City of Irvine Distributed Energy Resources (DER) Implementation Plan

DRAFT Report

Center for Sustainable Energy®

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Abbreviations and Acronyms

BESS	Battery energy storage system
BEV	Battery electric vehicle
CA	California
CAAP	Climate Action and Adaptation Plan
CAMX	California/Mexico
CEC	California Energy Commission
DAC	Disadvantaged community
DCFC	Direct current fast charging
DER	Distributed energy resource
EUI	Energy use intensity
EVI	Electric vehicle infrastructure
EVSE	Electric vehicle supply equipment
FY	Fiscal year
HVAC	Heating, ventilation, and air conditioning
PV	Photovoltaic
NG	Natural gas
SCE	Southern California Edison
SCG	SoCal Gas
ZEV	Zero-emission vehicles

Executive Summary

To help the City of Irvine prepare their Climate Action and Adaptation Plan (CAAP), The Center for Sustainable Energy (CSE) performed a study of 38 City-owned properties to identify opportunities to improve energy efficiency and determine optimal sizing of Distributed Energy Resources (DERs). DERs are small scale electricity supply or demand resources that are interconnected to the electric grid. Common DERs include Solar Photovoltaic (known as solar panels), Battery Energy Storage Systems (BESS), Combined Heat and Power (CHP), Diesel or natural gas generators, wind turbines and microturbines. Even electric vehicles can operate as DERs by supplying power back to the grid. Many of these technologies are not suitable solutions for the City, being out of place in an urban area (wind turbines) or being suited only to niche applications (microturbines). Others (traditional generators) only provide backup power and consume fossil fuels. For these reasons, this DER Implementation Plan focuses solely on solar PV, energy storage, and CHP.

> ***According to the City of Irvine Strategic Energy Plan, buildings represent the largest component of the city's energy consumption and GHG emissions.***

This report benchmarks the City's current energy consumption and provides recommendations for energy efficiency improvements and DER investments to reduce the carbon footprint of City buildings. The analysis was based on existing energy use data and also leverages the outcome of the Zero-Emission Vehicles (ZEV) Transition Plan to explore the impact of future fleet electrification and electric vehicle infrastructure on the City's electricity use. Appendix A provides a detailed, building-level analysis of all the City-owned buildings, including a summary of existing conditions, a desktop energy efficiency analysis, and recommendations for solar and energy storage sizing. Additionally, this report includes a Community Analysis that explores the potential for DER implementation beyond the City-owned building stock.

It is important to note that the broader CAAP will establish detailed goals for greenhouse gas (GHG) emission reductions City-wide in the near, mid, and long-term. At the time of this report, the development of the CAAP goals is in progress. In the absence of these broader CAAP goals, this report connects its recommendations to the goals outlined in the Irvine Strategic Energy Plan and the Irvine Achieves Resolution. In summary, CSE recommends the following next steps.

- Following the California loading order, the City should start by making energy efficiency upgrades in the City-owned facilities. The analysis included a review of twelve historical energy audits completed on City facilities within the last ten years, but most were older than 5 years. The City should plan for repeated audits every five years, prioritizing the highest energy consuming buildings.
- City buildings with high natural gas usage are prime candidates for a CHP system. CSE identified three City-owned buildings that met these criteria, and of these three facilities, one yielded a favorable outcome for CHP. The City should consider implementing a CHP system at the William

Woollett Aquatics Center. Natural Gas (NG) has higher GHG density than electricity, therefore measures to optimize NG usage should be prioritized.

- As the City pursues investments in renewable energy and energy storage, they should prioritize the buildings with the most positive payback period for offsetting 100% of electricity use with a combination of solar and battery storage. According to CSE's building-level DER analysis, the following facilities demonstrated the most positive payback periods:
    - Deerfield Community Center
    - Great Park Tennis Support Facility H
    - Heritage Park Community Center
    - Irvine Child Resource Center
- The following sites feature a cluster of City buildings in close proximity to one another. These sites should each be treated as units and pursue DERs as an NEM aggregate or microgrid model.
    - Great Park
    - Heritage Park
    - Civic Center and ICDC
    - OSF and Animal Care
- The Strategic Energy Plan makes a recommendation to pilot an all-electric retrofit at one of the smaller community centers. This would entail replacing the natural gas appliances such as space heating, cooking equipment and domestic water heaters with electric alternatives. CSE recommends University Community Center. Due to its small size but comparatively large amount of natural gas usage, it may be the most impactful option for an electrification pilot.
- Electrification of the City fleet over the next decade requires new electric vehicle infrastructure at Civic Center, OSF and community park locations where fleet vehicles are stationed. This added load will require new service at these locations and will increase energy costs. Investments in solar and storage at these locations can help offset the increase in energy consumption.
- Using publicly available benchmarking data, CSE identified the top 10 energy consuming facilities in the City of Irvine beyond the municipal buildings. The City should engage with the owners of these properties to encourage energy efficiency measures and DER investments.

All items listed above are discussed in greater detail throughout the report.

I. Data Collection

The City provided CSE with the following information to perform desktop studies of City facilities:

- Building utility accounts and billing information from Southern California Edison (SCE)
- Gas consumption data from SoCal Gas (SCG)
- Building square footage inventory
- Summary of existing DERs such as solar photovoltaics (PVs), battery energy storage, and gas generators
- Twelve historical energy audits (completed within the last 10 years)
- Electrical Interval data for all 38 facilities

Separate from this report, CSE developed a detailed Zero-Emission Vehicles (ZEV) Transition plan using fleet data on the City-owned vehicles. The final version of this plan was submitted to the City in early May 2022, and the results of this plan were used to analyze the energy consumption impacts from the transition to Zero Emission Vehicles.

Due to the impacts of COVID-19 in the year 2020, energy profiles from 2019 were used whenever possible to benchmark a more typical load profile.

II. Existing City Energy Usage

This section provides a high-level overview of energy consumption in the City at a municipal level. The analysis begins with a broad summary of energy use and then narrows down into consumption by energy type. This section also identifies the top energy consuming and GHG emitting City-owned buildings.

Energy Use

Irvine relies on three types of energy to power City-owned buildings and its vehicular fleet, broken down into the following categories:

- **Electricity -** The amount of electricity consumed by 38 buildings. Due to proximity, several buildings share electrical service. Electricity was therefore split between 30 utility accounts
- **Natural Gas -** There were 22 points of service for natural gas, serving 23 buildings
- **Gasoline -** Consumption by 528 City-owned vehicles. Note that gasoline consumption was unknown for approximately half of City-owned vehicles. The average of known vehicle consumption was used to approximate these vehicles. The potential for electrification of the City fleet is explored in greater detail in the ZEV Transition Plan.

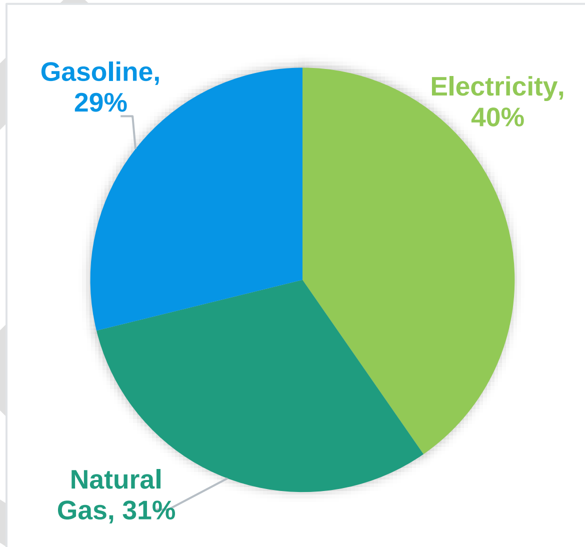


Figure 1. City Energy Use by Type

Table 1. Irvine Municipal Energy Consumption (Annual)

	Value	Unit	Energy consumed (kBtu)	% Of City Energy Use
Electricity	11,292,855	kWh	38,032,735	40%
Natural Gas	294,321	Therms	29,432,100	31%
Gasoline	237,315	Gallons	27,549,889	29%
Total Energy			**95,513,210**	

Each category represented about one third of City-wide municipal government energy consumption, with electricity consuming the most, at 40%. The top energy-consuming City-owned buildings were the two Aquatics Centers, the Civic Center, Lakeview Senior Center, and the Great Park Administrative buildings. The top two, William Woollett and the Civic Center, represent over one-third of City-owned building energy usage. When compared to community energy use, the municipal buildings accounted for 0.6% of energy consumed in the City of Irvine.

Table 2. City-Owned Buildings with the Highest Annual Energy Consumption

		ElectiCity (kWh)	Gas (Therms)	Energy consumed (kBtu)	% Of City Energy Use
1	**William Woollett Aquatics**	1,212,846	151,336	19,271,830	20%
2	**Civic Center**	3,274,178	31,854	14,356,895	16%
3	**Northwood Aquatics Center**	185,148	59,100	6,541,724	7%
4	**Lakeview Senior Center**	679,667	11,848	3,503,823	4%
5	**Great Park Admin and Misc**	917,815	0	3,131,584	3%

For further analysis, buildings were broken out into the following Categories:

- Civic Center
- Community Centers
  - Cypress
  - Deerfield
  - Harvard
  - Heritage Park
  - Lakeview
  - Las Lomas
  - Los Olivos
  - Northwood Community Center
  - Portola
  - Quail Hill
  - Sweet Shade
  - Turtle Rock
  - University
  - Woodbury
- Aquatic Centers
  - Northwoods Aquatics
  - William Woollett
- Great Park
- Other
  - Animal Care Center
  - Irvine Child Resource Center
  - Irvine Fine Arts
  - Irvine Child Development Center
  - Operation Support Facilities
  - Rancho Senior Center
  - Trabuco Center

Electricity Consumption

Representing 40% of Irvine municipal energy use, the City-owned buildings collectively consume 11.03GWh of electricity annually. The Civic Center was by far the largest electricity consumer, accounting for roughly one third of City electricity consumption. The Great Park, if treated as a unit, was the second largest consumer, accounting for 22% of municipal electricity consumption.

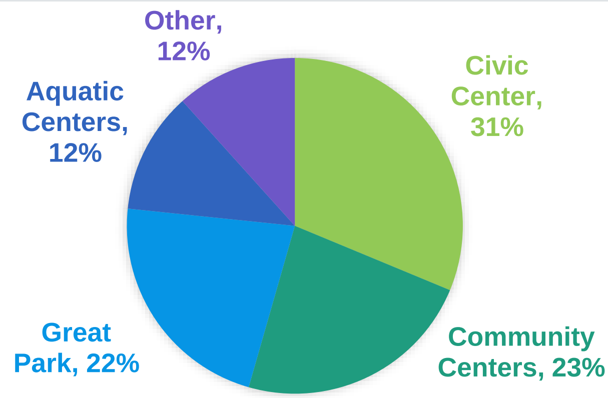


Figure 2. Electricity Consumption by City-Owned Building

Table 3. City-Owned Building Electricity Consumption by Facility Type (Annual)

	# Of Buildings	Electricity Consumption	% Of City Electricity Use
Civic Center	1	3,274,178	31%
Community Centers	14	2,616,695	23%
Great Park	14	2,507,846	22%
Aquatic Centers	2	1,320,914	12%
Other	7	1,317,156	12%
Total	**38**	**11,036,789**	**100%**

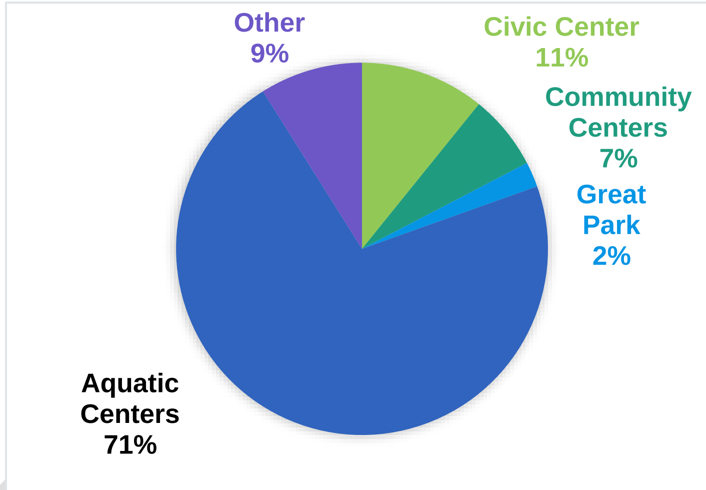
The Civic Center, William Woollett, Great Park Admin, and Lakeview, all featured in the Top 5 Energy consuming sites shown in

Table **2**, were also among the Top 5 electricity consumers. The fifth building, the OSF, has very low natural gas consumption, and so was left out of the Top 5 Energy consuming sites.

Table 4. Top Electricity Consuming City-Owned Buildings (Annual)

	Facility Name	Electricity (kWh)	% Of City Electricity
1	**Civic Center**	3,274,178	29%
2	**William Woollett Aquatics**	1,212,846	11%
3	**Great Park Admin and Misc**	917,815	8%
4	**Lakeview Senior Center**	679,667	6%
5	**Operations Support Facilities**	553,661	5%

Natural Gas Consumption



Natural Gas (NG) is primarily used for heating, both for water heating and for heating, ventilation, and air conditioning (HVAC) use. Since electricity can also be used for heating, not every Irvine facility has natural gas service. There are a total of 23 buildings with NG service and 22 SCG accounts, due to the two soccer stadiums at the Great Park that share gas service. Additionally, the City vehicle fleet also includes 52 renewable natural gas (RNG) vehicles.

