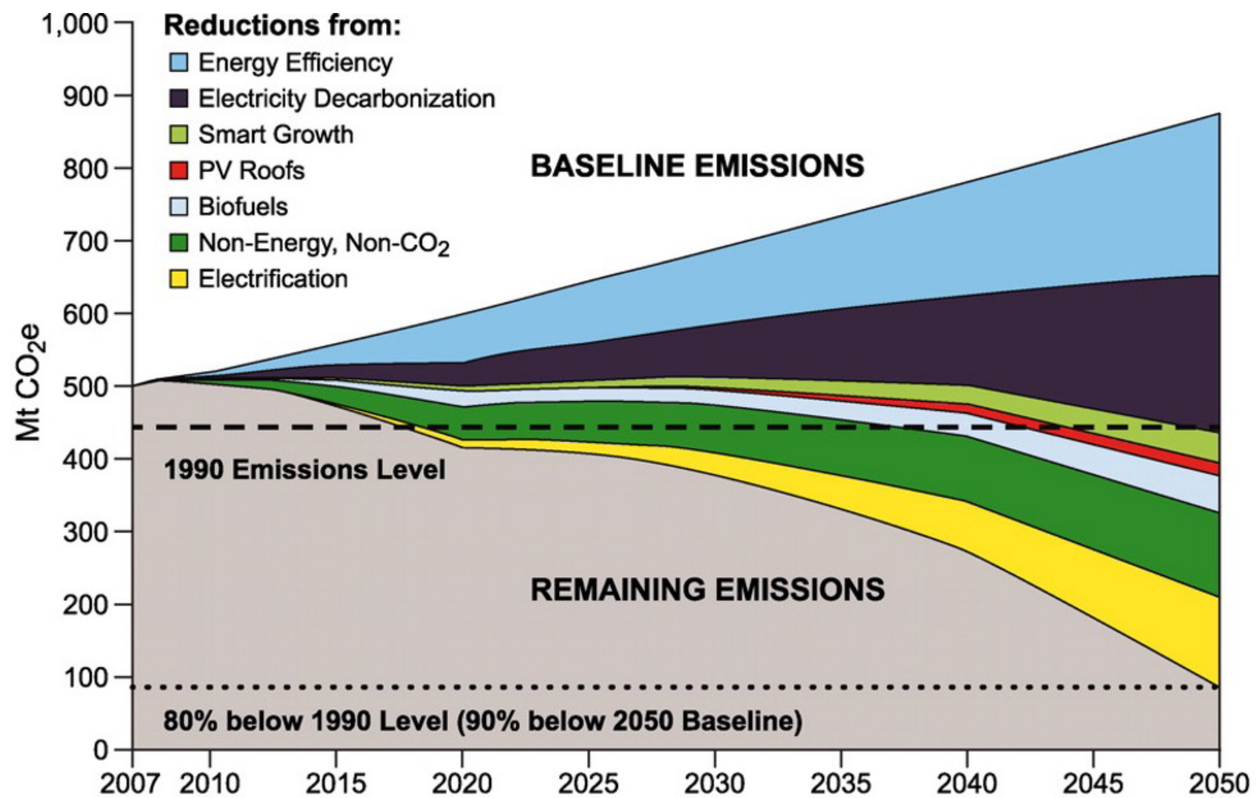
Following is an implementation roadmap for achieving NZE status at the campus:

- **Reduce overall energy usage**: Implement energy conservation measures (with paybacks less than 10 years) identified for each of the buildings to reduce overall electric and natural gas usage and hence the overall kBtu's of the campus. Advance measures to go through ASHRAE level 2 and 3 audits to reconfirm the savings and associated costs before implementation. Utilize a combination of incentives, on bill financing and available campus funds to fund these measures.
- **Promote metering of all utilities**: Implement a campus wide measure to provide metering to monitor natural gas, electric and water consumption at each of the facilities. Meters shall report to a central monitoring station and shall incorporate a front-end analytic software capable of not only providing monitoring capabilities for each of the utilities but also provide annual trends for each of the utilities by each facility.
- **Provide renewable energy sources and storage**: Implement a phased renewable energy sources and storage provision plan to offset overall imports from the utility, minimize overall natural gas emissions and shield the College from fluctuation in electric prices in the future. Utilize bond funding to implement the subject measure.
- **Stipulate and achieve ZNE status for all new and major renovations**: Achieve NZE status consistent with the CCC Governors Sustainability Policy and CA definition for NZE on source basis for all new buildings and major renovations to offset overall energy usage of the building(s). Measures should include setting an aggressive EUI target (A list of sample EUI targets is provided in Appendix for reference) based on the type and function of the building (s) early on in the project, adopting an integrated design approach for designing building systems, optimizing the orientation of the building (s), maximizing the overall efficiency of the envelope and MEP systems including provision of heat recovery systems and provision of renewable energy sources. Exceed current Title 24, Part 6 requirements by a minimum of 15%.
- **Promote water conservation strategies**: Implement water savings strategies in each of the new facilities and facilities undergoing major renovations to include high efficiency plumbing fixtures, drought tolerant vegetation, drip irrigation, use of aerators in faucets, storm water run off recapture and AHU condensate capture for irrigation use.
- **Promote US Green Building Practices**: Achieve a minimum of LEED Silver certification for each of the new buildings and major renovations at the campus. Include enhanced commissioning of facilities.
- **Promote EV Chargers**: Implement a phased approach to include provisions of EV chargers at each of the parking lots to promote electrification and minimize overall natural gas emissions.
- **Identify current and future baseline energy usage and Scope 1 and 2 greenhouse gas emissions baselines and create benchmarks:** Review Existing Baseline Greenhouse Gas Emission Inventory and update projections according to expected reductions to comply with AB32 requirements. Develop greenhouse gas emission reduction goals and document in a Climate Action Plan (CAP) with key strategies and associated reductions. Track Progress and report on greenhouse gas emissions.

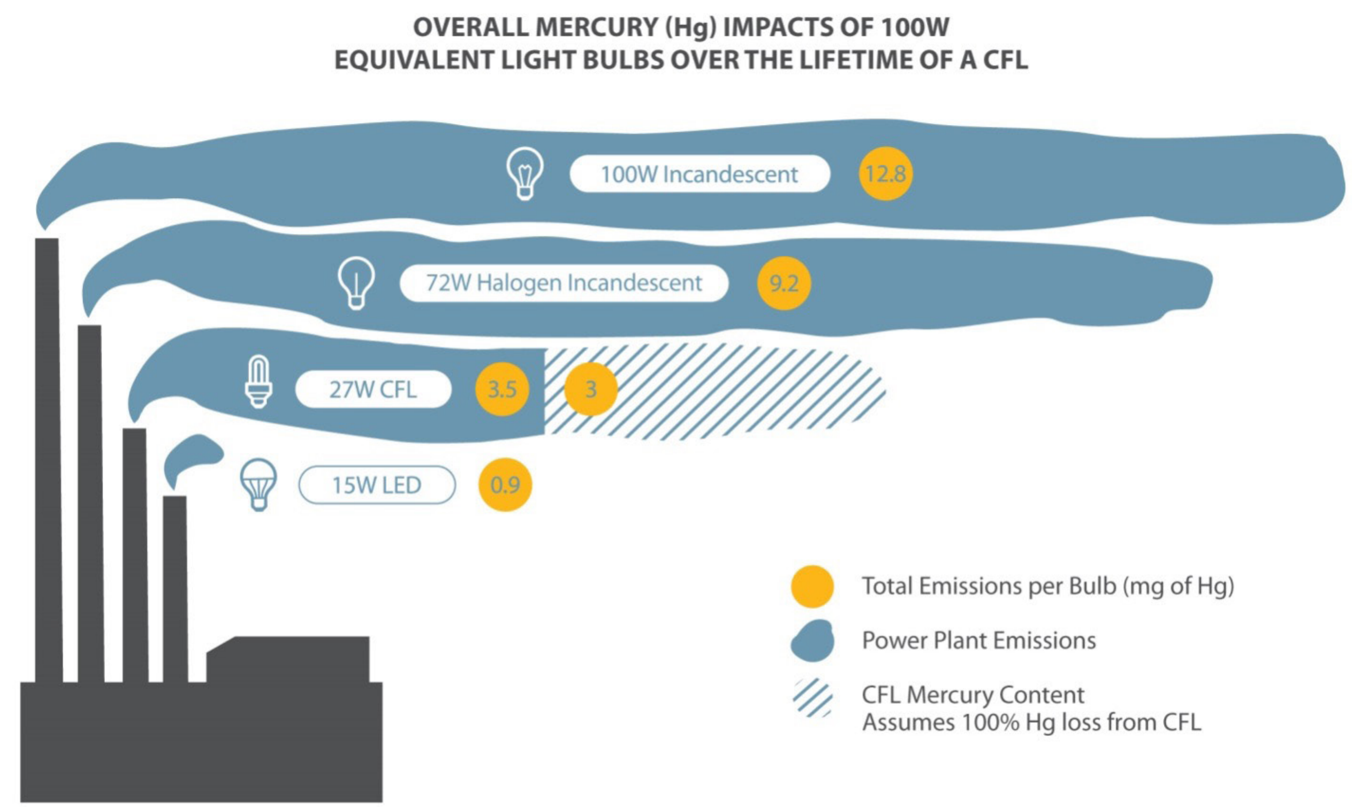
The most critical aspect of any NZE plan is the tracking of the efforts and ensuring each of the action plans presented get implemented. This implementation plan specifically addresses the importance of maximizing energy efficiency, promoting renewable energy sources, promoting electrification, promoting water conservation strategies and create sustainable and net zero energy facilities at the campus. tracking aspect of GHG emissions. In order to effectively address the action plans the District must first identify the current standing in terms of GHG emissions and the resulting effects of individual action plans. This plan would allow for a quantification of GHG reductions and be able to compare the reduction to the cost associated with the efforts to best determine practices that are within the target area and practical in implementation. The major aspect is to set an example so that more Educational Institutions can make substantial efforts to improve sustainability and achieve NZE status and in turn receive tangible valuable results both environmentally and economically.

Upon acting on each of the individual plans outlined above, the campus would be in a position to continually reduce the overall effect of greenhouse gasses on climate change.





Wedge Category:	Emissions Reduction Mt CO_2e (% of Total) 2030	2050	Types (and Numbers) of Measures Used	Key Attributes in 2050
Energy Efficiency	102 (33%)	223 (28%)	Building EE (18); Vehicle EE (9); Other EE (6)	Energy efficiency improved 1.3% per year on average for 40 years
Electricity Decarbonization	72 (23%)	217 (27%)	High renewables, high nuclear, high CCS, and mixture of the three	90% of generation requirement met with CO_2- free sources. Equivalent decarbonization in each scenario
Smart Growth	13 (4%)	41 (5%)	Reductions in vehicle miles traveled (VMT) (6)	VMT reduced in light duty vehicles (LDV) by 10%; freight trucks 20%; other transportation 20%
Rooftop PV	8 (3%)	21 (3%)	Residential and commercial PV roofs (2)	10% of electricity demand displaced by rooftop PV
Biofuels	18 (6%)	49 (6%)	Transportation biofuels; ethanol, biodiesel, biojet fuel (9); Residential, commercial, industrial biomethane (3)	2% of natural gas use in buildings displaced by biomethane, and 10-20% of petroleum-based fuels for vehicles displaced by biofuels
Non-Energy, Non-CO_2	67 (22%)	116 (15%)	Cement, agriculture, and other (3)	Non-fuel; non-CO_2 GHG emissions reduced 80% below baseline
Electrification	29 (9%)	124 (16%)	Transportation electrification (9); Other end-use electrification (5)	75% of LDV gasoline use displaced by PHEVs & electric vehicles; 30% of fuel use in other transport sectors electrified; 65% electrification of non-heating/ cooling fuel use in buildings; 50% electrification of industrial fuel uses
Baseline Case Emissions	688	875		
Mitigation Case Emissions	380	85		
Total Reduction	308	790		



PHASED STRATEGIES AND RECOMMENDATIONS

The following are phased strategies and our recommendations to not only promote sustainability at the campus but achieve NZE status and reduce overall greenhouse gas emissions to meet the current legislations and CCC Governors Sustainability Policy requirements.

Phase 1

1A: REDUCE OVERALL ENERGY USAGE

- Implement the following energy conservation measures identified in each of the buildings to reduce overall electric and natural gas usage and, hence, the campus's overall kBtu's. Advance measures to go through ASHRAE level 2 and 3 audits to reconfirm the savings and associated costs before implementation. Utilize a combination of incentives, on bill financing and available campus funds to fund these measures.

ECM #	ECM Description	Energy Savings, kWh/yr	Demand Savings, kW	Therm Savings, therms/yr	Construction Cost	Incentives / Rebate, $	Cost Savings, $	Simple Payback, Yrs
1	Interior Lighting Upgrade	111,817	32	0	$64,544	$9,196	$15,800	3.5
2	Exterior Lighting Upgrade	90,009	6	0	$147,700	$0	$13,006	11.4
3	Controls, RCx, and MBCx	147,609	0	1,760	$105,771	$20,408	$14,740	5.8
4	Fan Wheel Retrofit	48,105	2	0	$63,000	$0	$4,397	14.3
5	Plug Load Control	93,820	0	0	$70,000	$0	$8,575	8.2
6	Tankless DHW Heaters	48,347	0	-1,650	$35,612	$0	$3,248	11.0
7	Premium Efficiency Motors	7,250	0	0	$13,144	$0	$1,053	12.5
8	RTU Upgrade	23,629	0	0	$126,000	$1,860	$2,160	57.5
TOTALS:		570,585	40	110	$625,772	$31,464	$62,978	9.4

1B: PROMOTE METERING OF ALL UTILITIES AT THE FOLLOWING BUILDINGS

- Provide meters to monitor natural gas, electric and water consumption at each of the facilities. Meters shall report to a central monitoring station and shall incorporate a front-end analytic software capable of not only providing monitoring capabilities for each of the utilities but also provide annual trends for each of the utilities by each facility. Utilize a combination of On Bill financing and available campus funds to fund these measures.