Since NG has a higher GHG density than electricity, efficiency measures that reduce natural gas consumption or measures to convert natural gas equipment to electric (electrification) can be effective measures to reduce overall GHG emissions of the City-owned buildings. This is highlighted in the City's Strategic Energy Plan which proposes a pilot project to fully electrify an existing City building that currently relies on some amount of NG.

Table 5. City-Owned Building Natural Gas Consumption by Facility Type (Annual)

Facility Name	# Of Buildings	Natural Gas (Therms)	% Of City Gas Use
Aquatic Centers	2	210,436	71%
Civic Center	1	31,854	11%
Other	6	26,340	9%
Community Centers	11	19,242	7%
Great Park	3	6,449	2%
Total	**23**	**294,321**	**100%**

The two aquatic centers account for over 70% of City NG usage, with William Woollett alone consuming 51% of the City's NG. The high NG consumption of the William Woollett aquatic center used for pool heating makes it an ideal candidate for a combined heat and power (CHP) system. See the Combined Heat and Power section of this report for more details.

Table 5. Top Natural Gas Consuming Buildings (Annual)

	Facility Name	Natural Gas (Therms)	% Of City Gas
1	**William Woollett Aquatics**	151,336	51%
2	**Northwood Aquatics Center**	59,100	20%

3	**Civic Center**	31,854	11%
4	**Animal Care Center**	13,298	5%
5	**Lakeview Senior Center**	11,848	4%

GHG Emissions

This section breaks down the greenhouse gas (GHG) emissions caused by the City's energy use. Figure 4 shows the allocation of City municipal GHG emissions by energy type.

Note: This is provided as reference only and is not intended to replace other GHG inventories that have been performed for the City of Irvine. This was performed using 2019 data. Methodology is described below and may be different than those used for other GHG analyses.

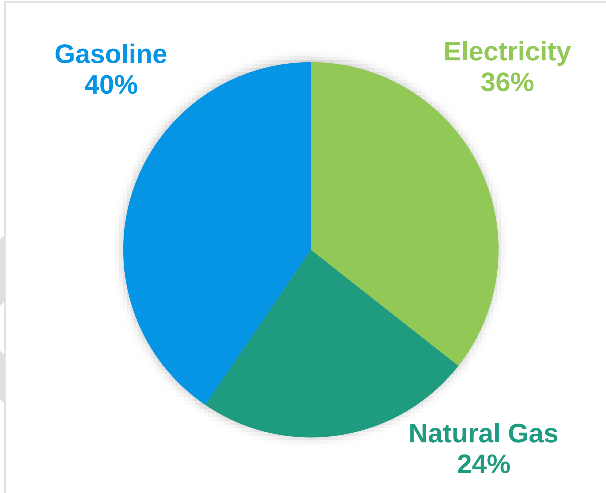


Figure 4. GHG Emissions by Energy Type

According to the U.S. Energy Information Administration (EIA), natural gas emits 116.65lbs of CO_2 per Million British Thermal Units (MMBtu)[1]. This equates to 11.665lbs of CO_2 per Therm. Fueleconomy.gov reports[2] that burning a gallon of gasoline emits 8,887 grams of CO_2. They further recommend that a factor of 1.25x be added to that figure to account for the emissions related to drilling, refining, and transporting gasoline for a total of 24.5lbs of CO_2 per gallon.

Assembly bill 117 (passed in 2002) allows communities to organize and decide for themselves their electricity supplier and source of generation. These organizations are known as Community Choice Aggregate (CCA) or Community Choice Energy (CCE) providers. Per California policy, consumers are automatically opted-in to the local CCE. The investor-owned utility (IOU) still maintains the power grid, but the CCE negotiates and purchases the energy used from their choice of generators. Revenue from energy procurement can be reinvested back into renewable energy development, or other community projects.

The Orange County Power Authority (OCPA) is a CCE available to the City of Irvine, its commercial businesses, and its residents. Starting in April 2022, OCPA began offering a 100% Renewable Choice; 100% of energy purchased comes from renewable sources (for those who have opted-in to the plan). According to the City, all municipal facilities have been opted into this plan.

[1] https://www.eia.gov/tools/faqs/faq.php?id=73&t=11
[2] https://www.fueleconomy.gov/feg/label/calculations-information.shtml

While the OCPA can purchase energy from more renewable sources, electricity makes no distinction between who purchased it and where it is delivered. Thus, even while enrolled in one of OCPA's plans, a facility will still draw power from the larger power grid. The OCPA is purely a financial arrangement, providing funding for existing generators and encouraging the development of future renewables. This is also true for customers of the IOU, Southern California Edison. For this reason, the fuel mix of the larger power grid was used for the purposes of this GHG inventory.

Irvine draws power from the California/Mexico (CAMX) subregion of the Western Interconnect. As of this writing, the CAMX fuel mix results in 453lbs of CO2 per MWh[3]. While this is about half the national average, it is still made up of 47% fossil fuels. Wind and solar account for 22% of generation.

Table 6. City Greenhouse Gas Emissions (Annual)

	Value	Unit	GHG Factor	GHG Emissions (lbs)	% Of City GHG Emissions	% of City Energy Use
Electricity	11,292,855	kWh	0.453lbs/kWh	5,115,663	36%	40%
NG	294,321	Therm	11.665lbs/therm	3,433,254	24%	31%
Gasoline	237,315	Gallon	24.5lbs/gallon	5,814,216	40%	29%
Total				**14,363,133**		

Buildings accounted for 60% of municipal GHG emissions, and the largest portion came from the two Aquatic Centers. As mentioned earlier, these two facilities account for most of the NG emissions, and due to the higher GHG density of natural gas, these buildings create higher emissions. Despite only accounting for 27% of City energy use, they account for 36% of GHG emissions. Two buildings, William Woollett Aquatics and the Civic Center accounted for 50% of all City-owned building GHG emissions.

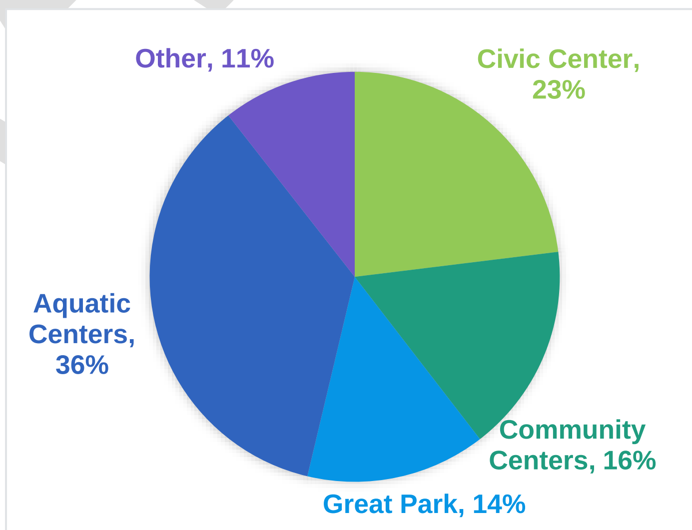


Figure 5. City Municipal GHG Emissions by Facility Type

[3] https://www.epa.gov/egrid/power-profiler#/CAMX

Table 7. City-Owned Building GHG Emissions by Facility Type (Annual)

	# Of Buildings	GHG Emissions (lbs CO2)	% Of GHG Emissions
Civic Center	1	1,970,777	23%
Community Centers	14	1,409,821	16%
Great Park	14	1,211,282	14%
Aquatic Centers	2	3,053,110	36%
Other	7	903,928	11%
Total		**8,548,918**	

Table 8. Top GHG Emitting City-Owned Buildings (Annual)

	Facility Name	GHG Emissions (lbs of CO2)	% Of City GHGs
1	**William Woollett Aquatics**	2,273,289	27%
2	**Civic Center**	1,970,777	23%
3	**Northwood Aquatics Center**	779,821	9%
4	**Lakeview Senior Center**	437,034	5%
5	**Great Park Admin and Misc**	425,303	5%

III. City-Owned Building DER Analysis

This section discusses the methodology employed in assessing buildings for DER installations and energy efficiency opportunities. See Appendix A for the complete results for each facility.

Table 9. Building Inventory

Building/Site Name
Animal Care
Irvine Civic Center
Cypress Community Center
Deerfield Community Center
Harvard Community Center
Heritage Park
Irvine Child Resources Center
Irvine Child Development Center
Irvine Fine Arts
Lakeview Senior Center
Las Lomas Community Center
Los Olivos Community Center
Northwood Aquatics Center
Northwood Community Center
Operations Support Facility (OSF)
Portola Springs Community Center
Quail Hill Community Center
Rancho Senior Center
Sweet Shade Ability Center
Trabuco Community Center
Turtle Rock
University Community Center
Woodbury Community Center
William Woollett Aquatic Center
Great Park Admin
Great Park Soccer A&B
Great Park Soccer C and Baseball E&F
Great Park Softball G
Great Park Tennis Support H
Great Park Basketball D

Methodology

Historic Energy Audits and Energy Efficiency Upgrades

First, CSE reviewed twelve historical energy audits provided by the City. Of those, eleven provided actionable items to improve energy efficiency. One, Turtle Rock, only provided a benchmark of current energy use. A summary of each audit is provided in its respective facility summary in Appendix A. The City should consider implementing these energy efficiency measures if they have not done so already. Due to changes in facility usage patterns, advancement in technology and other factors, CSE recommends repeating energy audits every 5 years. For example, LED lighting has become the standard for energy efficient lighting, so any suggested lighting upgrades should be reevaluated for LED. While these summaries provide a starting point for energy efficiency upgrades, they should not be considered an exhaustive list.

Any effort to reduce energy consumption of a facility will minimize baseline energy costs and associated GHG emissions; lower energy consumption also reduces the amount of DERs needed to offset with renewables. The largest impact through energy efficiency measures is usually achieved through lighting and HVAC equipment. For example, replacing typical outdoor High-Intensity Discharge (HID) lighting with LED fixtures can reduce demand by 65% to 74% and replacing indoor linear fluorescent lamps with LED can reduce demand by 30% to 40%. LED lighting also has a much longer life – 20 times that of fluorescents and 7 times that of outdoor HID – reducing the City’s long term labor costs associated with lamp replacement. HVAC demand can be greatly reduced by maintaining regular service schedules for equipment, as well as by examining operating schedules and temperature setpoints. Many energy efficiency measures are low or no cost. For example, adjusting the HVAC schedule or temperature setpoint, or setting IT equipment to power down when not in use.

Desktop Energy Audit

In lieu of on-site energy audits, a desktop audit was performed for each facility. Weekday and weekend seasonal load profiles were compared to the operating hours of the facility to identify opportunities for improvement. For these reviews, nighttime hours were considered 10pm-6am. These reviews accompany the DER analysis for each facility and may help the City determine priority for future on-site energy audits. Note that only electricity usage was analyzed, and there may be other efficiency opportunities related to natural gas usage that the City should consider.

To assess the energy performance of each building, CSE calculated the Energy Use Intensity (EUI), a measure of energy usage per square foot, for each building by combining electricity and natural gas consumption using the common units of kBtu. Energy usage in kBtu divided by square footage determines the EUI (kBtu/Ft^2). National median EUI for various facility types are published by Energy Star[4] where one therm of natural gas is equivalent to 100kBtu and one kWh of electricity is equal to 3.412kBtu. By calculating EUI, one can compare the energy consumption of a facility to that of a similar building or national median. A facility with a particularly high EUI when compared against the national median for its building type is a good candidate for an in-person energy audit.

DER Sizing and Siting Analysis

2019 consumption interval data sourced from SCE was used to evaluate which combination of Solar PV and BESS would provide the greatest cost benefit to the City using NREL's ReOpt[5] tool. ReOpt uses geographical location to determine realistic solar irradiation, paired with interval data and local rate tariffs to determine the optimal DER sizing to achieve various goals such as financial payback, resiliency, or renewable energy objectives. Analyses used the sites actual rate tariff for the most accurate utility costs. The AL-2 street lighting rate tariff was not available on ReOpt, so the closest substitute rate tariff was used to evaluate these sites:

Table 10. Street Lighting Rate Tariffs

Site	Existing Rate	Substituted Rate
Las Lomas Community Center	AL-2 (Metered, Non-TOU)	TOU-GS-2-D
Sweet Shade Ability Center	AL-2 (Metered, Non-TOU)	TOU-GS-2-E
University Community Center	AL-2 (Metered, TOU)	TOU-GS-2-E
Woodbury Community Center	AL-2 (Metered, Non-TOU)	TOU-GS-2-E
Great Park Soccer C and Baseball E & F	AL-2 (Metered, Non-TOU)	TOU-GS-3-E

[4] https://portfoliomanager.energystar.gov/pdf/reference/US%20National%20Median%20Table.pdf
[5] https://reopt.nrel.gov/

Great Park Softball G	AL-2 (Metered, Non-TOU)	TOU-GS-2-D
Great Park Tennis Support H	AL-2 (Metered, Non-TOU)	TOU-GS-2-D
Great Park Basketball D	AL-2 (Metered, Non-TOU)	TOU-GS-3-D

Table 11 shows the assumptions made for the site analyses based on CSE's experience with solar and storage projects. In addition, several assumptions are made about system operation. It was assumed that each facility could Net-Meter using its current rate tariff. Net metering is when energy is metered going both directions and the customer gets paid for the energy exported to the grid from solar PV. Battery charging from the grid was also disabled, only allowing the battery to charge from excess solar generation. This maximizes the effectiveness of the solar PV and enables the system to qualify for some requirements of the Self Generation Incentive Program (SGIP). To evaluate potential locations for solar PV installations, GPS imagery was used in the PVWatts tool[6] to scout locations and determine a potential system size. Actual physical space may vary and will need to be evaluated on a site-by-site basis.