Campus	Building	Installed Cost
CHC	ARTS	$25,254
CHC	CCR	$9,492
CHC	CDC	$45,872
CHC	CNTL 1	$50,932
CHC	CNTL 2	$25,764
CHC	CTB	$9,064
CHC	CYN	$9,312
CHC	EAST 1 & 2	$78,080
CHC	EXTERIOR	$280,000
CHC	LRC	$23,408
CHC	M&O	$13,216
CHC	NRTH	$5,376
CHC	PAC	$74,813
CHC	PSAH	$9,089
CHC	SSB	$13,055
CHC	VARIOUS	$2,290,000
CHC	WEST	$15,346
GRAND TOTAL		$ 2,978,071.88

1C: PROVIDE RENEWABLE ENERGY SOURCES AND STORAGE

- Provide PV systems at the following areas to offset overall imports from the utility, minimize overall natural gas emissions and shield the College from fluctuation in electric prices in the future. Utilize bond funding to implement the subject measure. Based on the existing demand and PV systems installed under phase 1, 740kW/2960kWh Battery Energy Storage System shall be integrated into the campus distribution system.

Area	PV Size [kW]	Mounting Type	Energy Generated [kWh]	Energy Generation [kBtu]	Campus Demand %	GHG Offset [lb]	System Cost ($)*	Payback Period	Electric Bill Savings	TIRR %
Group 1	2,117.8	MULTIPLE	4,056,468	13,840,669	100%	632,253	$4,452,000	10.2	$14,356,322	31%
Group 1 + 740kW/2960kWh Ba	2,117.8	MULTIPLE	4,056,468	13,840,669	100%	632,253	$7,550,763	7.8	$20,370,363	20%
Solar Farm Area 2	366.6	GROUND MOUNT	711,770	2,428,559	30%	320,297	$1,308,480	18.6	$2,787,590	4%
Solar Farm Area 3	355.3	GROUND MOUNT	671,014	2,289,500	29%	301,956	$1,299,456	18.8	$2,137,228	3%
Solar Farm Area 4	366.6	GROUND MOUNT	711,956	2,429,194	27%	320,380	$1,140,000	17.7	$2,007,948	4%
Solar Farm Area 6	1,070.0	GROUND MOUNT	1,993,901	6,803,190	75%	360,101	$3,429,120	20.7	$4,969,215	2%

* Note: Cost includes PV panel, Balance of System (BOS), and cost of all structures

Crafton Hills College Group 1			
Energy Type	Consumption KWH	Consumption Kbtu	Source Energy Factor (KBTU)
Electricity Purchase	2,529,936.00	8,632,141.63	23,112,559.22
G1 - Solar Farm 2	(711,769.00)	(2,428,555.83)	(7,649,950.86)
G1 - Solar Farm 3	(671,013.00)	(2,289,496.36)	(7,211,913.52)
G1 - Solar Farm 4	(711,955.00)	(2,429,190.46)	(7,651,949.95)
G1 - Solar Farm 6	(1,993,900.00)	(6,803,186.80)	(21,430,038.42)
Total Production	4,088,637.00	13,950,429.44	43,943,852.75

Phase 2:

2A: STIPULATE AND ACHIEVE ZNE STATUS FOR ALL NEW AND MAJOR RENOVATIONS

- Achieve NZE status consistent with the CCC Governors Sustainability Policy and CA definition for NZE on source basis for all new buildings and major renovations to offset overall energy usage of the building(s). Measures should include setting an aggressive EUI target (A list of sample EUI targets is provided in Appendix for reference) based on the type and function of the building (s) early on in the project, adopting an integrated design approach for designing building systems, optimizing the orientation of the building (s), maximizing the overall efficiency of the envelope and MEP systems including provision of heat recovery systems and provision of renewable energy sources. Exceed current Title 24, Part 6 requirements by a minimum of 15%.

2B: PROMOTE WATER CONSERVATION STRATEGIES

- Implement water savings strategies in each of the new facilities and facilities undergoing major renovations to include high efficiency plumbing fixtures, drought tolerant vegetation, drip irrigation, use of aerators in faucets, storm water run off recapture and AHU condensate capture for irrigation use.

2C: PROMOTE US GREEN BUILDING PRACTICES

- Achieve a minimum of LEED Silver certification for each of the new buildings and major renovations planned at the campus below. Include enhanced commissioning of facilities.

Future Buildings		
#	Building Name	Proposed Renovation
1	Gym Building	New
2	Performing Arts Center	New
3	East Instructional Building	New
4	Instructional Building	New
5	Soccer Field	New
6	East Valley Public Safety Training Center	New
7	Child Development Center	Renovation
8	Crafton Hall	Renovation
9	Central Complex 2	Renovation
10	Student Support Building	Renovation
11	West Complex	Renovation

2D: PROMOTE EV CHARGERS

- Implement a phased approach to include provisions of EV chargers at each of the parking lots below to promote electrification and minimize overall natural gas emissions.

CHC - Level 2 Charging

Parking Lot	Parking Spaces	EV Spaces	Electrical POC	Electrical POC Capacity	Electrical POC Existing Load (kW)	Proposed Load Addition (kW)	Proposed Electrical POC Estimated Load (kW)
A	74	5	Parking Lot A, Switchboard DBA	500	200	41.44	385.36
B	137	10	Parking Lot A, Switchboard DBA			76.72	
C	120	8	Parking Lot A, Switchboard DBA			67.2	
D	23	2	Central Complex, Main Switchboard	500	200	12.88	254.32
E	74	5	Central Complex, Main Switchboard			41.44	
F	80	6	Proposed EIB Building, Main Switchboard	500	200	44.8	291.28
G	83	6	Proposed EIB Building, Main Switchboard			46.48	
H	79	6	PSAH Building, Main Switchboard	500	200	44.24	385.36
I	252	18	PSAH Building, Main Switchboard			141.12	
J	173	12	Gym Building, Main Switchboard	750	300	96.88	396.88
K	128	9	Crafton Hall, Main Switchboard	500	200	71.68	271.68
L	85	6	Proposed CDC Building, Main Switchboard	300	120	47.6	212.4
M	80	6	Proposed CDC Building, Main Switchboard			44.8	
N	62	4	LRC Building, Main Switchboard	1500	600	34.72	634.72
P	57	5	Proposed PAC Building, Main Switchboard	500	200	40	240
R	46	3	Proposed IB Building, Main Switchboard	500	200	25.76	225.76
M&O	35	2	M&O Building, Main Switchboard	750	300	19.6	319.6
TOTAL	1588	112					

CHC - DC Fast Charging

Parking Lot	Parking Spaces	EV Spaces	Electrical POC	Electrical POC Capacity	Electrical POC Existing Load (kW)	Proposed Load Addition (kW)	Proposed Electrical POC Estimated Load (kW)
D	23	2	Central Complex, Main Switchboard	500	200	120.75	320.75
F	80	6	Proposed EIB Building, Main Switchboard	1500	200	420	1055.75
G	83	6	Proposed EIB Building, Main Switchboard	0	0	435.75	
L	85	6	Proposed CDC Building, Main Switchboard	1000	120	446.25	986.25
M	80	6	Proposed CDC Building, Main Switchboard	0	0	420	
N	62	4	LRC Building, Main Switchboard	1500	600	325.5	925.5
P	57	5	Proposed PAC Building, Main Switchboard	750	200	375	575
R	46	3	Proposed IB Building, Main Switchboard	500	200	241.5	441.5
M&O	35	2	M&O Building, Main Switchboard	750	300	183.75	483.75
TOTAL	551	40					

Phase 3

3: PROVIDE RENEWABLE ENERGY SOURCES

- Provide PV systems at the following additional areas to offset overall imports from the utility, minimize overall natural gas emissions and shield the College from fluctuation in electric prices in the future. Utilize bond funding to implement the subject measure.

Area	PV Size [kW]	Mounting Type	Energy Generated [kWh]	Energy Generation [kBtu]	Campus Demand %	GHG Offset [lb]	System Cost ($)*	Payback Period	Electric Bill Savings	TIRR %
Lot N	188.9	CARPORT	317,484	1,083,255	12%	142,868	$604,608	20.2	$1,175,285	4%
Lot R	124.1	CARPORT	232,490	793,256	9%	104,621	$397,056	18.5	$862,474	5%
Gym	237.8	ROOFTOP	377,364	1,287,566	14%	169,814	$761,024	21.3	$1,398,196	3%
IB	67.2	ROOFTOP	126,701	432,304	5%	57,015	$215,072	17.2	$503,940	5%
PAC	126.0	ROOFTOP	226,436	772,600	8%	101,896	$403,072	19.3	$829,759	4%
Lot J	614.8	CARPORT	1,142,635	3,898,671	42%	514,186	$2,067,232	20.5	$3,850,562	3%
Lot K	391.04	CARPORT	559,086	1,907,601	21%	251,589	$1,251,328	23.1	$2,058,311	2%
Lot M&O	74.26	CARPORT	136,170	464,612	5%	61,277	$237,632	18	$524,307	5%
Lot P	243.93	CARPORT	456,379	1,557,165	17%	205,371	$780,576	18.8	$1,658,975	4%
Solar Farm Area 1	423.0	GROUND MOUNT	821,556	2,803,149	30%	369,700	$1,353,600	18.7	$2,855,770	4%
Solar Farm Area 5	428.6	GROUND MOUNT	829,171	2,829,131	31%	373,127	$1,371,648	18.8	$2,878,532	4%

* Note: Cost includes PV panel, Balance of System (BOS), and cost of all structures

Crafton Hills College Group 2			
Energy Type	Consumption KWH	Consumption Kbtu	Source Energy Factor (KBTU)
Electricity Purchase	4,311,736.69	14,711,645.59	39,390,431.06
G2 - Lot N	(317,484.00)	(1,083,255.41)	(3,412,254.54)
G2 - Lot R	(232,491.00)	(793,259.29)	(2,498,766.77)
G2 - Gym	(377,364.00)	(1,287,565.97)	(4,055,832.80)
G2 - IB	(126,700.00)	(432,300.40)	(1,361,746.26)
G2 - PAC	(226,435.00)	(772,596.22)	(2,433,678.09)
G2 - SOLAR FARM 1	(821,558.00)	(2,803,155.90)	(8,829,941.07)
G2 - SOLAR FARM 5	(829,172.00)	(2,829,134.86)	(8,911,774.82)
G2 - LOT J	(966,949.00)	(3,299,229.99)	(10,392,574.46)
G2 - LOT K	(559,085.00)	(1,907,598.02)	(6,008,933.76)
G2 - LOT M&O	(136,171.00)	(464,615.45)	(1,463,538.67)
G2 - LOT P	(456,379.00)	(1,557,165.15)	(4,905,070.22)
TOTAL PRODUCTION	5,049,788.00	17,229,876.66	54,274,111.47

Ongoing

IDENTIFY CURRENT AND FUTURE BASELINE ENERGY USAGE AND SCOPE 1 AND 2 GREENHOUSE GAS EMISSIONS BASELINES AND CREATE BENCHMARKS

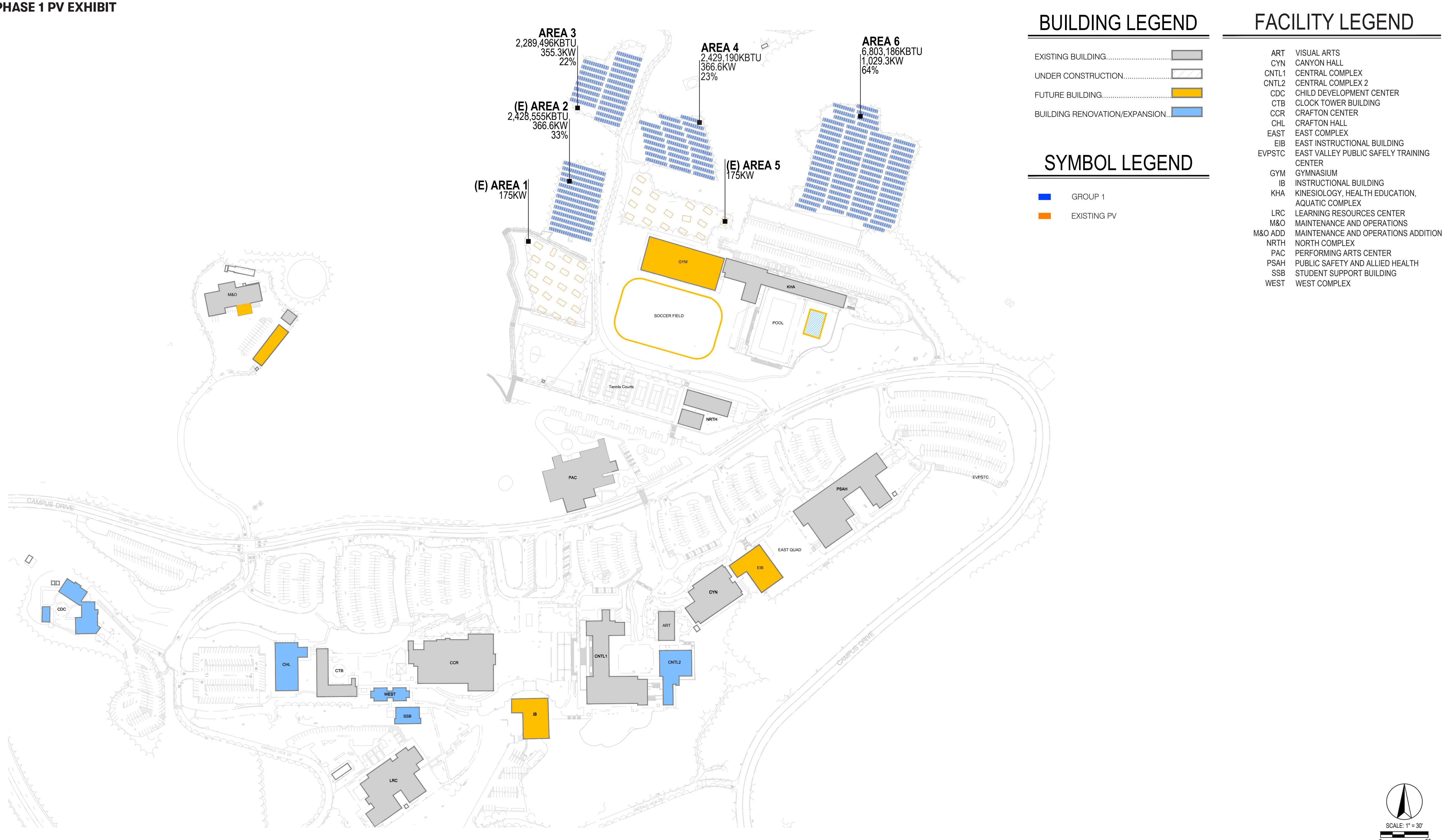
- Review Existing Baseline Greenhouse Gas Emission Inventory and update projections according to expected reductions to comply with AB32 requirements. Develop greenhouse gas emission reduction goals and document in a Climate Action Plan (CAP) with key strategies and associated reductions. Track Progress and report on greenhouse gas emissions.

SUMMARY OF OUR ANALYSIS AND RECOMMENDATIONS

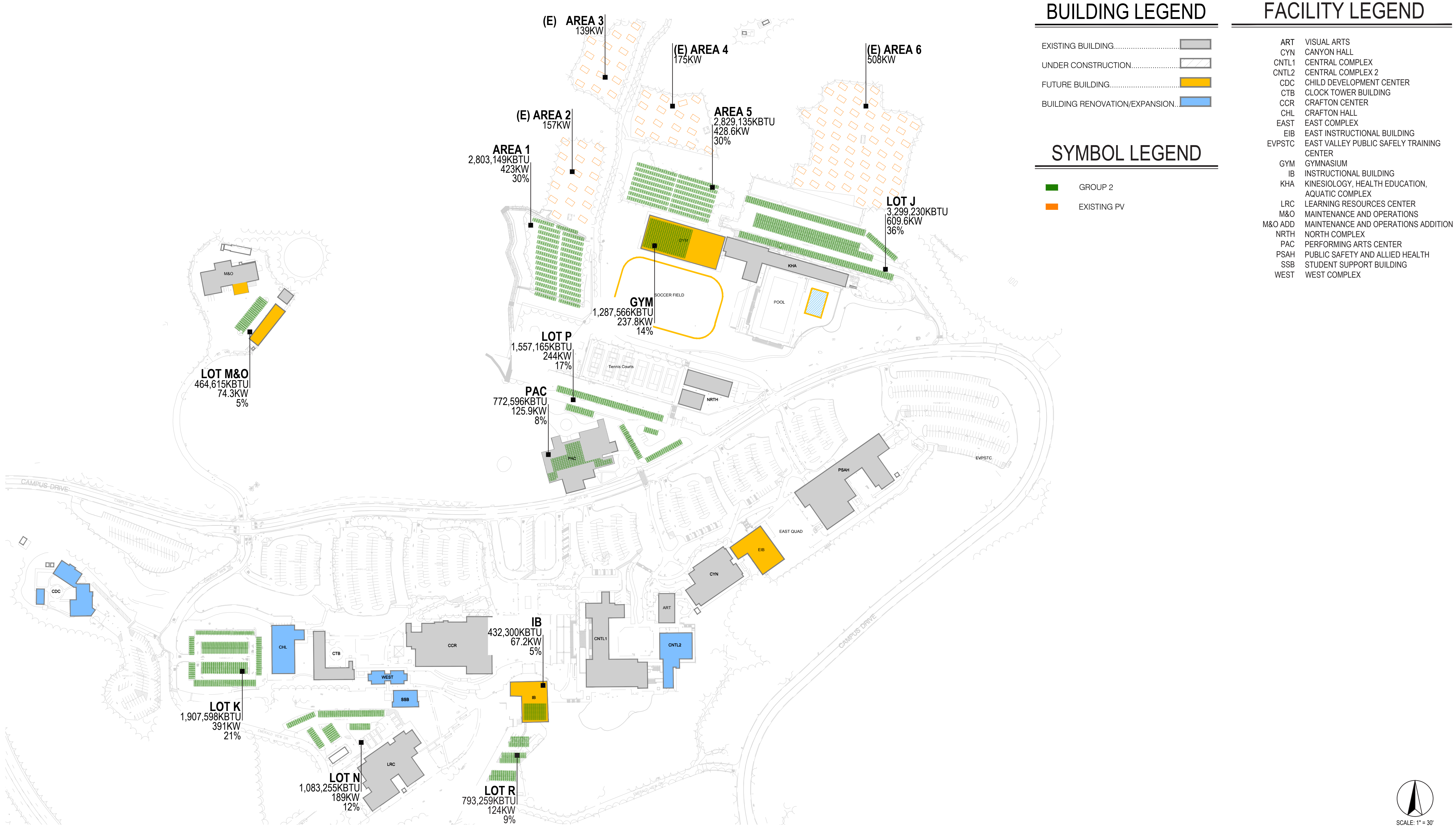
Priority 1	Projects within 2-5 years	Priority 3	Future Projects
Priority 2	Projects within 5 years		Ongoing Projects

Project Tracking #	Project	Phase	Proposed Year(s) of Execution	Brief Description of the Project	Priroty Level	Project Category	Total Projected Construction Costs ($) 1	Dollar Savings	Payback 2	Funding Source	Recommended Project Delivery Method and Funding Source
1	Energy Efficiency Upgrades	1A	2021-2024	Implementation of energy efficiency measures provided and detailed in Chapter 2 of the report with paybacks less than 10 years.	1	EE	$570,585	$62,978	9.4 years	On Bill Financing (OBF) and Cutomized Incentive Programs	Design Build with On Bill Financing
2	Provision of Group 1 PV Systems	1B	2021-2024	Implementation of PV systems in Group 1 areas as shown in PV Exhibit in Chapter 4	1	PV	$4.4M	$14.3M	10.2 years	Lease, PPA and Energy Loans	Design Build with Outright purchase
3	Provision of Group 1 PV & Battery Energy Storage System	1B-1	2021-2024	Implementation of PV systems in Group 1 areas as shown in PV exhibit in Chapter 4 and Battery Energy Storage System.	1	PV & Battery	$7.7M	$20.3M	7.8 years	Lease, PPA and Energy Loans	Design Build with Outright purchase
4	Provision of Metering	1C	2021-2024	Implementation of gas and electrical metering in each of the buildings at the campus to monitor existing energy consumption	1	EE	$630,000	N/A	N/A	On Bill Financing (OBF) and Cutomized Incentive Programs	Design Bid Build with Outright purchase
5	Provision of EV Chargers and Associated Infrastructure	2	2021-2024	Provision of EV Chargers and associated infrastructure as shown in EV Exhibit(s) in Chapter 3	2	EV	N/A	N/A	N/A	SCE Incentives and Grants	Design Bid Build with SCE Incentives and Grants
6	Provision of Group 2 PV Systems in Phases	3	2021-2024	Implementation of PV systems in Group 2 areas in phases as shown in PV Exhibit in Chapter 4	3	PV	$9.2M	$11.2M	$678,000	Lease, PPA and Energy Loans	Design Build with Outright purchase
7	New and Major Renovation of Facilities	Ongoing	Ongoing	Promoting sutainable strategies for new buildings and major renovations to achieve LEED Platinum and NZE certifications		New Buildings and Major Renovations	N/A	N/A	N/A	State and Bond Funds	

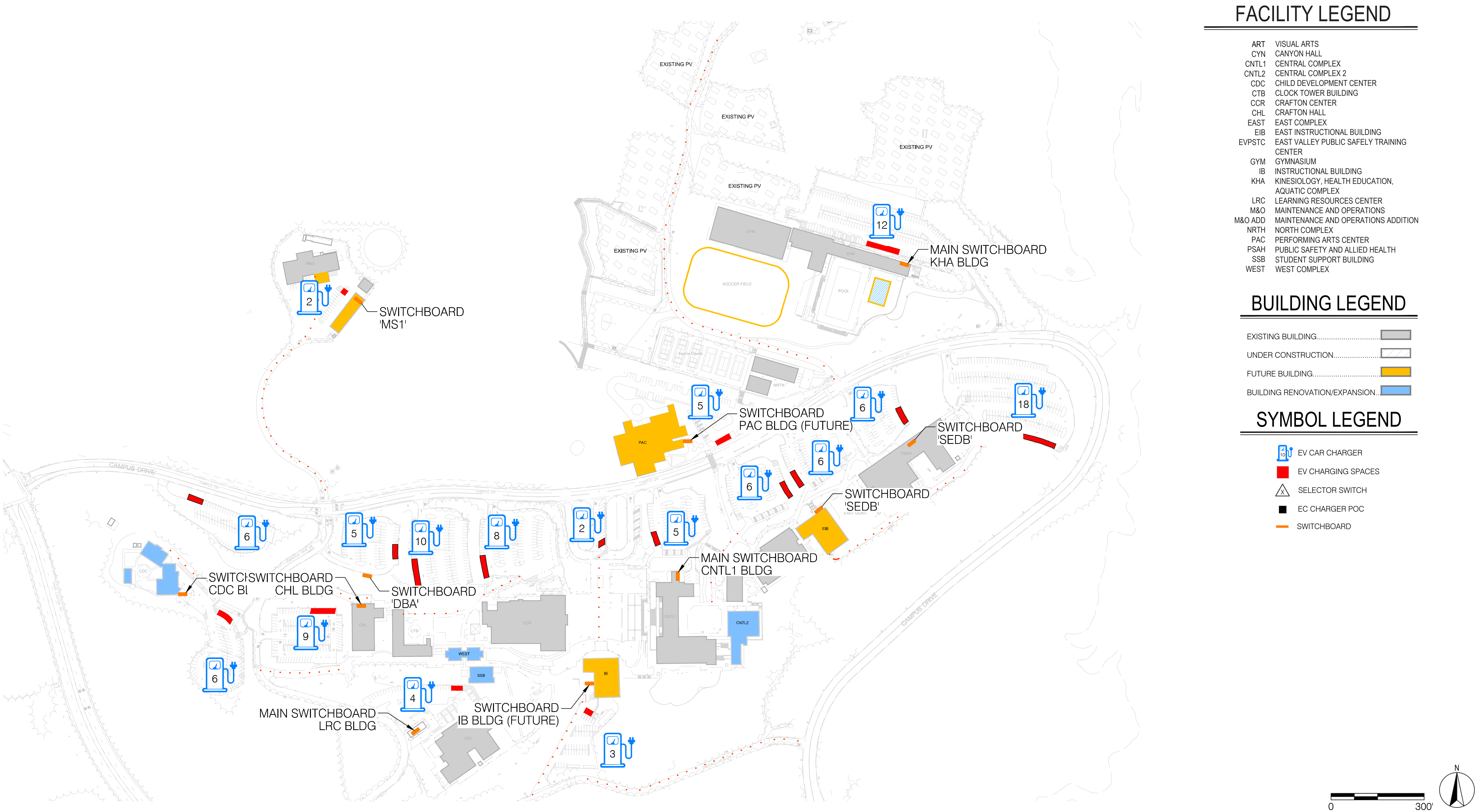
PHASE 1 PV EXHIBIT



PHASE 2 PV EXHIBIT



PROPOSED EV SITE PLAN



CHAPTER 6
Next Steps Towards a NZE Campus

CURRENT AND FUTURE EMISSIONS

It has been evident that climate change has become a main focus in the pursuit of sustainable solutions. As more evidence grows on the significant changes in the weather patterns in the past few decades and the impacts it has on disrupting human and natural systems far more quickly then what has been predicted, actions need to be made in order to maintain efforts in eliminating greenhouse gas emissions. A combination of government reinforcing policies and Educational Institutions taking own steps are sustaining this world through efforts around their own campuses to further reduce these emissions.