Table 11. ReOpt Analysis Assumptions

Assumption	Rate
Solar PV Cost	$2700/kW-DC
Battery Energy Storage Cost	$1000/kWh
SGIP Rebate for BESS	30%
Net Metering	Allowed
Charging Battery from Grid	Not Allowed

NEM 3.0

Net Energy Metering (NEM) is the billing arrangement in California that allows solar to be exported to the grid, providing bill credits back to the owner. NEM 2.0, started in 2016, is the current set of rules for how this energy is processed. Under the current system, for each kWh exported to the grid, the customer receives 1kWh credited back to their power bill. This creates very favorable conditions for solar and has driven tremendous growth in the solar market in California. NEM 2.0 has many other elements as well, for example a consumer on an NEM rate is automatically placed on a Time-of-Use (TOU) rate tariff, being charged different rates for energy consumed at different times of day. There is also a mandatory, one-time, interconnection fee to connect the solar to the grid as well as non-bypassable (mandatory) charges per kWh consumed to fund various statewide energy programs.

In December 2021, the California Public Utilities Commission (CPUC) published a proposal for an update to NEM, Version 3.0. This proposal is not final and has been paused several times since its release. There is no official timeline for when NEM 3.0 will become law. Many provisions proposed by NEM 3.0 stand to

[6] https://pvwatts.nrel.gov/

make rooftop solar less cost effective for consumers. These provisions include TOU rates with much higher energy costs during peak hours, lower payback for exported energy, and a monthly fee to have the system interconnected to the grid. While the final ruling is yet to be determined, it is likely that NEM 3.0 will erode the cost benefits of distributed solar.

City-Owned, Building-Level DER Analysis Results

Table 12 summarizes the results of DER sizing analysis. Full results by building can be found in Appendix A. Note that these systems are sized for maximum financial payback, and larger systems may be required to meet GHG reduction goals. The buildings are listed in alphabetical order. For buildings with "N/A" in the "% Electricity Offset" column no new renewable generation is recommended. The City should prioritize the buildings with the most positive payback period for offsetting 100% of electricity use with a combination of solar and battery storage (highlighted in red). Alternately, once GHG emissions reductions targets are established in the broader CAAP, the City could prioritize solar and storage based on the highest electricity consumers.

Table 12. Summary of DER sizing results

	Site #	% City Electricity Use	New Solar PV (kW-DC)	BESS (kW)	BESS (kWh)	% Electricity Offset
1	Animal Care Center	2%	23	13	79	14%
2	Basketball "D"	4%	124	68	200	36%
3	Civic Center	29%	124	68	200	6%
4	Cypress Community Center	2%	19	53	172	28%
5	**Deerfield Community Center**	**1%**	**43**	**7**	**25**	**100%**
6	Great Park Admin Bldg	8%	15	17	76	4%
7	Harvard Community Center	1%	5	4	26	12%
8	Irvine Child Resource Center	0%	19	1	6	100%
9	**Heritage Park Community Center**	**2%**	**157**	**28**	**84**	**100%**
10	Irvine Fine Arts	1%	25	15	81	23%
11	Irvine Child Development Center	1%	11	8	42	17%
12	Lakeview Senior Center	6%	260	43	131	60%
13	Las Lomas Community Center	2%	98	111	386	66%
14	Los Olivos Community Center	0%	0	4	21	N/A
15	Northwood Community Center	1%	0	21	112	N/A
16	Northwood Aquatics Center	2%	20	22	104	16%
17	Operation Support Facilities (OSF)	5%	274	25	70	78%
18	Portola Springs Community Center	0%	0	7	22	N/A
19	Quail Hill Community Center	2%	0	10	63	N/A
20	Rancho Senior Center	1%	9	7	37	14%
21	Soccer Stadium A & B	4%	65	148	469	22%

	Site #	% City Electricity Use	New Solar PV (kW-DC)	BESS (kW)	BESS (kWh)	% Electricity Offset
22	Baseball Stadium "E"	5%	121	225	788	32%
23	Softball Stadium "G"	1%	60	63	237	19%
24	Sweet Shade Ability Center	1%	3	3	15	6%
25	Tennis Support "H"	2%	144	72	246	100%
26	Trabuco Center	1%	0	10	53	N/A
27	Turtle Rock Community Center	2%	90	38	128	60%
28	University Community Center	2%	53	55	242	32%
29	William Woollett Aquatics	11%	10	18	56	2%
30	Woodbury Community Center	1%	11	9	57	16%

Combined Heat and Power (CHP) Screening

As part of CSE's building portfolio analysis, three sites were identified as potential candidates for onsite Combined Heat and Power (CHP) generation. The City of Irvine was referred to the Department of Energy's Western CHP Technical Assistance Partnership (CHP TAP) for an initial screening of the technology at the Civic Center, Northwoods High School Aquatics Center, and the William Woollett Aquatics Center. Combined heat and power, sometimes referred to as cogeneration, is an efficient and clean approach to generating on-site electric power and useful thermal energy from a single fuel source. CHP uses NG (or other fuels) to generate electricity for the site, while repurposing the waste heat from combustion for some useful purpose, such as space or water heating. CHP applications can operate at 65-75% efficiency, a significant improvement over the national average of 50% for these services when provided separately. The following results are summarized from the CHP TAP analysis.

Of the three sites that were screened, only the William Woollett Aquatics Center had favorable results where a high-level screening suggested a 208kW CHP system estimated to cost approximately $604,000 and have an estimated payback of about 9 years. Preliminary results show a potential for approximately $67,000 annual operating cost savings with an 11.1% return on investment (ROI). Other factors that may contribute to the City's interest in CHP include the City's concern about future energy costs impacting City facilities, the existence of an existing central heating system at the center, and the City's commitment to reducing its carbon footprint (William Woollett is the City's largest GHG producing facility). Table 13 below shows a sensitivity analysis to demonstrate the potential economic performance of a CHP system both with and without applicable utility Capacity Reservation Charges (CRC). These typical standby and departing load charges administered by SoCal Edison are suspended as per a recent CPUC ruling, which better the payback of installing a CHP system. The CPUC ruling to suspend CRC charges associated with CHP became effective on January 1, 2021 (D.21-01-018[7]). This suspension of applicable Capacity Reservation Charge component of standby charges will be effective until 2026 when the effectiveness of this suspension will be evaluated.

Table 13. CHP Sensitivity Analysis

CHP Screening Metric	With CRC Suspension	Without CRC Suspension
CHP Installed Cost	$603,924	$603,924
Annual Standby Charges	N/A	$44,932
Annual Departing Load Charges	N/A	$25,052
Annual Operating Savings	$67,237	$31,707
Simple Payback	9.0 Yrs.	19.0 Yrs.
Return on Investment	11.1%	5.3%

Next steps would include further evaluation of feasibility of a CHP system at the William Woollett Aquatics Center including a deeper analysis of the sites electric and thermal energy profile, physical siting, and interconnection of the equipment as well as CRC suspension requirements. If the City is interested, the DOE Western CHP TAP program can provide no-cost guidance on this matter and can be contacted for assistance by emailing CHPTAP@energycenter.org.

Offsetting with 100% Renewable Energy

This section details the cumulative amount of solar PV required City-wide to offset 100% of electricity usage for various scenarios. Some customers find that solar-only is more cost-effective than pursuing energy storage. However, battery energy storage is a developing technology and prices are likely to decrease in the coming years. According to NREL, the cost of commercial solar dropped by 69% from 2010 to 2020[8]. As battery technology progresses, it could follow a similar price decrease. Note that without storage, much of this energy would be exported to the grid. Any investment in solar today can be paired in the future with a suitable BESS. As a solar-only option, solar PV required to offset 100% of electricity was also provided for each City-owned facility in Appendix A.

This calculation was performed using the annual electricity consumption from SCE, paired with the yearly average Direct Normal Irradiance (DNI). The DNI is the average daily hours that a solar panel would receive if it tracked directly at the sun. The DNI is published by NREL[9] and is available worldwide. Solar could produce for as long as 10 hours on a clear sunny day in the summer, but the DNI averages in the shorter days in the winter as well as rainy and overcast days (Irvine averages 280 sunny days per

[7] https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M393/K334/393334241.PDF
[8] https://www.nrel.gov/docs/fy21osti/77324.pdf
[9] https://maps.nrel.gov/nsrdb-viewer/

year). The DNI in Irvine is 6.3 hours per day but since solar installations are more likely to be fixed, rather than sun-tracking, the more conservative LA metro average of 5.62 hours per day was used.

Table 14. Cumulative Solar Required to Offset with 100% Renewable Electricity

	Annual Electricity Consumption (kWh)	Solar Needed to Offset 100% (kW-DC)
Civic Center	3,274,178	2,128
All Community Centers	2,616,695	1,700
Great Park	2,507,846	1,630
Aquatic Centers	1,320,914	858
All Other Buildings	1,317,156	856
Electric Vehicles*	400,920	260
Total City Electricity	**11,036,789**	**7,432**
*Based on those recommended in the ZEV transition Plan		

DER Funding and Financing Opportunities

Purchasing and installing DERs can be accomplished by many different financial mechanisms. This section addresses some common financing mechanisms and incentive programs for DER installation.

Direct Purchase

Direct purchase is the most easily understood method. The City will contract through a provider to purchase and install solar and storage. The City benefits from the installation through lower electric bills and payments from excess energy exported to the grid. The City owns the equipment and is responsible for maintenance. The City finances the project with upfront payments or a payment plan.

Power Purchase Agreement

A solar Power Purchase Agreement (PPA) is an alternate financing option for solar. A PPA is a financial agreement where the developer arranges the design, permitting, and installation of the solar PV system. The developer then sells the generated power to the host customer at a cost typically lower than utility power (the developer also receives any tax credits or incentives from the installation). The developer is responsible for maintenance of the system. The main advantage of a PPA is that there is little to no upfront cost to the host customer. Though the City is not directly eligible for the Investment Tax Credit (ITC), they can benefit from them indirectly through a PPA in the form of lower electricity rates. Battery energy storage can also be included in a PPA.

Benefits to a PPA:

- Low or zero upfront costs
- City is not responsible for design, permitting and installation
- City is not responsible for maintenance

- Lower electricity rates compared to the local utility
- Indirectly benefit from the ITC

Solar Leasing

Similar to a PPA, the installer is responsible for the install and maintenance of the system, and the City rents the system from the developer. the City then freely uses the power generated by the system. Unlike a PPA, the City pays a fixed monthly rent for the use of the system rather than paying on a kWh basis. At the end of the lease, the City could choose to renew the lease, buyout the system from the lesser, or reach a new lease agreement to upgrade and modernize the system. The lessor can also remove the system at the end of the lease.

Green Revolving Fund

A Green Revolving Fund (GRF) provides dedicated funding for green energy projects. The City provides upfront capital to establish the fund. Projects that meet the requirements of the program can then be funded from the GRF. The intent of the GRF is to fund projects with an adequate payback period to allow the fund to replenish itself (revolve) or even to grow over time. A department who withdraws from the fund would be required to calculate cost savings from the project and pay that amount back to the fund. Applicable projects could include energy saving, water saving, reduce sewage or stormwater, improvements to operations, and installing renewables or other DERs.

Community Solar

Community Solar customers can either buy or lease a share of the solar panels in a large grid-scale solar installation. They then receive an electric bill credit for the electricity generated by their share of the array. This is an option for a site that does have the space or ability to install solar onsite. The installation could be outside of town, or even on the other side of the state.

Federal Investment Tax Credit (ITC)

While the City isn’t eligible for ITC, they can benefit indirectly through the reduced costs from a solar PPA or lease. The Federal Investment Tax Credit (ITC) applies to both battery energy storage systems and solar PV. For solar PV, the incentive received is based off the year construction started and cost of the installed system. For BESS, the incentive is also based off the year construction started, but in addition, the percentage of the tax credit received is also based off how much of the batteries charging is sourced from renewable energy.

Table 15. ITC Rates for Solar PV and Battery Storage

Technology	Rates
PV	• 26% for Projects that begin construction in 2021/22 • 22% for Projects that begin construction in 2023 • After 2021, Commercial drops to a permanent 10%
BESS	• Portion of 26% ITC if battery is charged by renewable energy 75-99% • Full 26% ITC if battery is charged by renewable energy 100%

Self-Generation Incentive Program (SGIP)

The Self-Generation Incentive Program (SGIP) provides a rebate for installing battery energy storage systems. The incentive is based on the size (in watt-hours) of the system. The following table has the current Step 3 incentive rates for SGIP.[10] SGIP funds are limited and could be exhausted in the future, so these figures are subject to change.

Table 16. ITC Rates for Solar PV and Battery Storage

	SCE
Large-Scale Storage	**Step 4**
Energy Storage	$0.30/Wh
Energy Storage with ITC	$0.22/Wh
Non-Residential Storage Equity	**Step 5**
Energy Storage	$0.85/Wh

[10] https://www.selfgenca.com/home/program_metrics/

IV. EVI Impact Study

In the ZEV Transition plan, CSE recommended that the City transition up to 138 existing internal combustion vehicles to electric vehicles by FY 2027-28. Charging that volume of vehicles will require a large amount of Electric Vehicle Supply Equipment (EVSE) as well as upgrades to existing electric infrastructure (EVI) to supply power to the supply equipment. Charging analysis from the ZEV Transition plan shows that these vehicles could contribute as much as 1.6MW of additional demand at the Civic Center, and 2.5MW demand at the Operations Support Facility (OSF). For comparison, the peak demand in 2019 at the Civic Center and OSF were 685kW and 142kW, respectively.

In this section, CSE will examine the impacts of electric vehicle charging, provide recommendations for load management strategies and DERs to reduce peak demand, and analyze the available capacity of the investor-owned utility (IOU), SCE, distribution system.

Methodology

CSE created EV charging profiles specific to Irvine's geographical location and fleet characteristics using the EVI-Pro Lite[11] software. EVI-Pro is a collaboration between The National Renewable Energy Lab (NREL) and the California Energy Commission (CEC) that uses data on vehicle travel and charging patterns to estimate typical charging profiles for home, public and workplace charging.

CSE used ReOpt Lite[12] to analyze estimated utility costs, power consumption and demand. ReOpt Lite is also developed by NREL and uses geographical location and local rate tariffs to produce reports on energy consumption and cost, as well as recommend optimal sizing of DERs like solar generation and battery energy storage (BESS).

Using the recommendations for EV replacements from the ZEV Transition plan, annual mileage, and vehicle fuel economy equivalents, and EVI-Pro load profiles, CSE determined the total expected annual electricity consumption (kWh). The average mileage of vehicles suggested for replacement was around 6000 miles per year, but CSE increased this number to 8000 miles per year to account for time spent idling. For carts and utility vehicles, vehicles averaged about 600 miles per year, and this was increased to 1000 miles to account for idling. Load profiles for each fiscal year (FY) were analyzed in ReOpt to determine the combination of solar PVs and BESS that would determine the highest return on financial investment.

[11] https://afdc.energy.gov/evi-pro-lite
[12] https://reopt.nrel.gov/

EVI Impact Analysis

Distribution System

In 2015, the California Public Utilities Commission issued Rulemaking 14-08-013 requiring public utilities to publish a Distribution Resource Plan (DRP), which included an Integration Capacity Analysis (ICA) for each electrical line in the distribution system. The ICA quantifies the maximum amount of power that can be injected to, or drawn from, the distribution system requiring minimal to no distribution upgrades or operational restrictions. This data was published to an interactive web portal[13] and provides access to, among other things, the amount of generation and load that can be added to the distribution line. The ICA is updated regularly and data from April 16, 2022, was used for this analysis.

Load and generation, especially solar, fluctuates throughout the day, but the power grid must be able to support even the worst-case scenario. When conducting the ICA study, SCE used the most limiting conditions on the most limiting day and hour to determine integration capacity. The amount of load that can be added was limited by the amount of load installable at that location without violating any thermal or voltage requirements on the line. It is important to note that the integration capacity values do not guarantee that distribution upgrades will not be needed and should be treated as guidelines only.

Electrical Load

CSE created load profiles to simulate charging patterns and analyze energy consumption and cost for the Civic Center and OSF. These profiles were created from workplace charging patterns specific to the Los Angeles / Long Beach / Anaheim Metro area. Peak demand occurs in the afternoon as vehicles return to their facilities at the end of the workday. Demand drops off considerably on the weekends with fewer employees working. Figure 6 illustrates the weekday and weekend charging profiles that were used for the EVI impact study.

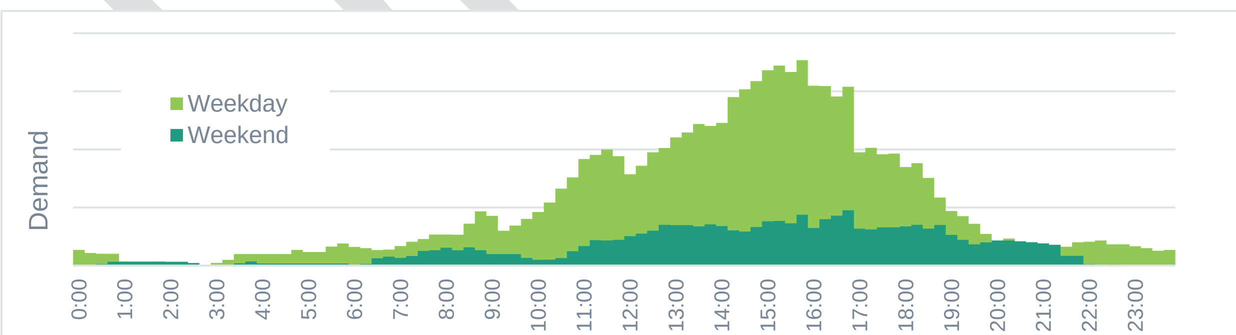


Figure 6. EV Charging Load Profile

[13] https://drpep.sce.com/drpep/

Since the Civic Center and OSF were not originally designed to support a large EV load, it is assumed that the EV charging depots at these sites will be metered and supplied on a separate service from SCE. This separate service already exists at the Civic Center (Meter 8002021859) for the few existing chargers at that site. Metering EV charging separately will enable the City to take advantage of EV-specific charging tariffs from SCE. These rates could result in a lower utility bill, especially if charging is scheduled to begin at night such as 9PM or later.

Electric Vehicle Equivalent Fuel Economy

For decades, miles traveled per gallon of gasoline has been the gold standard for measuring vehicle energy consumption. In lieu of gasoline, EVs consume electricity, measured in kWh. Fueleconomy.gov provides energy consumption for electric vehicles in kWh/100 miles. Table 17 contains the fuel economy of the various vehicles suggested as potential electric replacements in the ZEV Transition Plan.

Table 17. Electric Vehicle Fuel Economy by Make and Model

Vehicle	kWh/100 miles
Chevrolet Bolt EV	29
Chrysler Pacifica PHEV	41
Ford Lightning	43
Ford Escape PHEV	32
Ford e-Transit	54
Ford F-250e	54*
Hyundai Ioniq-5	31
Hyundai Santa Fe PHEV	44
Hyundai Tucson PHEV	42
Kia EV-6	29
Lightning e450	77
Lightning T350e	53
Toyota RAV4 PHEV	36
Volkswagen ID4	34

*Estimated, data not available

Information on the various carts and utility vehicles was largely unavailable. Electrical fuel economy was estimated based on information available on battery size and horsepower equivalent. The Lead-Acid batteries in these vehicles are less advanced than the lithium-ion batteries in most EVs. As a result, these vehicles only yielded marginally better fuel economy despite being much smaller vehicles.

Table 18. Club Car Summary

	# Batteries	Amp-Hours	Battery Capacity (kWh)	kW	Electric Range	kWh/100 Mile
Club Car E	6	170	8.16	2.40	37.40	21.82
Club Transporter Electric	8	170	10.88	2.70	44.33	24.55
Carryall 300e	6	170	8.16	2.40	37.40	21.82
Carryall 500e	8	170	10.88	2.70	44.33	24.55
Carryall 700e	8	170	10.88	2.70	44.33	24.55
Carryall 1700e*	8	170	10.88	2.70	44.33	24.55

*Estimated, information not available for this model yet

Peak Demand

Demand from EVSE will vary throughout the day and will be limited by three main factors. The first is installed infrastructure. Though 1.6MW and 2.5MW of EVSE were recommended at the Civic Center and OSF, respectively, the likelihood that every charging port will be in use at one time is low. The City may choose to install, for example, 1MW and 1.5MW of transformer capacity at those facilities instead. Civic Center already has some installed EVI capacity, so it will require a proportionately smaller upgrade than OSF. The second limiting factor will be the load management strategies performed by the EVSE providers. Load management strategies are detailed in the following section, as well as in depth in the ZEV Transition Plan. The third is the human factor. The driving patterns of employees will determine how many vehicles will need to charge on a given day at a given time. Though demand charges do not currently apply, the City should anticipate demand charges contributing to a significant portion of the utility bills at these facilities in the future. The City, SCE, the EVSE provider, and electrical design/builder will need to work together to determine the optimal demand management strategy.

Load Management Strategies

This section outlines the various load management strategies the City can deploy to lower utility bills and minimize required electrical infrastructure upgrades.

Shared Charging

Some chargers feature a “circuit sharing” capability, where multiple charging heads share a low amperage circuit. This allows charging to be split between multiple vehicles at once. For example, a 7.2kW charger could be shared between two or more vehicles using a single 40A circuit. However, each vehicle would charge half as fast, each receiving 3.6kW. This is not a good solution for the large-scale charging needs of the City. Vehicle battery capacity is growing rapidly, and this method of charging will result in very long dwell times.

Due to the much higher capacity of DC fast chargers, shared direct current fast chargers (DCFCs) is a more effective alternative to shared L2 charging. Several vehicles can charge at the same time using high output DC Fast chargers.

Delayed or Scheduled Charging
With this strategy, vehicles can be plugged in at any time of the day but will not begin charging until a predetermined time. Since fleet vehicles tend to return to base in the second half of the workday, when peak TOU charges are in effect, the City is highly recommended to pursue this strategy. This can also be coupled with sequential charging, where there is a limit to the number of vehicles charging at once. Once one vehicle is finished charging, another can begin. Delayed charging will reduce TOU energy charges, while sequential charging will lessen demand charges and limit the amount of required infrastructure upgrades.

Fleet Management
In addition to scheduled charging, fleet management software can monitor each vehicle's location, state of charge and proximity to charging infrastructure. Fleet management platforms can monitor charge completion time, charging station availability, establish charging queues and monitor depot power consumption. The management software can throttle charging based upon the TOU rate tariff or predetermined demand limits. Critical vehicles can be prioritized to charge first, and charging can be optimized so that each vehicle always maintains a minimum level of charge.

Vehicle to Grid (V2G) and Vehicle to X (V2X)

EVs contain a large battery and generally consume power by charging from the utility grid. Vehicle to Grid (V2G) allows EVs to provide power back to the grid, in response to various signals such as demand response or a power outage. They can generally provide the same grid services that a BESS can provide, such as storing solar energy, Time-of-Use arbitrage, and peak shaving. Technology providers can configure charging schedules so that EVs are always charged to a minimum threshold as needed. An EV can also discharge power to another vehicle, provide portable 120V power, and can even be used to provide backup power to a home (called Vehicle to X or V2X)

While V2G is optimal in vehicles that run on a fixed schedule or spend a lot of time parked, V2X will become increasingly important in the coming years. Any adequately charged vehicle with V2X may be able to discharge to a building or the grid as a DER when not in operation. Buses and trucks with large battery packs will provide a larger DER benefit per vehicle.

Ford Motor Company has announced that its new F-150 Lightning will be V2X capable – capable of powering one's home or charging another vehicle. The home will require a special charger and inverter. The F-150 Lightning will also be capable of exporting power to smaller critical facilities such as a Community Center during emergencies - if a bidirectional V2X DCFC has been installed at the site. The truck can provide backup power that would be traditionally supplied by an emergency generator. Other manufacturers are expected to offer similar functionality with their vehicles. Of the 137 vehicles recommended to be replaced with ZEVs by FY 27-28, 46 were Ford F-150 lightning. At 9.6kW each, this fleet could provide as much as 441kW of backup power in an emergency.

EV Rate Tariffs

SCE has three rate tariffs available for commercial EV charging based upon the charging demand at the site:

Table 19. Tariffs based on Charging Demand

Rate Tariff	Charging Demand
TOU-EV-7	<20kW
TOU-EV-8	20kW-500kW
TOU-EV-9	>500kW

Rate tariffs vary slightly in their figures, but they all feature a Time-of-Use (TOU) rate component, where electricity rates vary based on time of day and year. For On-Peak charging, from 4-9PM on weekdays, charging rates increase to around five times as expensive as off-peak[14]. These rate tariffs are exempt from demand charges until 2024, when they will come into effect. A demand charge will be levied based upon the highest demand occurring during the billing period. Shifting EV charging from peak hours to off-peak hours will lower TOU energy charges and minimizing peak demand will lower demand charges when they come into effect.

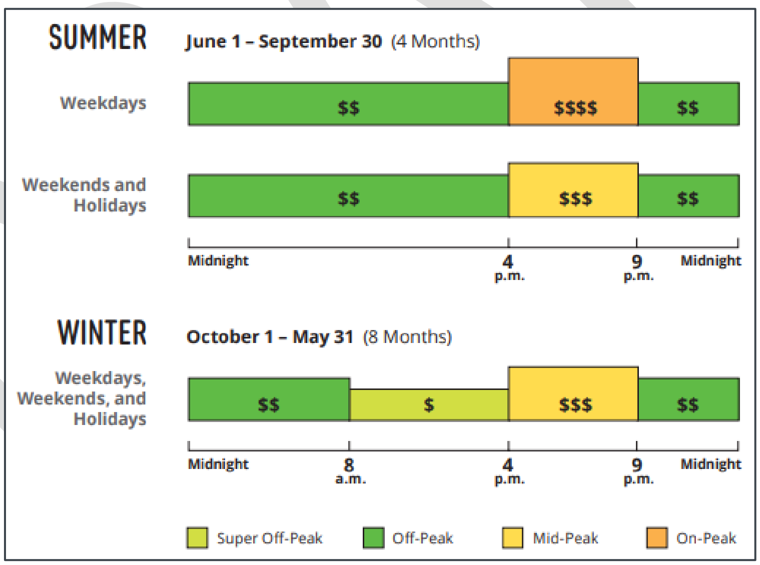


Figure 7. Charging Rates based on Time of Year (From SCE)

[14] https://crt.sce.com/how-to-electrify

EV Impact by Site

Irvine Civic Center

The ZEV Transition Plan recommends transitioning 44 light and medium duty vehicles to electric alternatives at the Civic Center by FY 27-28. This could add as much as $29,055 in annual charging costs to provide 130MWh of energy to Civic Center vehicles.