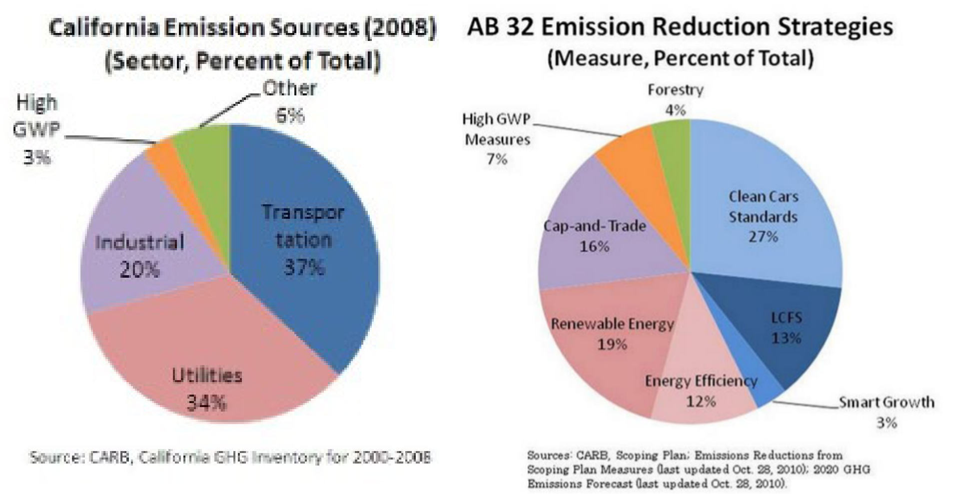
Several programs have been implemented into action in order to keep track and encourage Educational Institution in committing to reduce greenhouse gas emissions ('mitigation'). The recent CCC Governors Sustainability Policy and The American College & University President's Climate Change Commitment (ACUPCC) are an effort to address the issue of global climate disruption promised by a network of colleges and universities that have made commitments to eliminate greenhouse gas emission from specific campus operations, "while promoting the researcl and educational efforts and to promote the research and educational efforts of higher education to equip society tc re-stabilize the earth's climate. Their mission is to accelera progress towards climate neutrality and sustainability by empowering the higher education sector to educate students, create solutions, and provide leadership-by-example for the rest of society.

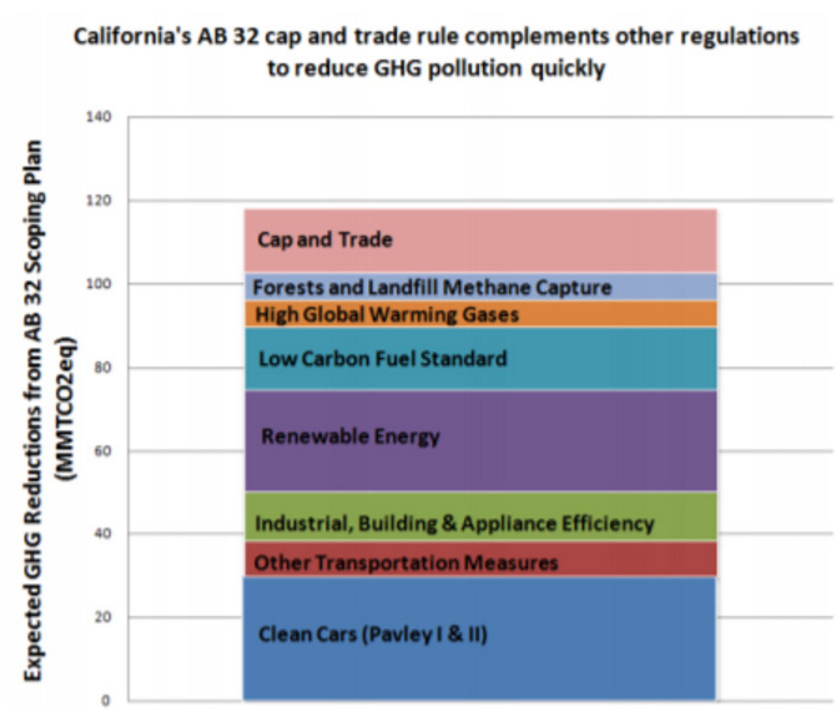
Greenhouse gas emissions, typically caused from the burning of fossil fuels such as coal, natural gas, and oil, are generally recognized as contributing factor to the climate change experienced over the years. United States EPA has promulgated regulations associated with greenhouse gas emissions. Assembly Bill 32 followed by AB 3232 passed by the California legislation requires reductions in carbon dioxide, methane, nitrous oxide, hydro fluorocarbons, per fluorocarbons, and sulfur hexafluoride.

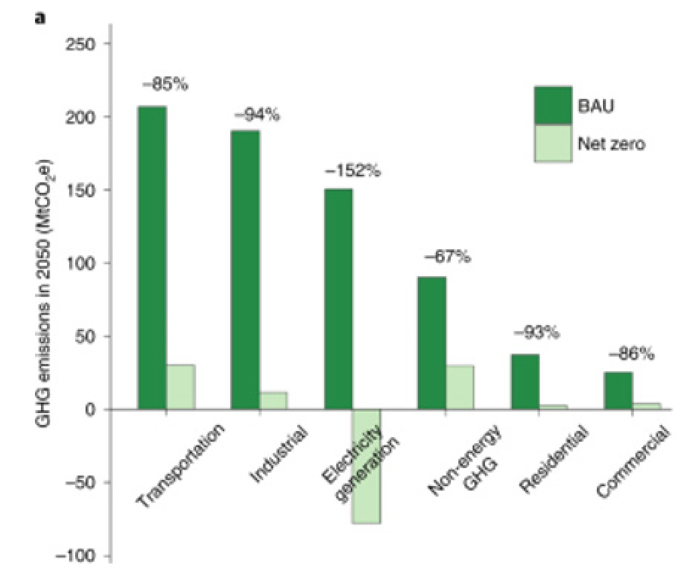
- To 1990 levels by the year 2020
- 40% reduction from 1990 levels by 2030
- 80% reduction from 1990 levels by 2050

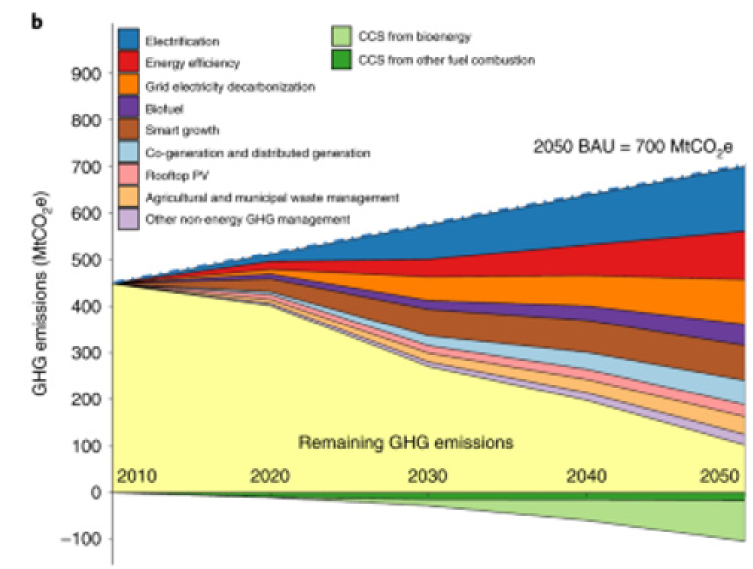
The California Cap-and-Trade Regulation (Regulation) was formally adopted by the Air Resources Board (ARB or Board) in 2011. Per the regulation, the ARB is currently developing a methodology to allocate allowances to California Universities and Colleges that recognize early actions to reduce greenhouse gas (GHG) emissions and invest in energy efficiency and CHP. ARB will propose a methodology for the direct allocation of allowances to California Universities that are covered entities as a result of early action GHG reduction activities.

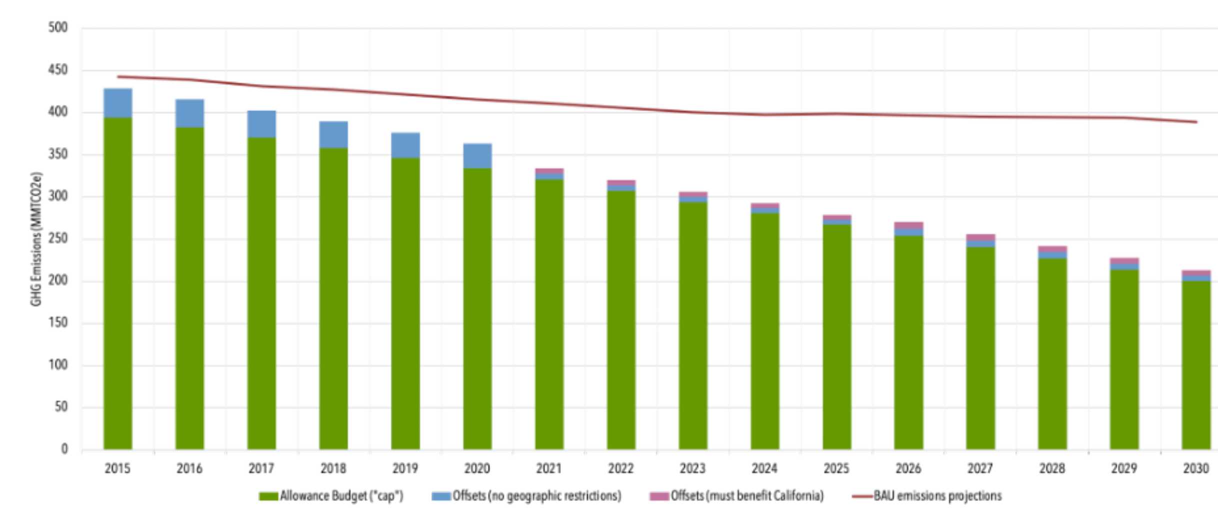
Below is the CA emissions sources for 2008 and AB 32 emissions reduction strategies and forecast for 2020.











Campus Emissions

The campus emissions sources are currently classified as follows:

ON CAMPUS STATIONARY SOURCES

- Consumption of Propane and Diesel Fuel
- Refrigerant and Chemical Leakage
- Fertilizer Application

PURCHASED UTILITIES SOURCES

- Purchased Electricity
- Electricity Transportation and Distribution Losses
- Natural Gas

MOBILE EMISSION SOURCES

- Student Commuting
- Faculty/Staff Commuting
- Directly Financed Travel
- University Fleet Fuel Consumption

The current campus carbon emissions sources reporting is as follows:

SCOPE 1 – DIRECT EMISSIONS

- Consumption of Natural Gas, Propane and Diesel Fuel
- Refrigerant and Chemical Leakage
- Fertilizer Application
- College Fleet Fuel Consumption

SCOPE 2 –INDIRECT EMISSIONS

- Purchased Electricity

SCOPE 3 –OPTIONAL EMISSIONS

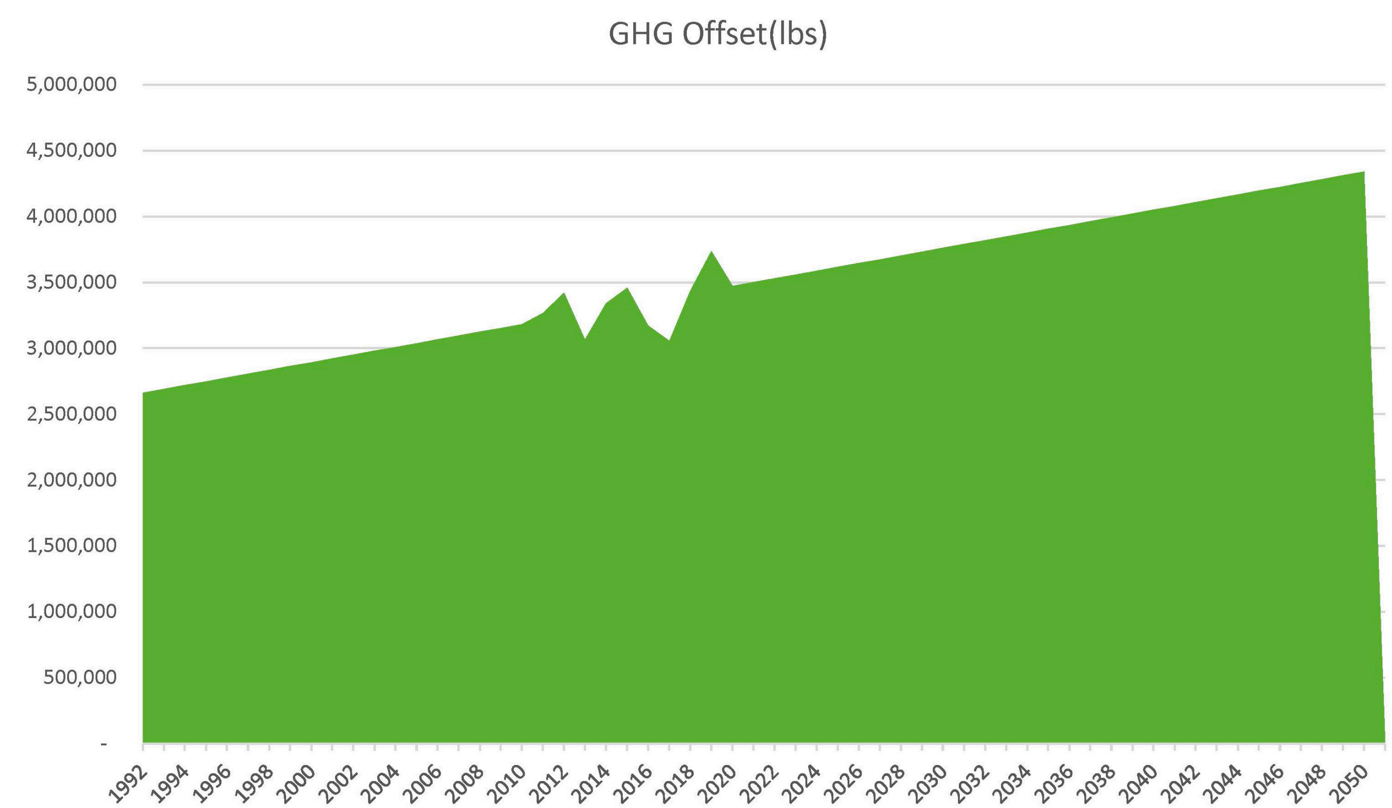
- Student Commuting
- Faculty/Staff Commuting
- Directly Financed Travel
- Electricity Transportation and Distribution Losses