Table 20. Civic Center Electric Vehicle Adoption Recommendations by Fiscal Year

	22-23	23-24	24-25	25-26	26-27	27-28
Number of Vehicles Added	16	2	0	9	6	11
Number of Vehicles (Cumulative)	16	18	18	27	33	44
Total Annual Energy Consumption (kWh Cumulative)	42,880	47,920	47,920	78,160	96,240	130,890
Annual Utility Costs	$10,799	$11,845	$11,845	$18,117	$21,867	$29,055

Powering these vehicles effectively could require as many as 64 L2 and 4 DC Fast chargers, adding 1.6MW of electrical demand. This demand will drive costs for infrastructure upgrades as well as higher utility bills when demand charges come into effect in 2024. The City should work with the EVSE provider along with SCE to determine the most cost-effective load management solution to limit the amount of required infrastructure upgrades.

Table 21. Civic Center Electric Vehicle Infrastructure Recommendations

Chargers	Near term	kW Each	kW Total	Mid Term (cumulative)	kW Each	kW Total (cumulative)
120v Outlet	2	1.8	3.6	2	1.8	3.6
L2 9.6kW	10	9.6	96	10	9.6	96
L2 19.6kW				54	19.6	1058.4
DCFC 120kW Min	3	120	360	4	120	480
		Near-Term kW	**459.6**		**Mid-Term kW**	**1638**

For comparison, the existing peak demand at the Civic Center is 685kW. To mitigate some electrical costs, the City could consider installing DERs to help offset the added energy consumption. BESS can be deployed whenever charging demand rises above a certain threshold, known as “peak-shaving”. This technique will make BESS more lucrative when demand charges are introduced.

Table 22. Civic Center DER Recommendations

	22-23	23-24	24-25	25-26	26-27	27-28
Solar (kW-DC)	27	31	31	50	62	84
Battery (kW)	4	4	4	7	8	11
Battery (kWh)	22	25	25	40	50	68
Net Present Value (25 Years)	$8,139	$9,096	$9,096	$14,836	$18,268	$24,844
% Renewable Energy	100%	100%	100%	100%	100%	100%
Annual Utility Savings	$7,135	$7,975	$7,975	$13,007	$16,015	$21,781
Payback Period (Years)	9.1	9.09	9.09	9.09	9.09	9.1

Table 22 offers solar and storage sizing to provide optimal financial payback. Carport solar in the secured area is likely the only option for Civic Center EV charging. Three rows of carport solar could accommodate as much as 360kW-DC of solar. Note that this analysis intends only to offset power consumed by EV charging and is separate from the power consumed by the main Civic Center building.

Figure 8. Potential Siting for Solar at Civic Center

The Civic Center grounds have three distribution lines running to it. Presumably, one each for City Hall, the Police Headquarters, and the fueling depot (circuits 1-3 shown in Figure 9). Unfortunately, none of these have room for the addition of EV load. Nearby circuit 4 has room for as much as 6MW of added load, but it is almost certain that distribution upgrades will be required for Civic Center EV charging. Additionally, installing solar PV on any of the existing lines will likely also require distribution system upgrades; circuit 4 shows a very small amount of capacity for solar PV.

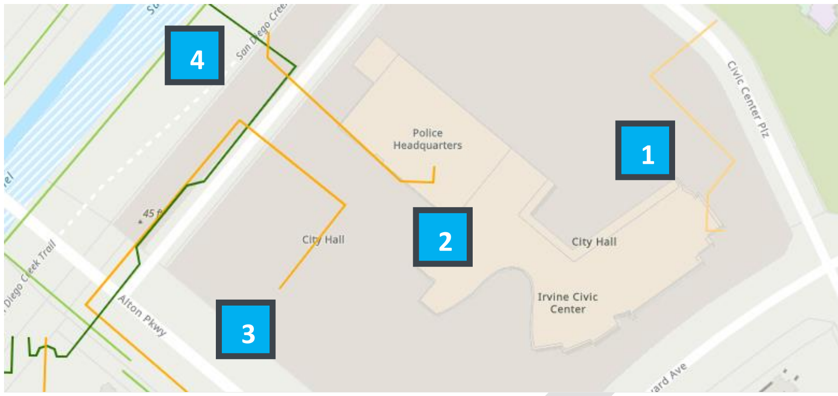


Figure 9. Distribution Lines at Civic Center

Table 23. Integration Capacity Analysis – Civic Center

Distribution Segment	Solar PV Capacity (MW)	Added Load Capacity (MW)
1	0	0
2	0	0
3	0	0
4	0.01	6.27

Operations Support Facility

The ZEV Transition Plan recommends transitioning as many as 89 light and medium duty vehicles at the OSF to electric alternatives by FY 27-28. This could add $57,915 in annual charging costs to provide 2.70MWh of energy to OSF vehicles.

Table 24. OSF Electric Vehicle Adoption Recommendations by Fiscal Year

	22-23	23-24	24-25	25-26	26-27	27-28
Number of Vehicles Added	18	6	2	7	26	30
Number of Vehicles (Cumulative)	18	24	26	33	59	89
Total Annual Energy Consumption (kWh Cumulative)	80,960	99,520	111,840	145,680	204,130	270,030
Annual Utility Costs	$18,698	$22,548	$25,103	$32,122	$44,246	$57,915

Powering these vehicles effectively could require as many as 30 dedicated 120v outlets for carts, 51 L2, and 13 DC Fast chargers, adding 2.47MW of electrical demand. This demand will drive costs for infrastructure upgrades as well as higher utility bills when demand charges come into effect in 2024. The City should work with the EVSE provider along with SCE to determine the most cost-effective load management solution to limit the amount of required infrastructure upgrades.

Table 25. OSF Electric Vehicle Infrastructure Recommendations

Chargers	Near term	kW Each	kW Total	Mid Term (cumulative)	kW Each	kW Total (cumulative)
120v Outlet	30	1.8	54	30	1.8	54
L2 9.6kW	14	9.6	134.4	14	9.6	134.4
L2 19.6kW				37	19.6	725.2
DCFC 120kW Min	8	120	960	13	120	1560
		Near-Term kW	**1148.4**		**Mid-Term kW**	**2473.6**

For comparison, the existing peak demand at the OSF is 142kW. To mitigate some electrical costs, the City could consider installing DERs to help offset the added energy consumption. BESS can be deployed whenever charging demand rises above a certain threshold, known as "peak-shaving". This technique will make BESS more lucrative when demand charges are introduced.

Table 26. OSF DER Recommendations

	22-23	23-24	24-25	25-26	26-27	27-28
Solar (kW-DC)	52	64	72	93	131	173
Battery (kW)	7	9	10	13	18	24
Battery (kWh)	43	53	59	77	108	143
Net Present Value (25 Years)	$15,182	$18,662	$20,973	$27,318	$38,279	$50,637
% Renewable Energy	100%	100%	100%	100%	100%	100%
Annual Utility Savings	$13,528	$16,630	$18,689	$24,343	$34,109	$45,122
Payback Period (Years)	9.15	9.15	9.15	9.15	9.15	9.15

Table 26 offers solar and storage sizing to provide optimal financial payback. Carport solar over the various vehicle parking areas could accommodate as much as 380kW-DC of solar. Note that this analysis intends only to offset power consumed by EV charging and is separate from the power consumed by the main Civic Center building.

Figure 10. Potential Siting for Solar at OSF

The OSF is fed from four distribution lines, feeding various buildings around the site. Although all four lines have room to add several MW of EV load, installing solar PV at the OSF will likely require infrastructure upgrades.

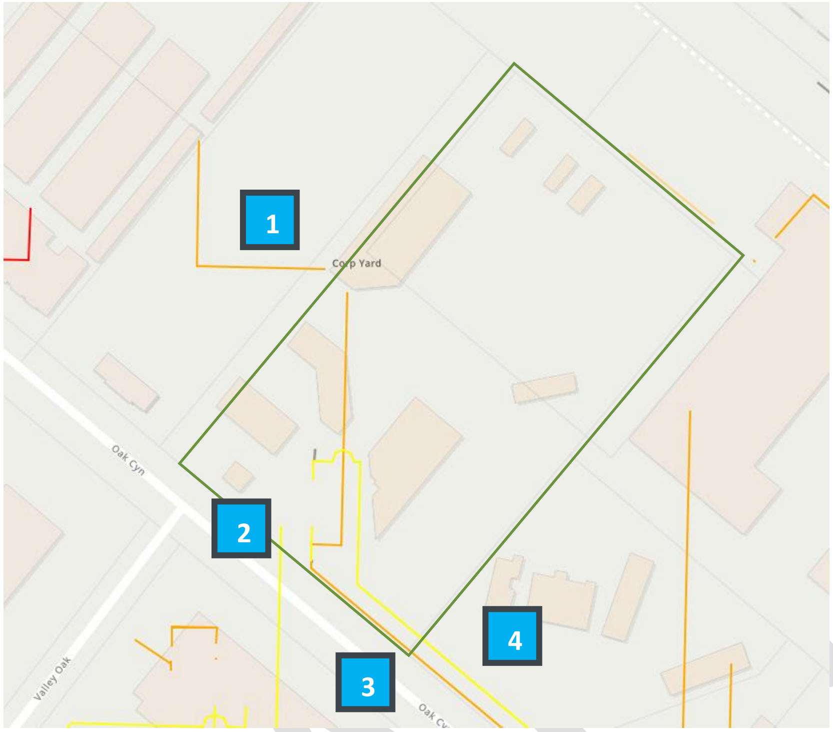


Figure 11. Distribution Lines at OSF

Table 27. Integration Capacity Analysis - OSF

Distribution Segment	Solar PV Capacity (MW)	Added Load Capacity (MW)
1	0	**3.01**
2	0	**5.94**
3	0	**3.53**
4	0	**6.23**

Community Parks

Twenty-seven vehicles in the City fleet, mostly large passenger vans, park at six various Community Centers. To accommodate these vehicles, the ZEV Transition plan recommended installing at least two L2 chargers at each site. Heritage Park, where most of the twenty-seven vehicles are parked, it is recommended to install 7 L2 chargers and 1 DCFC charger.

Table 28. Other Recommended EVSE at Community Park Locations

Chargers (L2)	Near term	kW Each	kW Total
Cypress	2	19.2	38.4
Woodbury Park	2	19.2	38.4
Heritage Park	7	19.2	254.4
Heritage Park (DCFC)	1	120	
Turtle Rock	2	19.2	38.4
Portola	2	19.2	38.4
University	2	19.2	38.4
		Near-Term kW	**446.4**

Of the 27 Community Park vehicles, five were recommended for replacement by FY 2027. Charging these vehicles could collectively consume 21,200 kWh of electricity annually and cost $4,505 in utility costs.

Table 29. Community Park Vehicle Replacements by FY 2027

Number of Vehicles	5
Location	Heritage, Woodbury
Vehicle Type	Ford E350 or Transit T-350
kWh/Mile	0.53
Annual Energy Consumed	21,200
Utility Costs	$4,505

ICA Analysis at Cypress, Woodbury, and Portola show no available capacity for added EVI load, so infrastructure upgrades are potentially necessary at these facilities. It is possible that the addition of a few L2 chargers is a small enough load as to not cause strain on the grid, but the City will need to work with SCE to determine final infrastructure requirements. Turtle Rock and University each show 1MW+ of distribution capacity, and there is adequate capacity for both the L2 chargers and the added DCFC at Heritage Park.

See Appendix B for more details on the Community Park ICA analysis.

V. Community Analysis

Methodology

To understand the energy use of the broader Irvine community, CSE conducted a review of publicly available utility data from SCG and SCE.

CSE also conducted a desktop review of publicly available benchmarking data from the California Building Energy Benchmarking Program[15] to identify the top ten energy consuming facilities in the City and performed a DER siting analysis for each. This analysis can be used by City staff for outreach to the building owners and managers of top consumers.

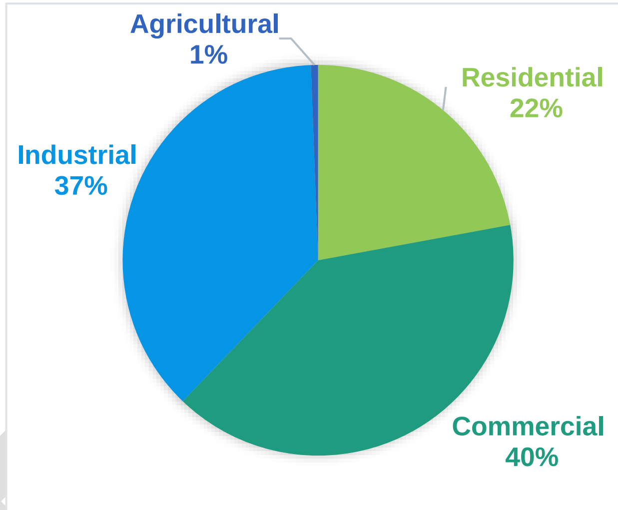
EUI is available from Energy Star Portfolio Manager for buildings in California over 50,000 Sq. Ft., and national EUI data is available from Energy Star. Due to the impacts of COVID-19 in 2020 and 2021, data from 2019 was used whenever possible to reflect more typical usage patterns.