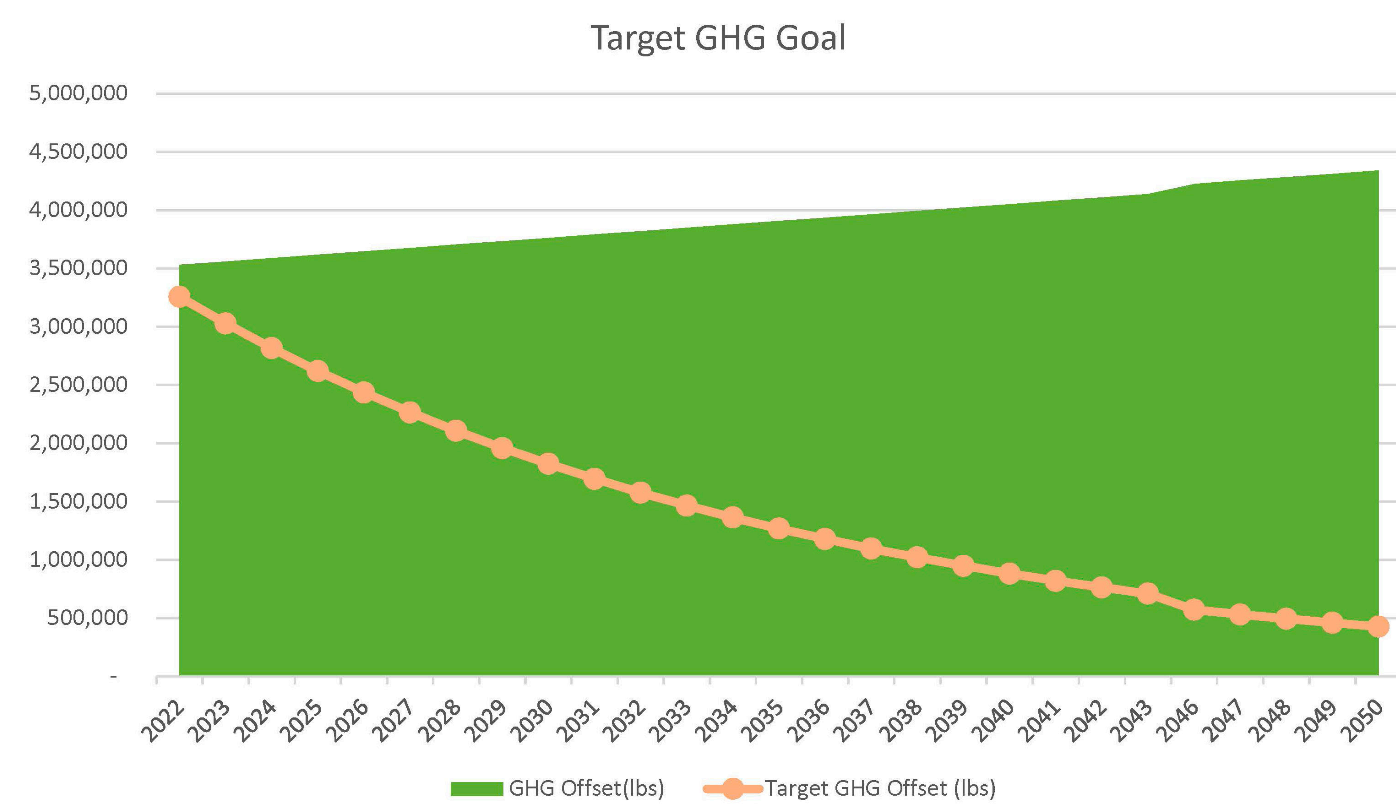
The College accounted for a total of 26,614MTeCO2 of emissions in 1990. An 80% reduction from 1990 levels to comply with AB 32 would be 5,322.8 MTeCO2. The 1990 emissions data assumes that the percentage of student, staff, and faculty members commuters have remained constant over the years.

In 2008, the University accounted for 32668 MTeCO2. By 2030, it is estimated that the College needs to reduce their annual greenhouse gas emission by 26,985 metric tons to meet 40% below 1990 emissions.

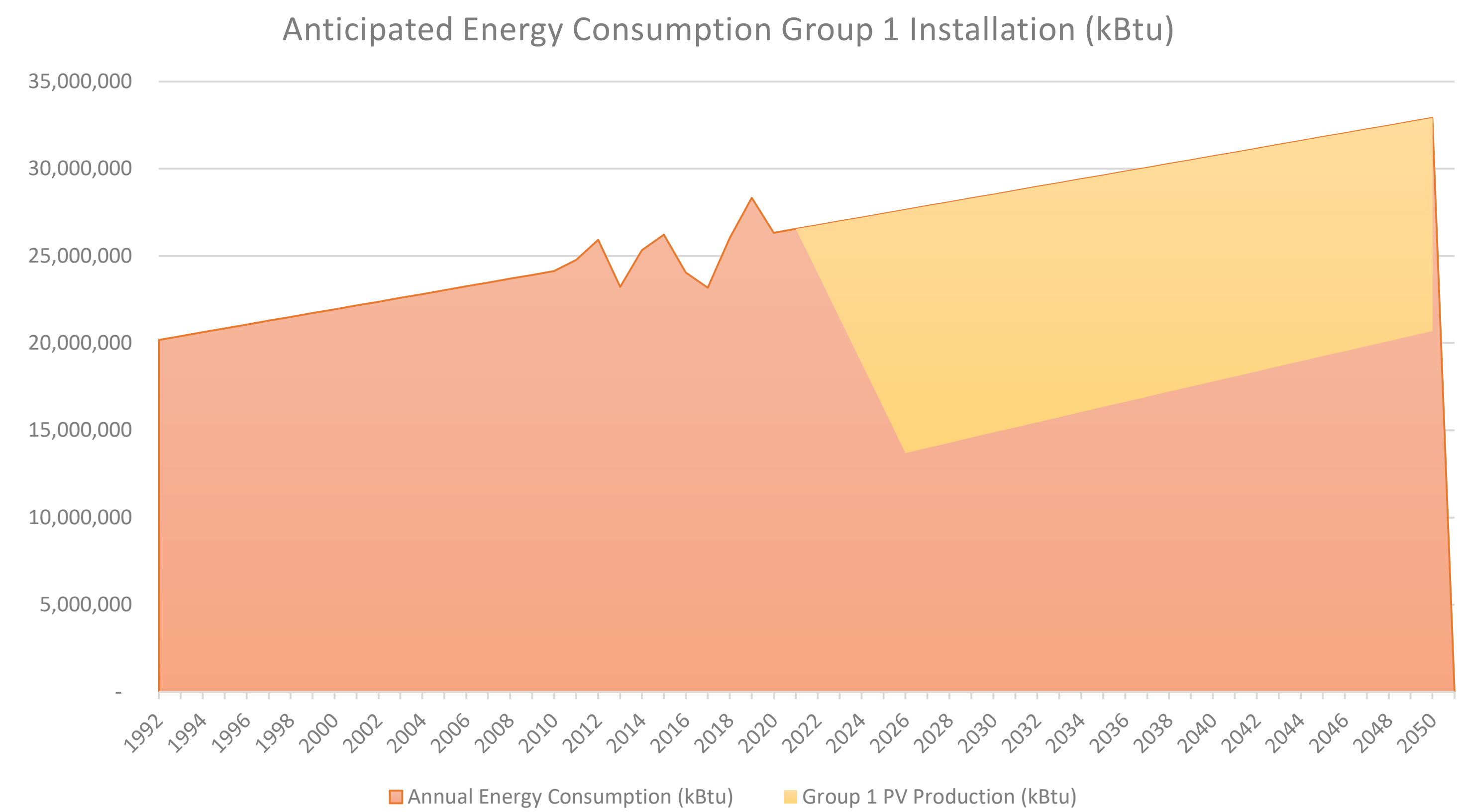
If College trends were to continue, it is projected that emissions would plateau by 2033.

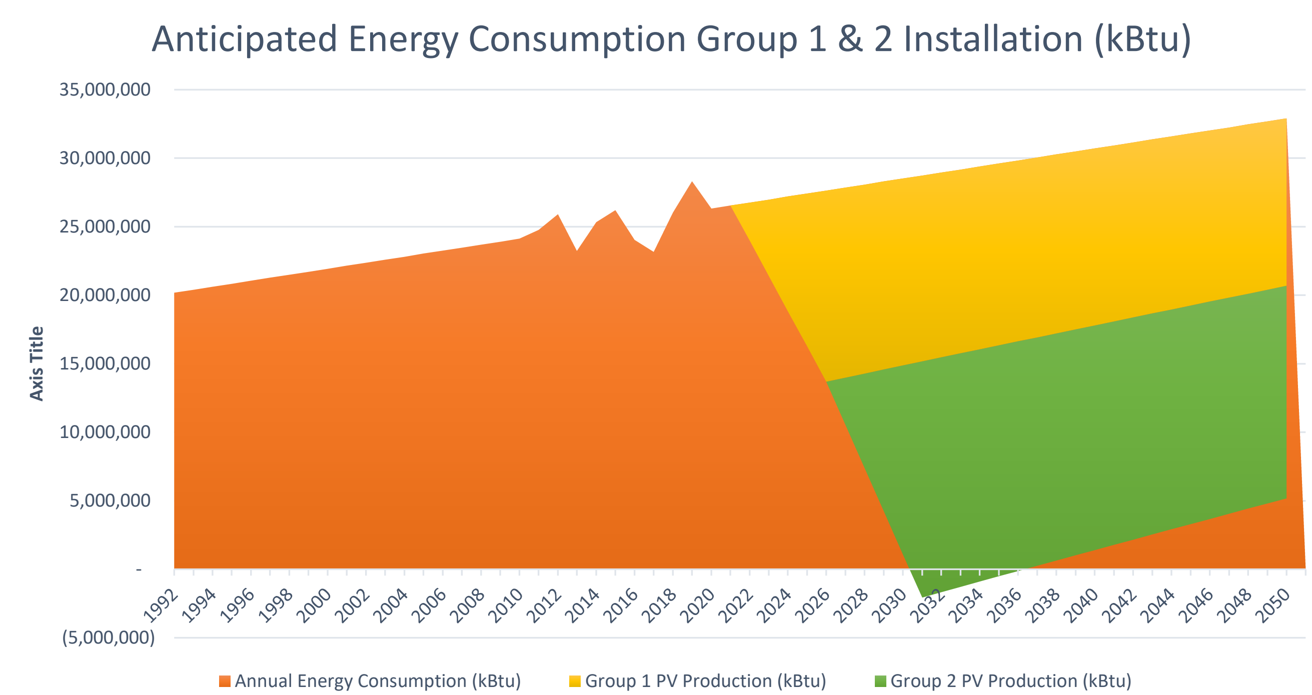
By 2050, it is estimated that the College needs to reduce their annual greenhouse gas emission by 38,067 metric tons to meet 80% of 1990 emissions. The first graph to the right shows increase in greenhouse gas emissions from various elements with business as usual approach.

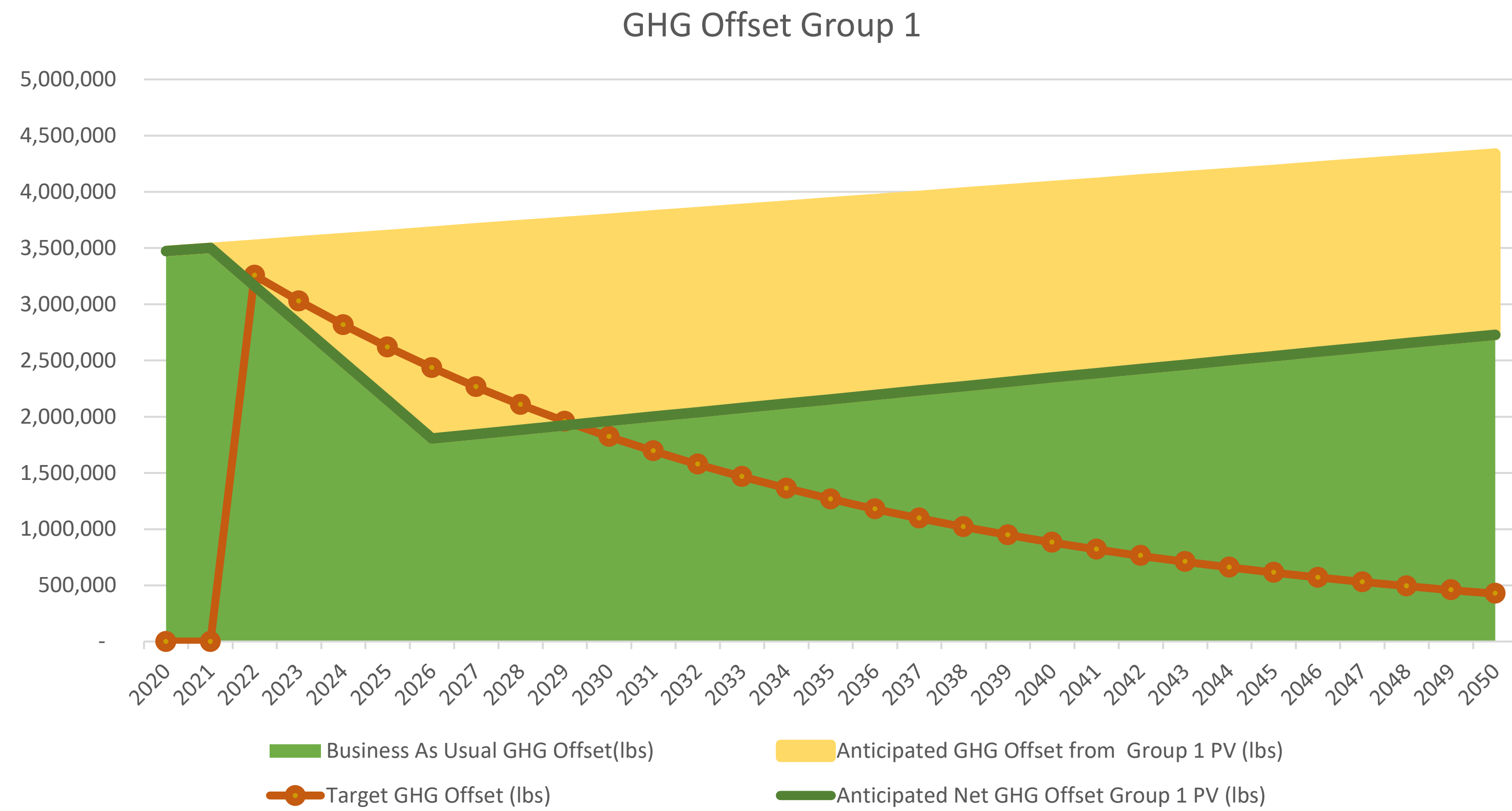


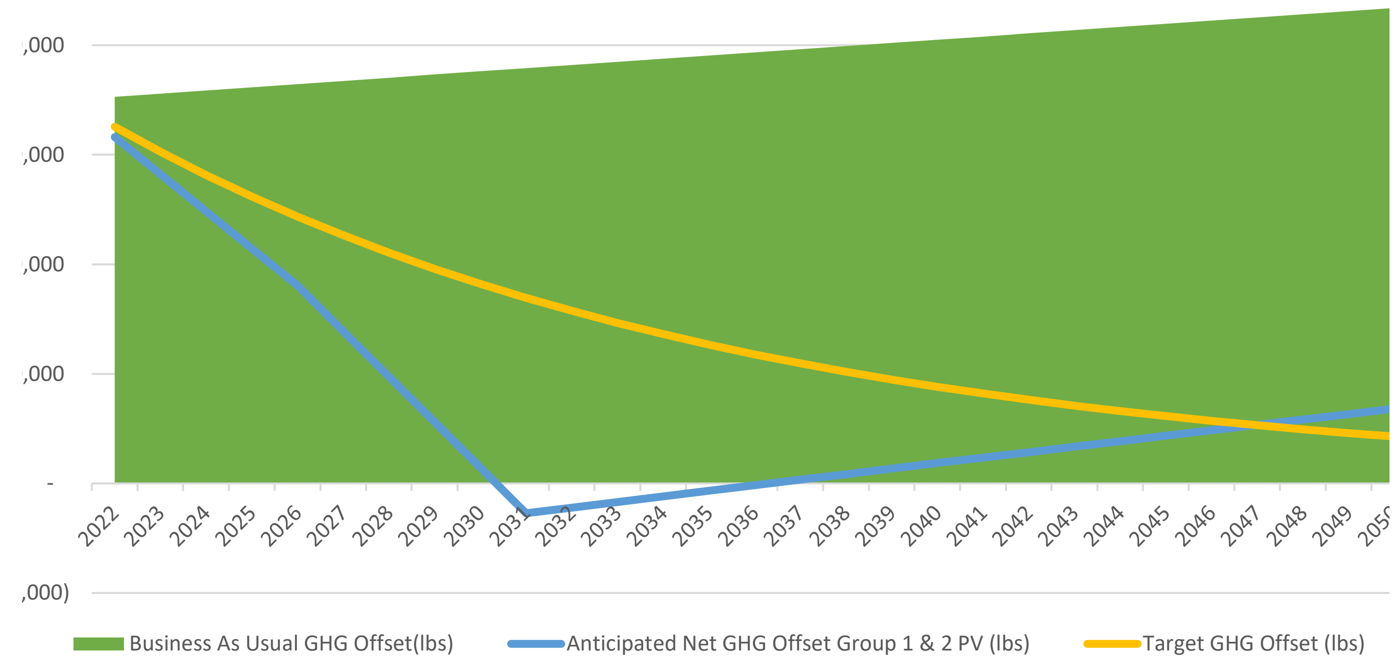


Our recommended strategies will help reduce the campus' overall greenhouse gas emissions. All strategies shown are directed towards reducing the greenhouse gas emissions of campus facilities and are show in the second graph to the right.






GHG Offset Group 1
5,000,000
4,500,000
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
-
Business As Usual GHG Offset(lbs)
Anticipated GHG Offset from Group 1 PV (lbs)
Target GHG Offset (lbs)
Anticipated Net GHG Offset Group 1 PV (lbs)


,000
,000
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-
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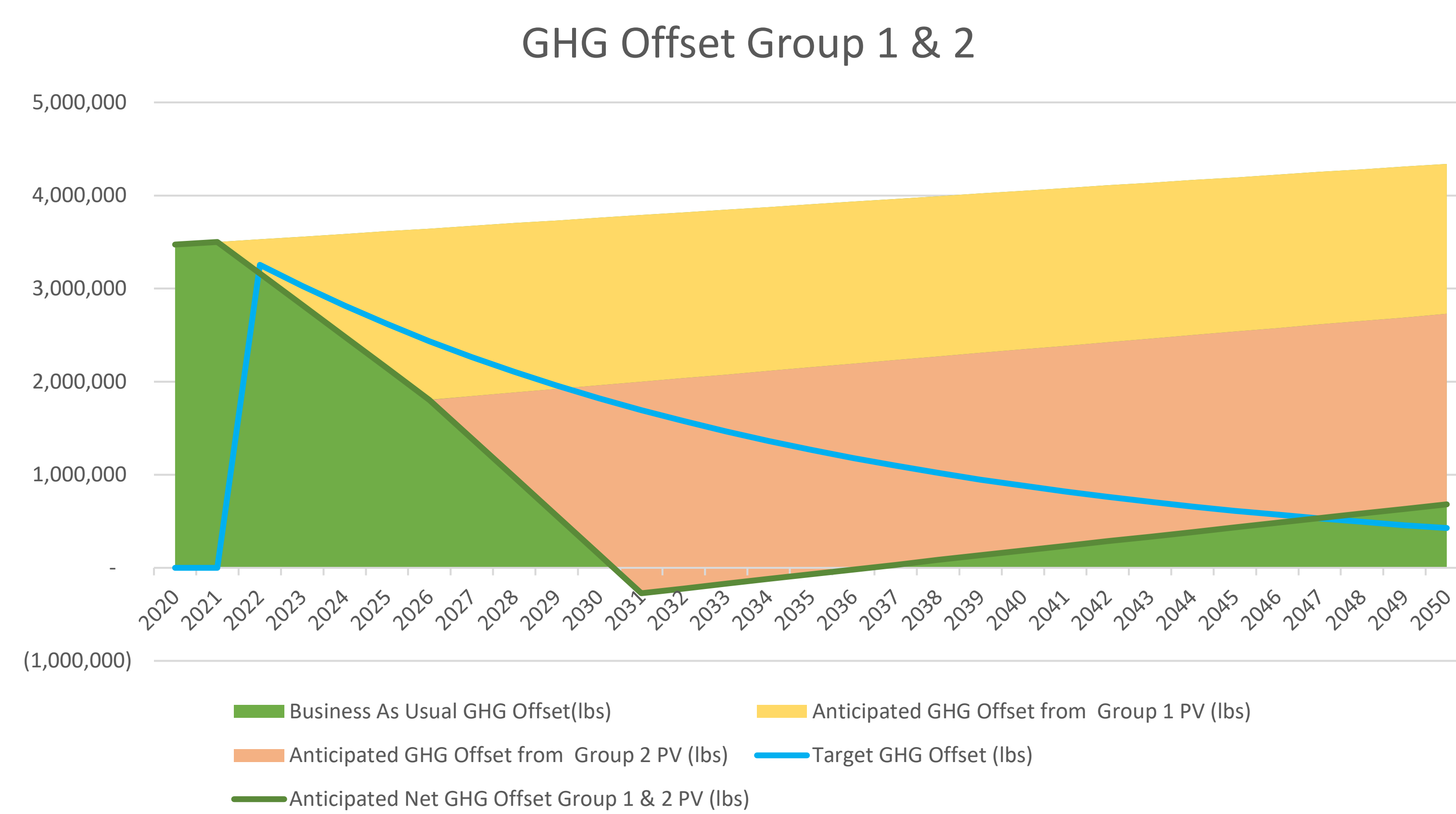
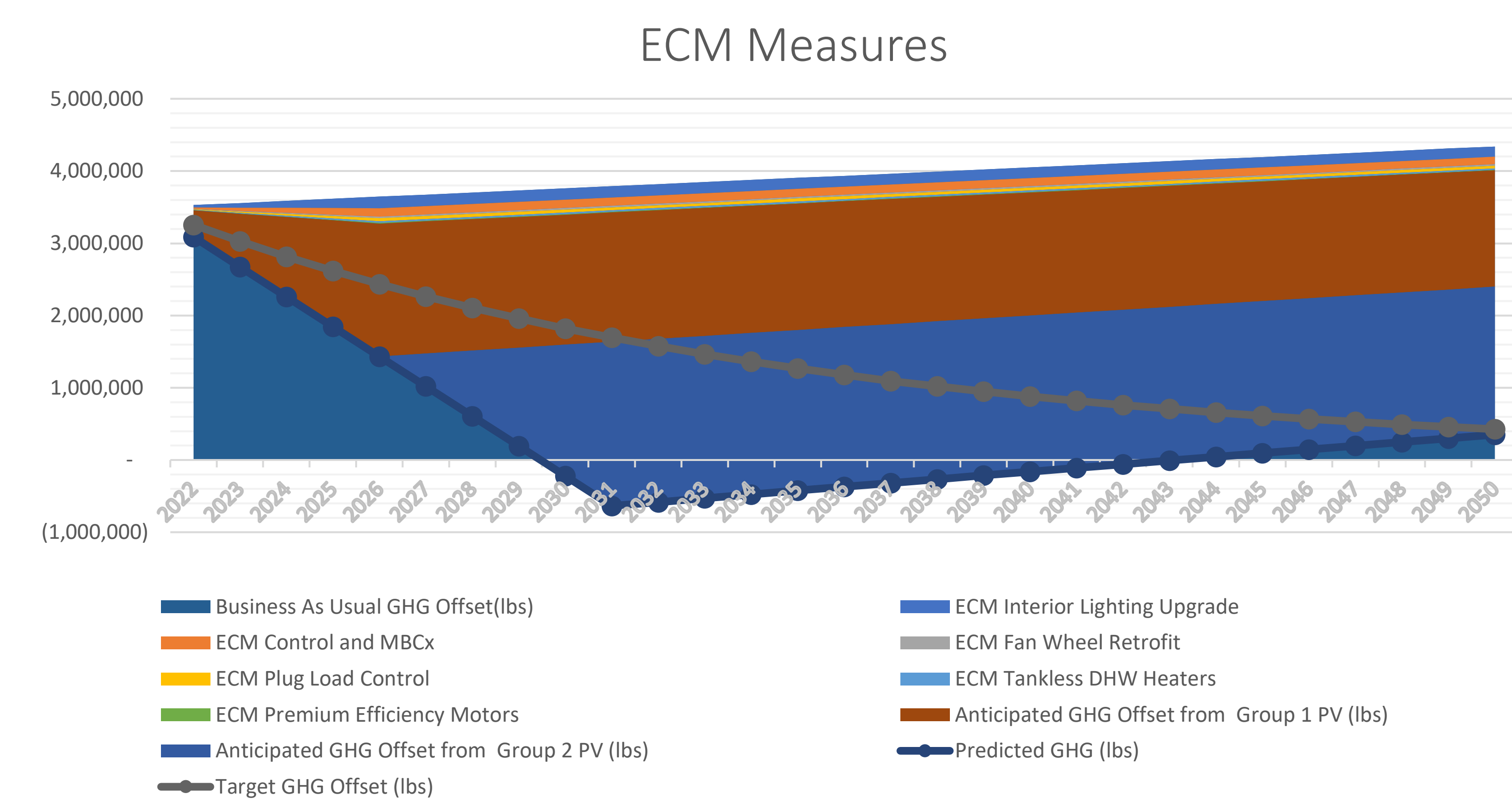
Business As Usual GHG Offset(lbs)
Anticipated Net GHG Offset Group 1 & 2 PV (lbs)
Target GHG Offset (lbs)


GHG Offset Group 1 & 2
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
-
(1,000,000)
Business As Usual GHG Offset(lbs)
Anticipated GHG Offset from Group 1 PV (lbs)
Anticipated GHG Offset from Group 2 PV (lbs)
Target GHG Offset (lbs)
Anticipated Net GHG Offset Group 1 & 2 PV (lbs)


ECM Measures
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
-
(1,000,000)
Business As Usual GHG Offset(lbs)
ECM Interior Lighting Upgrade
ECM Control and MBCx
ECM Fan Wheel Retrofit
ECM Plug Load Control
ECM Tankless DHW Heaters
ECM Premium Efficiency Motors
Anticipated GHG Offset from Group 1 PV (lbs)
Anticipated GHG Offset from Group 2 PV (lbs)
Predicted GHG (lbs)
Target GHG Offset (lbs)

Our recommended strategies will help reduce the campus' overall greenhouse gas emissions. All strategies shown are directed towards reducing the greenhouse gas emissions of campus facilities and are show in the second graph to the right.