Electrical consumption data was input into ReOpt Lite to determine the optimal DER installations for each of the sites. Like the City-owned building analysis, CSE used an estimated SGIP incentive to determine potential financial payback of DERs. PVWatts was used to determine potential sites and sizing for future solar installations.

A simulated load profile was generated for each site based on building type and annual energy consumption. Geographical location was used to determine solar irradiation. An upper bound for installed solar was determined based on available area from satellite imagery. An SCE rate tariff for large commercial buildings with onsite renewables was used to determine financial results (TOU-8). The analysis for each site was performed to determine the combination of solar and storage resulting in the greatest financial payback.

[15] https://www.energy.ca.gov/programs-and-topics/programs/building-energy-benchmarking-program

Irvine Community Energy Consumption



Electricity Usage

In 2019, electrical usage for the City of Irvine was dominated by commercial and industrial users, with the commercial sector accounting for 40% of total usage and industrial accounting for 37%. Residential and agriculture made up a smaller percent, 22% and 1% respectively.

If this energy is assumed to come from the CAMX power grid, generating this amount of electricity would produce 568,000 tons of GHG emissions (453lbs CO2/MWH, as of this writing).

Customers within its territory are automatically opted into the Orange County Power Authority (OCPA), which provides, at baseline, a fuel mix that features more renewable energy content than the SCE generation mix (38% vs 30.9%). OCPA also offers Smart Choice (69% Renewable), and a 100% Renewable Choice. Community outreach to encourage consumers to switch to Smart Choice or 100% Renewable Choice could drive large scale development of grid-scale renewable energy installations. Options are available for both residential and commercial customers.

Table 30. Community Electricity Consumption (2019)

Sector	Annual Electricity Consumption (MWh)
Residential	555,085
Commercial	1,006,469
Industrial	935,251
Agricultural	14,644
Total	**2,511,449**

Natural Gas Usage

Over half of natural gas consumption in Irvine was by Residential customers, evenly split between Single and Multifamily customers. Commercial natural gas consumption accounted for 34% of the total, and the remaining 14% from Industrial users. SoCalGas did not report an agricultural sector.

Each therm of natural gas produces 11.665lbs of CO2. The cumulative use of natural gas by the community produces 367,000 tons of GHGs.

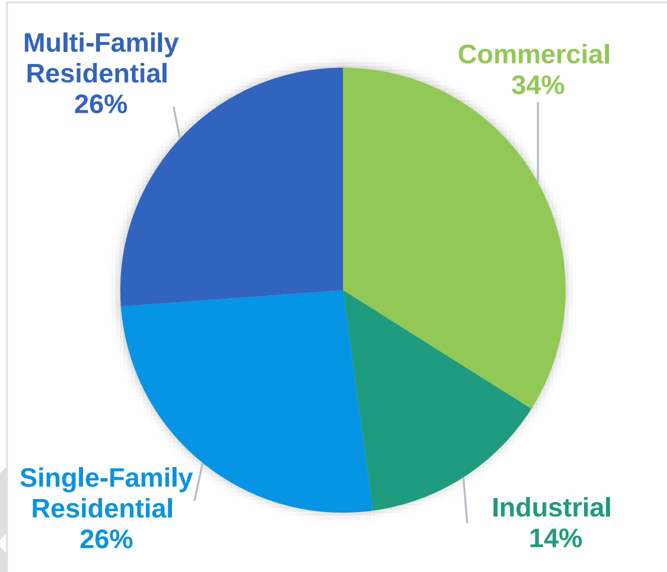


Table 31. Community Natural Gas Consumption

Industry	Annual Natural Gas Consumption (Therms)
Commercial	21,391,347
Industrial	8,767,610
Single-Family Residential	16,364,380
Multi-Family Residential	16,485,218
Total	**63,008,555**

Energy Usage

Electrical and Natural gas consumption were converted to common units of MMBtu using the following conversions:

- 1 MWh electricity → 3.412MMBtu
- 1 Therm NG → 0.1MMBtu

Industrial, Residential, and Commercial each accounted for roughly one third of community energy consumption, with 27%, 35%, and 37%, respectively. Agricultural energy consumption barely registered, with 0.34%.

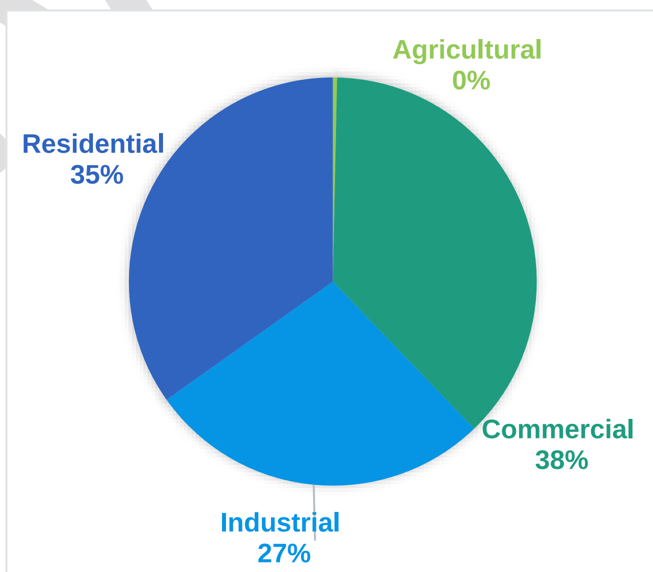


Table 32. Community Energy Consumption

Sector	Electrical (MMBtu)	Natural Gas (MMBtu)	Total Energy Consumption (MMBtu)	% Total Usage
Agricultural	49,965	-	49,965	0.34%
Commercial	3,434,072	2,139,135	5,573,207	37%
Industrial	3,191,076	876,761	4,067,837	27%
Residential	1,893,950	3,284,960	5,178,910	35%
Total	**8,569,064**	**6,300,856**	**14,869,919**	

In general, Irvine community buildings ranked as higher energy consumption per square foot than nationwide buildings of similar type. Colleges, medical and hospital, shopping malls, mixed use facilities, lifestyle centers, wholesale clubs, distributions centers, hotels, and offices all ranked above average energy consumption per square foot compared to the national average.

Table 33. Community Energy Use and GHG Emissions Summary

Energy Type		Units
Community Electricity Use	2,511,449	MWh
Community Gas Use	63,008,555	Therms
Community Energy Use	14,869,919	MMBtu
GHG Emissions - Electricity	568,843	Tons CO2
GHG Emissions - Gas	367,497	Tons CO2
GHG Emissions - Total Energy Use	936,340	Tons CO2

Median Site EUI Comparison Usage

CSE compared EUI for publicly benchmarked Irvine buildings. EUI calculates the energy usage of a building per square foot. Removing building size as a factor, one can compare the EUI of a site to other sites of similar type.

When comparing median site EUIs for the City of Irvine to the national median, Irvine was more energy dense in most building occupancy types. The biggest overages in median EUI were for College/University, and Medical Offices. For the cases in which Irvine was under the national median EUI, the largest difference in these were Senior Care Communities, Multifamily Housing, and Supermarket/Grocery Stores.

Table 34. EUI Comparison to National Average

Building Occupancy Type	Irvine Median EUI	National Median EUI	Over/Under
College/University	153.4	84.3	69.1
Medical Office	97.55	51.2	46.4
Hospital (General Medical & Surgical)	277.7	234.3	43.4
Other - Mall	131.6	101.6	30.0
Mixed Use Property	60.4	40.1	20.3
Lifestyle Center	121.8	103.5	18.3
Wholesale Club/Supercenter	68.55	51.4	17.2
Distribution Center	33.75	22.7	11.1
Hotel	67.8	63	4.8
Office	55.5	52.9	2.6
Retail Store	50.4	51.4	-1.0
Non-Refrigerated Warehouse	15.9	22.7	-6.8
Movie Theater	48.8	56.2	-7.4
Self-Storage Facility	2.8	20.2	-17.4
Supermarket/Grocery Store	173.4	196	-22.6
Multifamily Housing	31.9	59.6	-27.7
Senior Care Community	48	99	-51.0

Top Energy Consuming Facilities

The top ten consumers within the City of Irvine were identified based on the electrical consumption, generation, and natural gas usage for buildings submitted to the Building Energy Benchmarking program. For each analysis, any known DERs were included in the analysis.

Table 35. Top Energy Consuming Facilities in Irvine

Property Name	Number of Buildings	Address	Electricity (kWh)	Generation (kWh)	Natural Gas (Therms)	Energy Consumption (MMBtu)
UC Irvine	200+	66 Bison Ave.	9,353,810	5,747,702	12,573,428	1,308,871
OC Irvine Hospital Campus[6]	1	6640 Alton Pkwy.	21,161,476	4,531,535	1,292,848	201,490

Property Name	Number of Buildings	Address	Electricity (kWh)	Generation (kWh)	Natural Gas (Therms)	Energy Consumption (MMBtu)
Park Place Tower	8	3333-3355 Michelson Drive	16,043,950		38,792	58,623
Centerpointe Apartments	4	7725 Gateway	3,775,090		420,275	54,908
36311 - Irvine Distribution Center	2	9300 Toledo Way	12,426,571		3,294	42,730
Hotel Irvine	1	17900 Jamboree Rd.	5,857,516		197,962	39,782
Park Place Apartments	6	3395 Michelson Drive	3,369,560		237,270	35,224
1 & 3 Glen Bell Way	2	1-3 Glen Bell Way	6,034,963		79,211	28,513
The Royce Apartments	3	3301 Michelson Drive	2,509,176		179,881	26,549
Irvine Marriott	1	18000 Van Karman	3,896,300		122,334	25,528

Note that UC Irvine has a goal of carbon neutrality by 2025, and this includes a goal to provide 100% clean electricity for all facilities. UCI is already planning a second phase of carport solar. Appendix C contains a detailed DER analysis for each facility.

Table 36. DER Recommendations at the Top 10 Energy Consuming Facilities in Irvine

Property Name	Address	Solar (kW-DC)	Battery Energy Storage
UC Irvine	66 Bison Ave.	3,743	309kW/780kWh
OC Irvine Hospital Campus	6640 Alton Pkwy.	2,111	175kW/681kWh
Park Place Tower	3333-3355 Michelson Drive	4,879	384kW/669kWh
Centerpointe Apartments	7725 Gateway	761	68kW/194kWh
36311 - Irvine Distribution Center	9300 Toledo Way	8,531	707kW/1,692kWh
Hotel Irvine	17900 Jamboree Rd.	1,016	100kW/204kWh
Park Place Apartments	3395 Michelson Drive	1,947	81kW/226kWh
1 & 3 Glen Bell Way	1-3 Glen Bell Way	1,640	247kW/511kWh
The Royce Apartments	3301 Michelson Drive	1140	54kW/169kWh
Irvine Marriott	18000 Van Karman	1,134	69kW/147kWh

VI. Conclusions and Next Steps

Based on the City's Strategic Energy Plan, there are two recommendations that align with the DER analysis CSE conducted:

- ES2 – "Portfolio-Wide Procurement for Facilities"
- B3 – "Decarbonize City Facilities"

Based on the findings of the DER analyses discussed throughout this report, CSE recommends the City consider the following actions for next steps to satisfy the goals of the Strategic Energy Plan. The City may need to recalibrate these actions based on the final CAAP.

ES2 - Energy Efficiency and Investment in Solar and Storage

The following facilities have existing historical energy audits:

- Animal Care Center
- Civic Center
- Deerfield Community Center
- Harvard Community Center
- Heritage Park Community Center
- Lakeview Senior Center
- Las Lomas Community Center
- Northwood Community Center
- Operation Support Facilities
- Woodbury Community Center
- Great Park

The historical energy audits provide a backlog of actionable items the City can address to reduce energy consumption. CSE recommends that all remaining facilities undergo on-site energy efficiency audits and that audits be repeated every 5 years. Future in-person audits should be prioritized based on facilities with the highest energy consumption. Additionally, the City should further explorer the potential for CHP at the William Woollett Aquatics Center.

There are currently seven existing solar PV systems (244.39kW-DC) installed on City-owned buildings which collectively generate 224,000kWh of electricity annually, offsetting 2% of municipal electricity consumption. Each City-owned facility was screened for DERs both for financial payback as well as offsetting 100% of electricity with solar PV. The following facilities showed the most positive payback period for offsetting 100% of electricity use with a combination of solar and battery storage:

- Deerfield Community Center
- Great Park Tennis Support Facility H
- Heritage Park Community Center

- Irvine Child Resource Center

The following sites feature a cluster of city buildings in close proximity to one another, CSE recommends treating these sites as units and pursue DERs as an NEM aggregate or microgrid model:

- Great Park
- Heritage Park
- Civic Center/Irvine Child Development Center
- OSF and Animal Care

B3 - Decarbonize City Facilities

Throughout this document are recommendations to decarbonize City facilities. These recommendations include:

- Review and follow up on action items from the historical energy audits
- Repeat energy audits for all facilities every five years
- Pursue CHP at William Woollett
- Install solar and energy storage at City facilities (See Appendix A)
- "Electrify" buildings to shift away from natural gas usage

The Strategic Energy Plan makes a recommendation to pilot an all-electric retrofit at one of the smaller community centers. This would entail replacing the natural gas appliances such as space heating, cooking equipment and domestic water heaters with electric alternatives. The following Community Centers use natural gas and are under 10,000 square feet:

- Cypress
- Deerfield
- Las Lomas
- Los Olivos
- **University**
- Woodbury

University Community Center uses a comparatively large amount of gas for its size; it may be the most impactful option for an electrification pilot.