The Campus Lighting Reduction and 2011 Solar Photovoltaic System decreased the campus greenhouse gas emissions. In total the planned facilities reduced the campus greenhouse gas emissions by 3,551 metric tons per year (9.3% of 2020 goal).

Energy Efficiency Measures Completed to Date

The campus has completed various energy efficiency projects over the years which has effectively allowed the campus to grow while maintaining the same amount of energy and GHG emissions. A brief overview of the projects is provided below for reference.

- Energy Efficient Central Chiller Plant and Chilled Water Site Distribution – Chilled water central plants were installed at the campus along with below-grade distribution systems to serve chilled water to a majority of buildings throughout the campus. The centralized plants allow for diversity within the system and utilize less energy than a decentralized option. The central plant projects account for approximately X MWh of annual savings.
- Solar Farm – A 1,200 kW concentrated photovoltaic solar farm was installed on the north east side of the campus. This project generates approximately 1,600,000 kWh of annual savings.
- Site Lighting Upgrades – Upgrades to site lighting, including LED fixtures and controls account for approximately 300,000-500,000 kWh of annual savings.
- Exceeding applicable Title 24 Part 6 requirements by at least 15% for all new and renovated buildings
- Commissioning of Buildings

In order to meet the ambitious goals of AB32 (80% below 1990 levels by 2050) and achieve an NZE status, the District will have to come up with a strategic plan to reduce greenhouse gas emissions from student and staff commuting. The second graph to the rightprovides campus emissions and overall campus goals to reduce the same.

A combination of implementing the recommended energy conservation measures and provision of renewable energy sources as detailed in Chapter 2 and 4 of this report will help the campus reduce the overall greenhouse gas emissions and help to comply with the current legislations. The following objectives, targets, metrics and action plans will be used for a roadmap to managing the climate change at the campus and mitigate the effects of greenhouse gas emissions.

BENCHMARKING

Benchmarking existing buildings and taking an accurate inventory of resources consumed is a critical step in the planning process. Benchmarking happens in the following four steps.

1. Data gathering
2. Data organization
3. Data gap analysis
4. Data improvement

Data gathering

Toward achieving the key goals for implementing the NZE plan, the design team started with gathering data from utility bills, student enrollment current and projected, projected growth in campus facilities, and sources of carbon emissions.

Utility bills included 15 electric meters, 20 gas meters, 40 water meters from 2010 onwards and solar production from 2011 onwards.

Data organization

Energy data was gathered from existing utility meters bills and data from individual energy meters where installed at individual buildings. These included both electric and gas meters and were utilized to develop baselines for both current energy usage in kBtu's and the overall greenhouse gas emissions. The data was also gathered to determine the EUI's by individual buildings and the overall EUI's of the campus. The overall utility metered data was then normalized to match total usage data by individua buildings.

A graph showing the total electric and natural gas usage is provided below for reference. An exhibit showing EUI's of the campus and EUI's by individual buildings is also provided at the end of the section for reference.

An exhibit showing the existing meters is provided below for reference:

ELECTRIC METERS

Buildidng Heat Maps

FACILITY LEGEND

ART	VISUAL ARTS
CYN	CANYON HALL
CNTL1	CENTRAL COMPLEX
CNTL2	CENTRAL COMPLEX 2
CDC	CHILD DEVELOPMENT CENTER
CTB	CLOCK TOWER BUILDING
CCR	CRAFTON CENTER
CHL	CRAFTON HALL
EAST	EAST COMPLEX
EIB	EAST INSTRUCTIONAL BUILDING
EVPSTC	EAST VALLEY PUBLIC SAFELY TRAINING CENTER
GYM	GYMNASIUM
IB	INSTRUCTIONAL BUILDING
KHA	KINESIOLOGY, HEALTH EDUCATION, AQUATIC COMPLEX
LRC	LEARNING RESOURCES CENTER
M&O	MAINTENANCE AND OPERATIONS
M&O ADD	MAINTENANCE AND OPERATIONS ADDITION
NRTH	NORTH COMPLEX
PAC	PERFORMING ARTS CENTER
PSAH	PUBLIC SAFETY AND ALLIED HEALTH
SSB	STUDENT SUPPORT BUILDING
WEST	WEST COMPLEX

ENERGY USAGE (EUI)

0-35
36-60
61-80
81-90
91-100
101-125
Not Mapped

N

0 300'

STRATEGIES

Utilizing data from Benchmarking, the design team began the next phase in the process by first identifying different strategies to achieve the KPIs established. To assist in further discovering and analyzing strategies we developed a framework: Use-Reduce, Produce, Store, Share and Procure.

By applying this framework, the design team identified X different strategies to explore further with performance analysis. For every strategy, we evaluated implementation cost on a rough order of magnitude; estimated energy savings; estimated utility cost savings; estimated GHG reductions; return-on-investment in simple payback years and discussed pros and cons of implementing such strategy from a maintenance and operations standpoint. A total of X strategies were identified to reduce overall energy usage and reduce overall greenhouse gas emissions. A brief description of all the strategies are provided below.

USE-REDUCE: SPACE UTILIZATION

The best way to save energy is to not expend it in the first place. Looking at opportunities to leverage existing space within the campuses and the district should be the first step. The district has implemented a web-based space scheduling system since XX. It is a web-based scheduling and event-publishing system that provides a centralized scheduling system, data repository and calendar of events for the college and to optimize the usage of campus facilities. The software can also help to identify areas of increased demand so sufficient rooms can be made available for additional classes for our students.

The district plans to continue to develop and assign scheduling FTEs targets per school and connect them to efficiency and budget. The goal is also to implement XX to inform room utilization and reallocate room space where needed, saving energy and other resources.

USE-REDUCE: ASHRAE LEVEL 1 ANALYSIS – HVAC, LIGHTING, CONTROLS

An energy audit was performed at the campus to determine potential energy efficiency measures (ECMs) for reducing energy use and Greenhouse Gas (GHG) emissions. The energy audit was performed at the campus and involved all the existing facilities. The energy audit comprised of an ASHRAE Level I audit of all buildings on campus. The purpose of these audits is to identify opportunities for energy savings within the buildings. The following describes the methodology behind a Level I audit as well as the ECMs analyzed at the corresponding buildings.

A field survey of each building on campus was undertaken to investigate potential energy improvements and conservation measures. The intent of the survey was to document equipment quantities/capacities, identification of improvements for major systems, and development of high level energy savings. Where equipment was inacceptable or model information not available, the team made assumptions for the size, capacity, and performance of equipment based on known system types. Based on this survey, a list of recommended energy conservation measures (ECMs) was developed and applied to each building. Calculations were conducted on a per ECM/building basis to determine the following: annual electrical savings (kWh), annual natural gas savings (therms), annual electrical cost savings, annual natural gas cost savings, and total energy cost savings.

USE-REDUCE: ASHRAE LEVEL 1 ANALYSIS – ENVELOPE

Over 65% of facilities at both campuses were built prior to XX. Although there is an excellent opportunity to upgrade the envelope to meet or exceed today's energy codes, this strategy will require extensive remodeling and disruption to buildings that are not designated for renovation or demolition. XX out of XX buildings are designated to be renovated or demolished and replaced. The design team recommends analyzing the opportunity to improve the existing building envelope during the time or renovation. Strategies to consider are to improvement to thermal mass, the insulation, air tightness, glazing and fenestration design to allow for more energy savings and natural light and views. A detailed envelope commissioning is recommended during renovation projects.

USE-REDUCE: ASHRAE LEVEL 1 ANALYSIS – PLUG LOAD MANAGEMENT

Plug loads refer to equipment other than HVAC equipment such as computers, printers, copiers, fax machines etc., that are plugged into the electrical outlets. Typically, plug loads represent at least 25% of energy consumption of a commercial building. Through high performance design strategies, as a building's overall energy consumption is reduced, the proportion of plug load energy consumption can go as high as 50%. So, it is increasingly becoming important to manage the type of plug loads as well as how and when they consume energy. The common methodology is to provide dedicated electrical circuits and panels to accommodate plug loads so at any given time, the entire circuit could be turned off to save energy. Such a strategy is increasingly being required by California Title 24 Part 6. The design team realizes that revising the electrical circuits for existing buildings to allow for plug load management is cost prohibitive and so is recommending exceeding Title 24 requirements on new and renovation building projects as it relates to plug load management.

USE-REDUCE: EV CHARGING STATIONS

To achieve the requirements of EO B-16-12, which is to replace at least 25% of the fleet owned by campus to ZEV as well as providing infrastructure for charging. The district currently owns XX vehicles that include fork lifts, golf carts, trucks and maintenance vehicles. The design team recommends reviewing ZEV options for new and replacement vehicles. The need for infrastructure to charge these ZEVs are actually driven by student's driving ZEVs. The district currently has no EV Charging Stations at their campus. A detailed plan showing locations of proposed EV Charging stations is provided at the end of the section.

USE-REDUCE: RETRO-COMMISSIONING – HVAC, LIGHTING, CONTROLS

SHARE: HEAT RECOVERY SYSTEMS

The campus shall promote heat recovery systems (heat recovery chiller, air source heat pumps, variable refrigerant systems) to minimize natural gas usage for both space heating and domestic hot water usage and promote the reduction of greenhouse gas emissions. Heat recovery systems utilize the waste heat or harnessed heat to heat the space or produce domestic water thereby increasing the overall coefficient of performance (COP) of the machine and minimize overall energy usage and hence the greenhouse gas emissions.

SHARE: MICRO-GRID SYSTEMS

Microgrids are modern, small-scale versions of the centralized electricity system. Micro grids offer reliability, carbon emission reduction, diversification of energy sources, and cost reduction. Like the bulk power grid, smart micrgrids generate, distribute, and regulate the flow of electricity to consumers, but do so locally. Smart microgrids are an ideal way to integrate renewable resources on a campus level and form building blocks of a perfect power system.

A review of the campus electrical distribution system revealed that significant modifications and sophisticated controls will need to be added to enable the system function as a microgrid. Automatic load shed controls will need to be added to ensure that the cogeneration system continues to function and is not overloaded in event of a power outage when the campus demand exceeds generation. The campus will also need to diversify its on-site energy generation portfolio and include renewable energy sources and storage systems to maximize the advantage of implementation of the micro grid system. Our recommendation therefore is to plan the implementation of the micro-grid in the future as prices of storage systems and on site generation fall and additional funding is available to implement provision of these additional renewable energy sources and an automatic load shed control system.

HIGH LEVEL ACTION PLAN

Following is a high level action plan for achieving NZE status at the campus:

REDUCE OVERALL ENERGY USAGE

Implement energy conservation measures (with paybacks less than 10 years) identified for each of the buildings to reduce overall electric and natural gas usage and hence the overall kBtu's of the campus. Advance measures to go through ASHRAE level 2 and 3 audits to reconfirm the savings and associated costs before implementation. Utilize a combination of incentives, on bill financing and available campus funds to fund these measures.

PROMOTE METERING OF ALL UTILITIES

Implement a campus wide measure to provide metering to monitor natural gas, electric and water consumption at each of the facilities. Meters shall report to a central monitoring station and shall incorporate a front-end analytic software capable of not only providing monitoring capabilities for each of the utilities but also provide annual trends for each of the utilities by each facility.

PROVIDE RENEWABLE ENERGY SOURCES AND STORAGE

Implement a phased renewable energy sources provision plan to offset overall imports from the utility, minimize overall natural gas emissions and shield the College from fluctuation in electric prices in the future. Utilize bond funding to implement solar and battery energy storage system to maximize the on site generation utilization and minimize the utility demand charges.

STIPULATE AND ACHIEVE ZNE STATUS FOR ALL NEW AND MAJOR RENOVATIONS

Achieve NZE status consistent with the CCC Governors Sustainability Policy and CA definition for NZE on source basis for all new buildings and major renovations to offset overall energy usage of the building(s). Measures should include setting an aggressive EUI target (A list of sample EUI targets is provided in Appendix for reference) based on the type and function of the building (s) early on in the project, adopting an integrated design approach for designing building systems, optimizing the orientation of the building (s), maximizing the overall efficiency of the envelope and MEP systems including provision of heat recovery systems and provision of renewable energy sources. Exceed current Title 24, Part 6 requirements by a minimum of 15%.

PROMOTE WATER CONSERVATION STRATEGIES

Implement water savings strategies in each of the new facilities and facilities undergoing major renovations to include high efficiency plumbing fixtures, drought tolerant vegetation, drip irrigation, use of aerators in faucets, storm water run off recapture and AHU condensate capture for irrigation use.

PROMOTE US GREEN BUILDING PRACTICES

Achieve a minimum of LEED Silver certification for each of the new buildings and major renovations at the campus. Include enhanced commissioning of facilities.

PROMOTE EV CHARGERS

Implement a phased approach to include provisions of EV chargers at each of the parking lots to promote electrification and minimize overall natural gas emissions.

IDENTIFY CURRENT AND FUTURE BASELINE ENERGY USAGE AND SCOPE 1 AND 2 GREENHOUSE GAS EMISSIONS BASELINES AND CREATE BENCHMARKS

Review Existing Baseline Greenhouse Gas Emission Inventory and update projections according to expected reductions to comply with AB32 requirements. Develop greenhouse gas emission reduction goals and document in a Climate Action Plan (CAP) with key strategies and associated reductions. Track Progress and report on greenhouse gas emissions.

The most critical aspect of any NZE plan is the tracking of the efforts and ensuring each of the action plans presented get implemented. This implementation plan specifically addresses the importance of maximizing energy efficiency, promoting renewable energy sources, promoting electrification, promoting water conservation strategies and create sustainable and net zero energy facilities at the campus. tracking aspect of GHG emissions. In order to effectively address the action plans the District must first identify the current standing in terms of GHG emissions and the resulting effects of individual action plans. This plan would allow for a quantification of GHG reductions and be able to compare the reduction to the cost associated with the efforts to best determine practices that are within the target area and practical in implementation. The major aspect is to set an example so that more Educational Institutions can make substantial efforts to improve sustainability and achieve NZE status and in turn receive tangible valuable results both environmentally and economically.

Upon acting on each of the individual plans outlined above, the campus would be in a position to continually reduce the overall effect of greenhouse gasses on climate change.


IMPLEMENTATION ROADMAP
1
REDUCE OVERALL ENERGY USAGE
2
PROMOTE METERING OF ALL UTILITIES
3
PROVIDE RENEWABLE ENERGY SOURCES
4
STIPULATE AND ACHIEVE ZNE STATUS FOR ALL NEW AND MAJOR RENOVATIONS
5
PROMOTE WATER CONSERVATION STRATEGIES
6
PROMOTE US GREEN BUILDING PRACTICES
7
PROMOTE EV CHARGERS
8
IDENTIFY CURRENT AND FUTURE BASELINE ENERGY USAGE AND SCOPE 1 AND 2 GREENHOUSE GAS EMISSIONS BASELINES AND CREATE BENCHMARKS

SUMMARY OF OUR ANALYSIS AND RECOMMENDATIONS

Priority 1	Projects within 2-5 years	Priority 3	Future Projects
Priority 2	Projects within 5 years		Ongoing Projects

Project Tracking #	Project	Phase	Proposed Year(s) of Execution	Brief Description of the Project	Prioty Level	Project Category	Total Projected Construction Costs ($) 1	Dollar Savings	Payback 2	Funding Source	Recommended Project Delivery Method and Funding Source
1	Energy Efficiency Upgrades	1A	2021-2024	Implementation of energy efficiency measures provided and detailed in Chapter 2 of the report with paybacks less than 10 years.	1	EE	$570,585	$62,978	9.4 years	On Bill Financing (OBF) and Cutomized Incentive Programs	Design Build with On Bill Financing
2	Provision of Group 1 PV Systems	1B	2021-2024	Implementation of PV systems in Group 1 areas as shown in PV Exhibit in Chapter 4	1	PV	$4.4M	$14.3M	10.2 years	Lease, PPA and Energy Loans	Design Build with Outright purchase
3	Provision of Group 1 PV & Battery Energy Storage System	1B-1	2021-2024	Implementation of PV systems in Group 1 areas as shown in PV exhibit in Chapter 4 and Battery Energy Storage System.	1	PV & Battery	$7.7M	$20.3M	7.8 years	Lease, PPA and Energy Loans	Design Build with Outright purchase
4	Provision of Metering	1C	2021-2024	Implementation of gas and electrical metering in each of the buildings at the campus to monitor existing energy consumption	1	EE	$630,000	N/A	N/A	On Bill Financing (OBF) and Cutomized Incentive Programs	Design Bid Build with Outright purchase
5	Provision of EV Chargers and Associated Infrastructure	2	2021-2024	Provision of EV Chargers and associated infrastructure as shown in EV Exhibit(s) in Chapter 3	2	EV	N/A	N/A	N/A	SCE Incentives and Grants	Design Bid Build with SCE Incentives and Grants
6	Provision of Group 2 PV Systems in Phases	3	2021-2024	Implementation of PV systems in Group 2 areas in phases as shown in PV Exhibit in Chapter 4	3	PV	$9.2M	$11.2M	$678,000	Lease, PPA and Energy Loans	Design Build with Outright purchase
7	New and Major Renovation of Facilities	Ongoing	Ongoing	Promoting sutainable strategies for new buildings and major renovations to achieve LEED Platinum and NZE certifications		New Buildings and Major Renovations	N/A	N/A	N/A	State and Bond Funds	

APPENDIX

Greenlots Smart EV Charging Solutions

greenlots
A Member of the Shell Group

Facility managers face limitations to their existing electrical infrastructure when installing and managing electric vehicle (EV) charging stations. Because few buildings were designed with integrated EV charging stations, your building may not have the electrical capacity necessary to support the number of EV charging spots you wish to install. Moreover, adding electrical capacity can be very expensive, and some locations may have structural or other limitations hindering electrical upgrades.

Introducing Greenlots EV Load Management for Charging

Offer more chargers without infrastructure upgrades

Greenlots EV Load management software enables facility owners to efficiently manage their energy load right at the charging port. Our smart charging and optimization solutions can dynamically respond to building load requirements, ensuring that the EV load does not exceed the building capacity while still making it easy for drivers to charge when they need to. Our software can increase the number of EV chargers a site can make available while eliminating or reducing the need for expensive infrastructure upgrades.

Reduce utility bills and avoid peak-pricing charges

Load management is also used to reduce electricity costs by avoiding utility peak demand charges, which can become a significant cost. Station managers can set a power ceiling below the demand charge threshold during peak demand times to ensure power use never exceeds that ceiling. We also offer integrated DER solutions that allow facility managers to directly pull power from energy storage or solar PV. At locations where demand pricing is high, these savings can be substantial.

Greenlots SKY EV Charging Network Software is an end-to-end EV charging network management solution that simplifies owning and operating EV charging infrastructure. The software's advanced load management capabilities include:

- Load Sharing
- Load Scheduling
- Onsite Storage or DER Integration

Greenlots EV Load Management Solutions

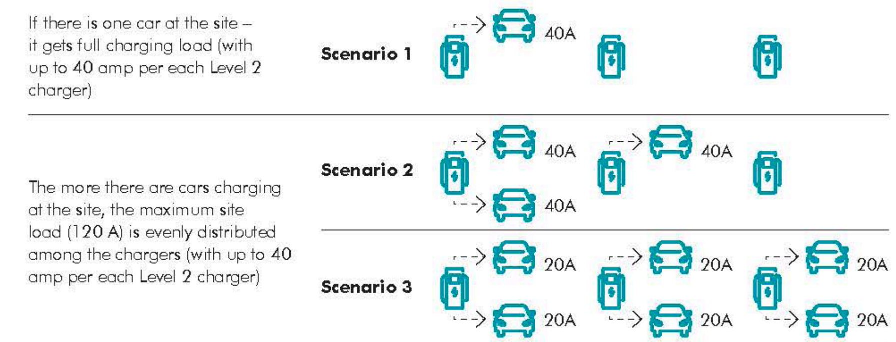
Load Sharing

Primary benefit:
Eliminate or reduce the need for infrastructure upgrades

Maximum value for:
Workplaces, Condos and Apartments, and Commercial & Industrial facilities (C&I)

Load sharing allows site hosts to install more EV chargers than the site's circuit breaker, panel or transformer capacity would otherwise allow. Greenlots SKY EV Charging Network Software uses customizable algorithms that enable customers to set a maximum charging load limit allowing for automatic sharing of available power between EV chargers, when charging load is expected to go beyond its limit. Power between the chargers can be distributed evenly or based on charger priority.

Example: Total amperage at the site for EV chargers: 120 A



The bottom line: Load Sharing eliminates the need for expensive upgrades to a site's circuit breaker, panel or transformer, while enabling more charging ports at the given location.

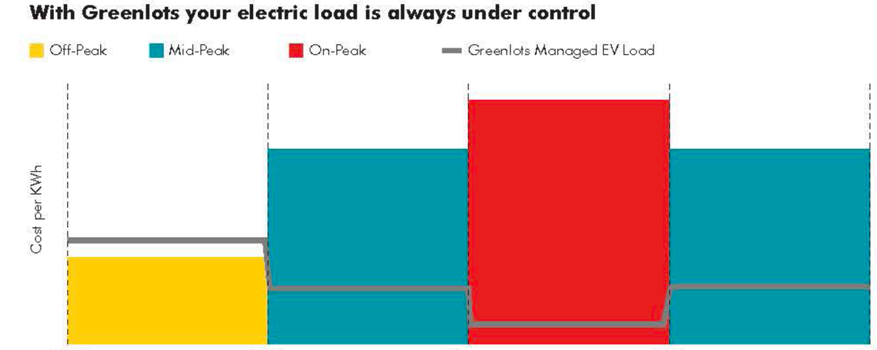
Load Scheduling

Primary benefit:
Reduce electricity costs

Maximum value for:
Workplaces, Condos and Apartments, C&I, and Fleet Owners

Load scheduling enables site hosts to prevent or curtail charging sessions during hours when the cost of electricity is high. This feature is highly beneficial for site hosts with unpredictable loads at their location, as well as for fleet owners who need vehicles fully charged by a specific time without exceeding load limits. Based on utility tariffs, site hosts can manually set the maximum site load for specific hours during a day.

With Greenlots your electric load is always under control



The bottom line: With Load Scheduling, site hosts save significantly on utility bills by shifting charging to cheaper hours, while assuring EVs are always charged to meet operational requirements.

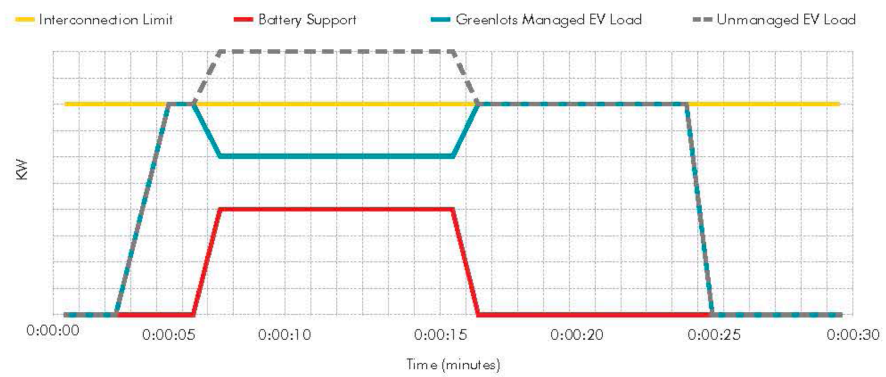
Onsite Storage or DER Integration

Primary benefit:
Reduce utility bills and minimize hefty peak demand charges

Maximum value for:
Large commercial facilities, public DC Fast Charging Hubs, and Fleet Owners

Distributed energy resources (DER), such as energy storage or solar PV systems, provide sites with additional power that can be used when electricity prices are higher than normal. Greenlots can easily integrate DER into charging systems, enabling site owners to minimize costs during peak demand by pulling energy from the DER, rather than the grid.

Greenlots Managed EV Charging Load with Energy Storage



The bottom line: Onsite Storage or DER integration allows site hosts to greatly reduce electricity costs by decreasing the peak load drawn from the grid and drastically minimizing peak demand charges.

Turnkey Approach to EV Charging

Site Qualification

We offer compliance support, feasibility studies, and permitting and regulatory oversight

Choice of Charging Hardware

We have partnerships with leading hardware providers, offering the latest in EV charging technology

Engineering & Installation

We oversee the complete engineering, design, construction and installation of EV charging stations

Commissioning

We make sure the EV charging infrastructure and all system components meet your project's operational requirements

EV Charging Network Software

Our network management software offers real-time access and control of your EV charging stations

Driver Mobile App

Our mobile app allows drivers to locate the nearest charger, track their charging status, and easily make payments.

Customer Support and O&M Services

We have a variety of customer support packages to best suit your ongoing service needs.

Ready to learn more about Greenlots Load Management Solutions for your site?
Contact us at: +1-888-751-8560 · info@greenlots.com

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