In addition to decarbonizing City-owned facilities, Irvine can encourage decarbonizing facilities on the community level through:

- Outreach to the City's largest energy consumers to assist in DER development
- Encouraging the community to opt-in to an OCPA power plan

Additional Recommendations

In addition to screening for DERs, energy efficiency and CHP, CSE makes the following recommendations:

- Based on generation data, the Solar PV at Northwood Community Center appears to be underperforming, CSE recommends inspecting it for proper operation.
- Interval data at William Woollett, Great Park Admin, and Harvard Community Center suggests much lower electricity use than what is shown on billing data. CSE recommends checking with SCE that metering is properly set up at these facilities.
- Set up a platform to monitor Solar PV generation interval data. More granular data will make for more accurate DER sizing and more detailed tracking for GHG reduction goals.
- Net metering data was unavailable at Cypress Community Center. For more accurate DER sizing, CSE recommends refreshing this analysis with more recent data before pursuing DERs.
- Data at Los Olivos was incomplete due to being new construction and the impacts of COVID-19. Before pursing DERs CSE recommends refreshing the analysis with more recent data for more accurate DER sizing.
- On a community level, the City will need to encourage the highest energy consuming buildings to consider investments in energy efficiency upgrades and solar and storage technologies.
- Due to the electrification of the City fleet, the City also needs to factor in the added load at Civic Center, OSF and various community park locations to make ensure DER investments at these locations factor in the impact of EVs and EVI.

Appendix A – City-Owned Building DER Analysis

How to Interpret the DER Analysis:

The summary of existing conditions includes:

- Site address
- Existing DERS, such as solar, battery energy storage, or gas generator
- The SCE rate tariff - this is the pricing plan that determines the sites electric bill
- Building square footage
- Amount of electricity consumed per year
- Annual electricity cost, based on 2019 billing data
- Annual natural gas consumption, based on 2019 billing data
- Annual natural gas cost, based on 2019 billing data

Energy Usage Intensity is a measure of energy use per square foot. For each facility CSE provided the following information:

- Energy Usage Intensity (EUI)
- EUI Building type, the closest building type available for EUI data from Energy Star
- National Average EUI, the average EUI for that Building Type
- Comparison to National Average compares the facility's EUI to the national average from Energy Star. A positive number means higher than average energy consumption and a negative number means below average energy consumption

The DER analysis provides:

- Solar PV Installation - the optimal amount of solar PV for optimal financial payback based on ReOpt analysis
- Battery Energy Storage System - BESS recommended by ReOpt for optimal financial payback
- Net Present Value provides an estimate of the total financial payback of the project after 25 years, in today's dollars
- Annual Power Bill Savings - An estimate of Year 1 reduction in electricity costs achieved by the system sized for optimal financial payback
- Simple Payback period - The amount of time elapsed until the reductions in power bill amount to the upfront costs of the solar and storage
- Solar needed to offset 100% of electricity usage is the required system size to generate an equal amount of electricity annually to the annual consumption of the site.
- Each analysis comes with siting map showing possible solar PV siting locations, as well as the installation type. The amount of solar is tied to the solar needed to offset 100% metric, unless there is a limit due to available space then it is tied to the result of the optimal financial analysis results.

City Community Centers

Cypress Community Center

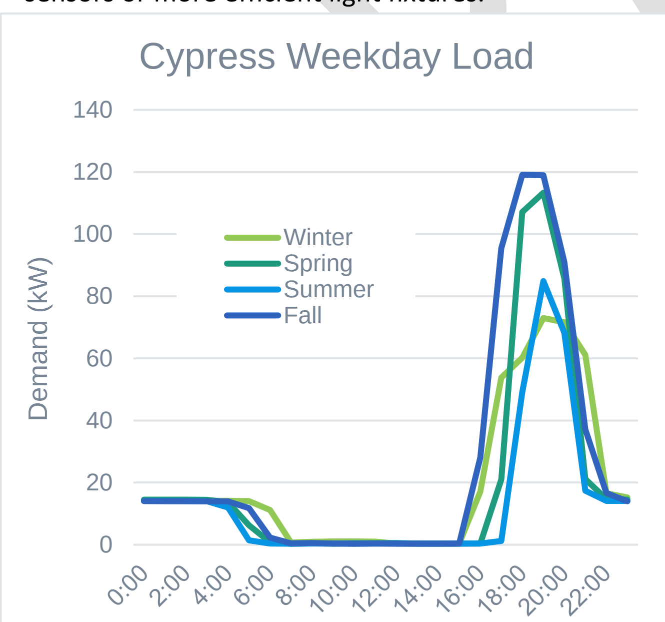
Cypress Community Center is a multi-use facility that offers a variety of classes for the community. It includes a multipurpose room, an exercise room, patio space, and outdoor and playground amenities. Cypress has an existing 19kW-DC existing solar PV installation.

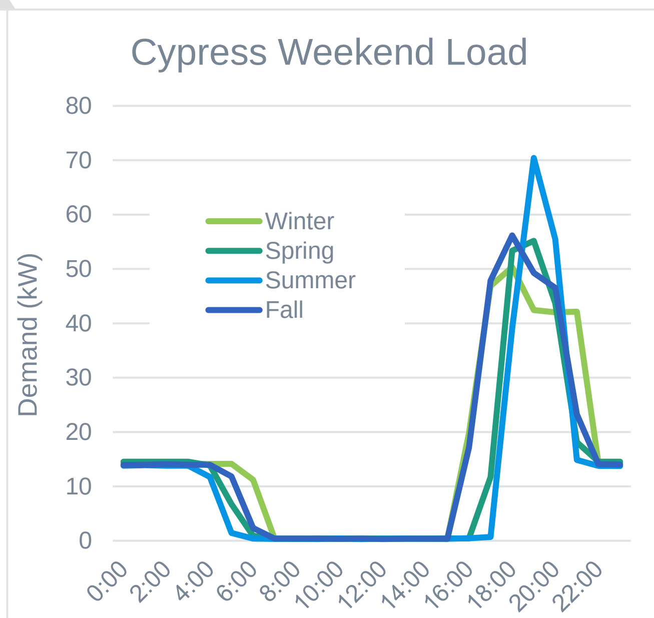
Table A-1. DER Analysis at Cypress Community Center

Existing Facility Information			
Address	255 Visions		
Rate Tariff	TOU-GS-2-E		
Square Footage	4,520		
Annual Electricity Consumption (kWh)	209,566		
Average Annual Electricity Bill	$62,141		
Annual Gas Consumption (Therms)	6		
Annual Gas Bill	$183		
Energy Usage Intensity	154.13		
EUI Building Type	Public Social / Meeting Hall		
National Average EUI (kBtu/ft²)	109.6		
Comparison to National Average	**+41%**		
Recommended Solar and Storage System			
Existing Solar PV	19.8kW-DC		
Additional Solar PV	19.2kW-DC		
Battery Energy Storage System	53kW, 172kWh		
Net Present Value (25-year estimate)	$32,011		
Annual Power Bill savings	$15,360		
Simple Payback	8.2 years		
Solar needed to offset 100% electricity usage	132kW-DC		
Site #	**PV Installation Type**	**Area (Sq. ft.)**	**Estimated System Size (kW-DC)**
1	Carport	2,474	34.5
2	Carport	2,496	34.8
3	Carport	2,410	33.6
4	Carport	2,410	33.6

Figure A-1. Solar PV Siting at Cypress Community Center

Cypress Community Center is open from 9am-9pm on weekdays, 9am-10pm on Saturdays, and noon-6pm on Sundays. The meter data provided does not show net metering, so the existing 19.8kW-DC Solar PV drives the load to zero during sun hours. Generation metering for the existing solar shows that the Solar PV generates 30,000kWh per year, but the facility still consumes over 200,000kWh per year - there is still room for more solar. Note that even with electric load reduction from the existing solar, Cypress has a high EUI compared to average. If solar PV production were factored back in, the EUI would be even higher. The facility maintains an overnight load year-round of 13kW from 10pm-6am - presumably parking lot and path lighting. This represents 25% of the facility's total consumption ($5,920 at off-peak rates). CSE recommends the City investigate if the overnight load could be reduced by adding proximity sensors or more efficient light fixtures.





Deerfield Community Center

Deerfield Community Center is a multi-use facility that offers a variety of classes for the community. It includes a multipurpose room, a craft room, patio space, and outdoor and playground amenities.

Table A-2. DER Analysis at Deerfield Community Center

Existing Facility Information			
Address	55 Deerfield West		
Rate Tariff	TOU-GS-2-D		
Square Footage	3,543		
Annual Electricity Consumption (kWh)	68,006		
Average Annual Electricity Bill	$13,337		
Annual Gas Consumption (Therms)	251		
Annual Gas Bill	$451		
Energy Usage Intensity	79.22		
EUI Building Type	Public Social / Meeting Hall		
National Average EUI (kBtu/ft²)	109.6		
Comparison to National Average	**-28%**		
Recommended Solar and Storage System			
Solar PV	43kW-DC		
Battery Energy Storage System	7kW, 25kWh		
Net Present Value (25-year estimate)	$8,753		
Annual Power Bill savings	$9,522		
Simple Payback	9.9 years		
Solar needed to offset 100% electricity usage	48kW-DC		
Site #	**PV Installation Type**	**Area (Sq. ft.)**	**Estimated System Size (kW-DC)**
1	Roof	2160	30.16
2	Roof	1129	15.7

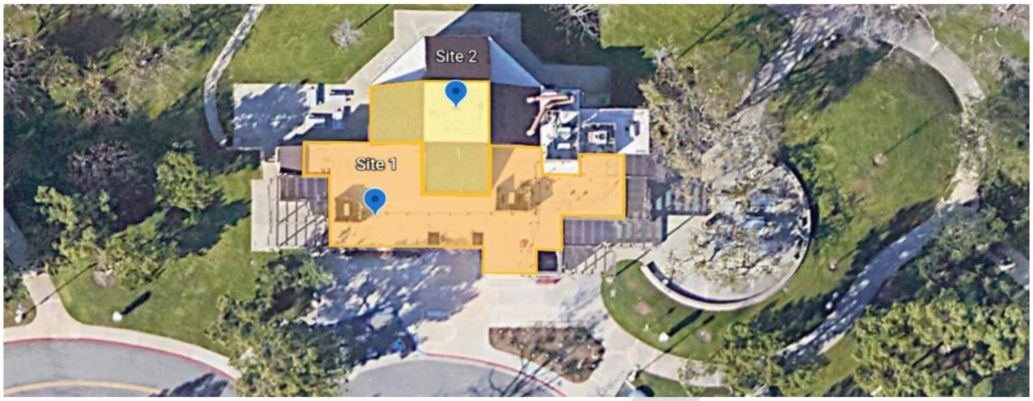


Figure A-3. Solar PV Siting at Deerfield Community Center

Deerfield Community Center is open from 9am-9pm on weekdays, 9am-10pm on Saturdays, and noon-6pm on Sundays. Deerfield's load profile follows a consistent pattern with its operating hours. The use of air conditioning in the summer increases the average daily peak from 9kW in the winter to 16kW in the summer and increases average daily energy consumption by 67%. The overnight load (10pm-6am) accounts for 25% of total energy consumption and is presumably parking and path lighting ($1,976 at off-peak rates). CSE recommends the City investigate if the overnight load could be reduced by adding proximity sensors or more efficient light fixtures.

CSE recommends following up with the results of the historical energy audit to see if improvements can be made to the HVAC and lighting load. Since most of the demand occurs in the daytime, installing solar PV could also be an effective way to offset daytime load.

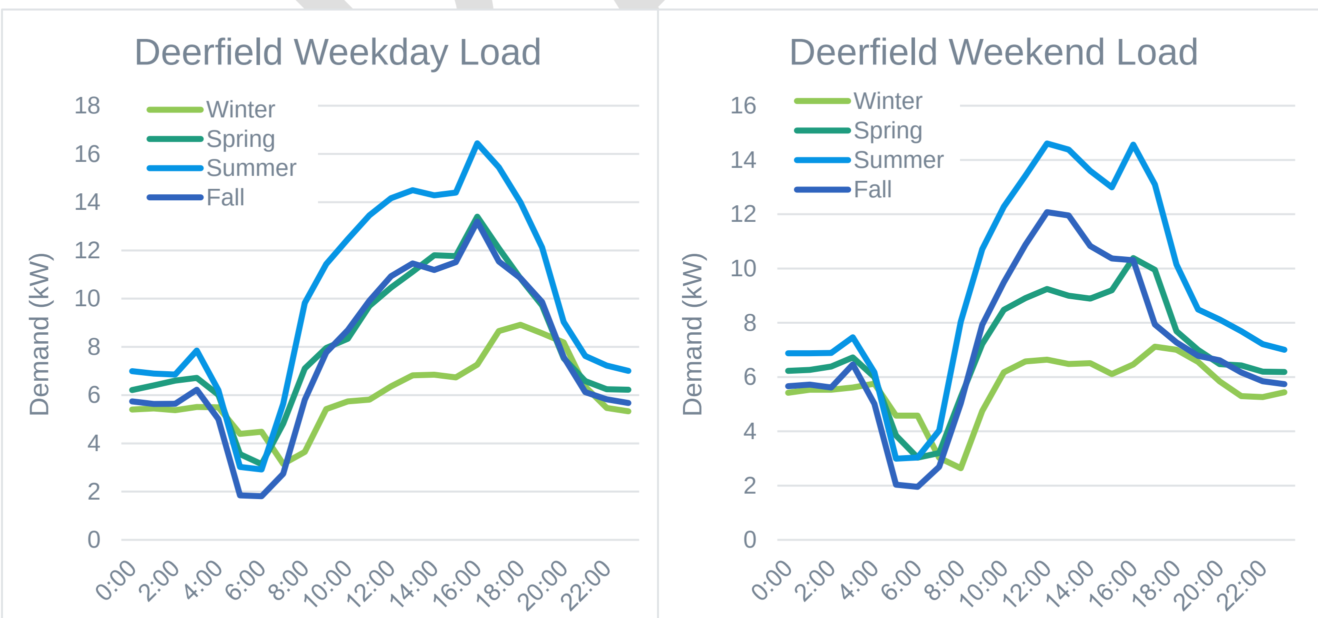


Figure A-4. Load Profiles at Deerfield Community Center

Table A-3. Deerfield Existing Energy Audit Results by AESC (2013)

	Recommendations
1.	Upgrade all existing light fixtures in the community center to reduced wattage and remove (2) lamps from the (4) lamp fixtures.
2.	Replace track lighting in the multipurpose rooms with dimmable fixtures
3.	Install interior occupancy sensors throughout the community center
4.	Install day lighting controls in the multipurpose room and office. These rooms have sufficient lighting from windows and skylights
5.	Install occupancy sensors on the Tennis, Volleyball, and Squash courts
6.	Replace exterior High-Pressure Sodium (HPS) Path lighting with LED
7.	Install thermostat controls in both multipurpose rooms to adjust HVAC based on occupancy
8.	Replace existing end-of-life HVAC equipment with high efficiency rooftop units with gas heating and economizer unit
9.	Install vending machine controls to turn off lighting and compressors based on demand

Harvard Community Center

Harvard Community Center is a multi-use facility located within Harvard Community Park that offers a variety of classes and activities to the community.

Table A-4. DER Analysis at Harvard Community Center

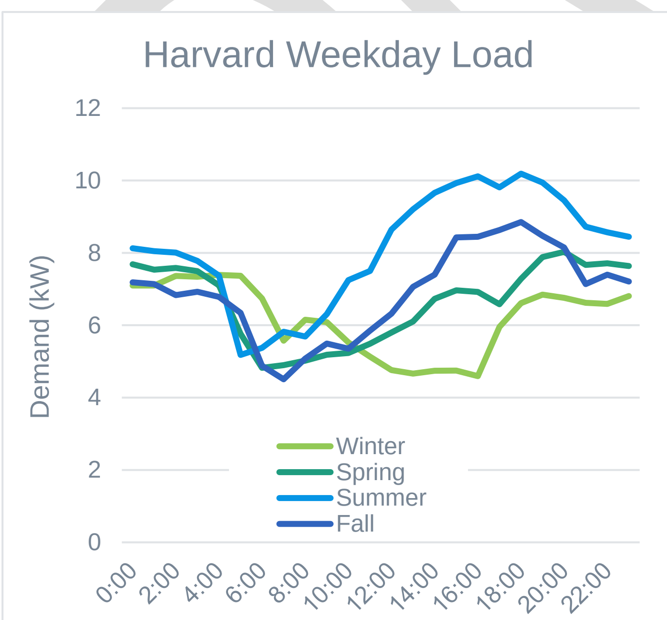
Existing Facility Information	
Address	14701 Harvard Ave
Rate Tariff	TOU-GS-2-E
Square Footage	3,511
Annual Electricity Consumption (kWh)	110,878
Average Annual Electricity Bill	$20,547
Annual Gas Consumption (Therms)	-
Annual Gas Bill	-
Energy Usage Intensity	112.15
EUI Building Type	Public Social / Meeting Hall
National Average EUI (kBtu/ft²)	109.6
Comparison to National Average	+2%
Recommended Solar and Storage System	
Solar PV	5kW-DC
Battery Energy Storage System	4kW, 26kWh
Net Present Value (25-year estimate)	$1,510
Annual Power Bill savings	$2,080
Simple Payback	10.92 years
Solar needed to offset 100% electricity usage	75kW-DC

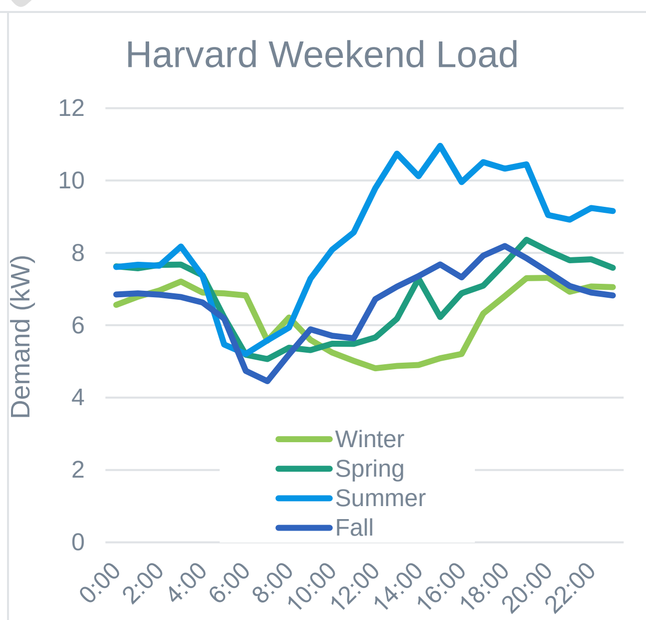
Site #	PV Installation Type	Area (Sq. ft.)	Estimated System Size (kW-DC)
1	Carport	2883	40.2
2	Roof	1807	25
3	Carport	1183	16.5

Figure A-5. Solar PV Siting at Harvard Community Center

Harvard Community Center operates from 4-9pm on weekdays, 9am-10pm Saturdays, and noon-6pm on Sunday. Despite having short operating hours on weekdays, the additional load from air conditioning can be seen running from 6am-9pm in the summer and fall. CSE recommends examining the HVAC schedule at Harvard to make sure it is consistent with occupied hours.

Overnight (10-6am), the facility maintains an average of 8kW year-round. This overnight load can exceed the daytime load during the winter and spring when air conditioning use is low and accounts for 35% of total energy consumption ($3,195 at off-peak rates). This load is likely parking lot and path lighting. CSE recommends the City investigate if the overnight load could be reduced by adding proximity sensors or





more efficient light fixtures. Curiously, when compared to utility bill consumption, interval data suggests that Harvard consumed much less electricity than what was shown on the utility bill for the same meter. CSE suggests working with SCE to determine if metering is being performed correctly.

Table A-5. Harvard Energy Audit Results by AESC (2012)

	Recommendations
1.	Replace interior light fixtures with lower wattage units
2.	Install occupancy sensors in rooms where occupancy is not continuous such as restrooms and offices
3.	Install vending machine controls to turn off lighting and compressors based on demand
4.	Replace High-Pressure Sodium (HPS) exterior path lighting with lower wattage fixtures

Lakeview Senior Center

Lakeview Senior Center is a multi-use facility that offers classes and activities catered to people ages 50 and older. This facility includes a game room, meeting room, two multipurpose rooms, a craft room, an auditorium, a studio, a café, a kitchen, a patio, and a rose garden.

Table A-6. DER Analysis at Lakeview Senior Center

Existing Facility Information	
Address	20 Lake Road
Rate Tariff	TOU-GS-2-D
Square Footage	26,500
Annual Electricity Consumption (kWh)	679,667
Average Annual Electricity Bill	$101,490
Annual Gas Consumption (Therms)	11,848
Annual Gas Bill	$10,518
Energy Usage Intensity	129.64
EUI Building Type	Public Social / Meeting Hall
National Average EUI (kBtu/ft^2)	109.6
Comparison to National Average	**+18%**
Recommended Solar and Storage System	
Solar PV	260kW-DC
Battery Energy Storage System	43kW, 131kWh
Net Present Value (25-year estimate)	$40,543
Annual Power Bill savings	$55,744
Simple Payback	10.16 years
Solar needed to offset 100% electricity usage	428kW-DC

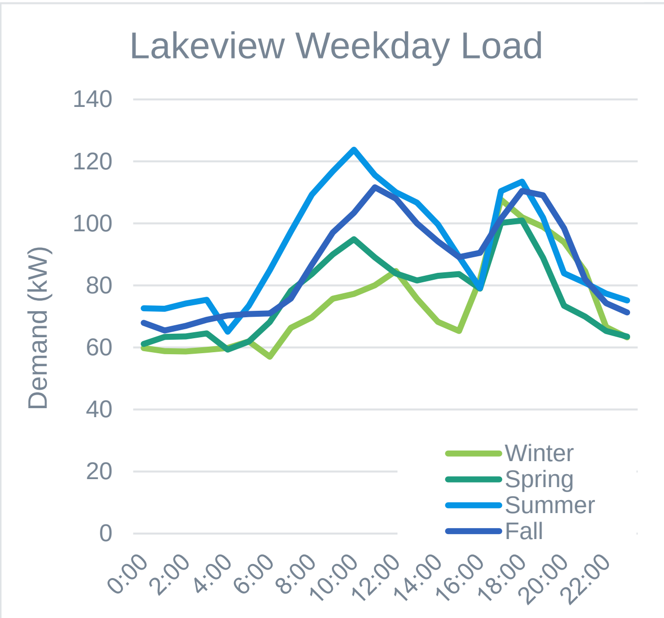
Recommended System for Resilience	
Solar PV	126kW-DC
Battery Energy Storage System	27kW, 53kWh
Diesel Generator	44kW
Net Present Value (25-year estimate)	-$20,834
Annual Power Bill savings	$20,711
Simple Payback	11.80 years
Diesel Fuel consumed in 7-day outage	328 Gallons

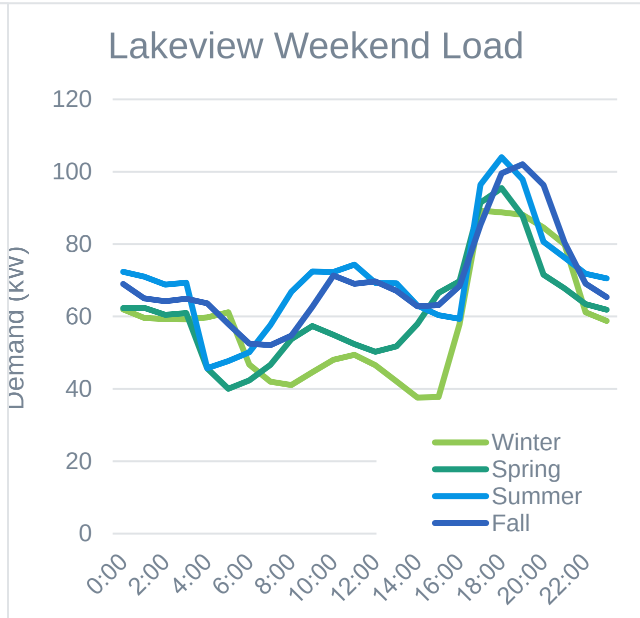
Site #	PV Installation Type	Area (Sq. ft.)	Estimated System Size (kW-DC)
1	Carport	6,789	94.6
2	Carport	3,109	43.3
3	Carport	2,808	39
4	Carport	3,486	48.6
5	Carport	3,195	44.5
6	Carport	7,833	109
7	Carport	7,831	102

Figure A-7. Solar PV Siting at Lakeview Senior Center

Lakeview Senior Center operates from 8am-6pm on weekdays and is closed on weekends. Additionally, it is reservable at other times throughout the week. Lakeview experiences a spike in demand from 4pm-10pm daily when the center is reservable for classes and activities.

Lakeview maintains an exceptionally large overnight load, 65kW on average. This is larger than the peak demand of many other City facilities. At 27% of total building consumption ($22,019 at off-peak rates). CSE recommends the City investigate if the overnight load could be reduced by adding proximity sensors or more efficient light fixtures.





Lakeview also acts as an emergency shelter for the City, and it contains a commercial kitchen that cooks meals for vulnerable senior citizens. CSE performed a resiliency analysis to determine the minimum combination of solar, BESS, and traditional diesel generator required to last a 7-day outage.

This analysis assumes that 50% of the site load will receive backup power in an outage, and that the outage occurs on the day with the highest peak demand of the year (August 26th). The same financial assumptions were made about solar and storage ($2700/kW-DC for solar, and $1000/kWh for BESS). $500/kW-AC was assumed for the diesel generator. Unlike the financial analyses, a resiliency analysis targets the smallest system required to last for a specified outage. Note that this is the minimum required, and any additional equipment will increase Lakeview's ability to provide power in an outage.

Analysis returned 126kW-DC Solar, 27kW/53kWh BESS, and 44kW Diesel generator. This configuration would last the outage in the given year (2019), and based on historical data, this configuration has a 69% chance of lasting the full 168 hours in a typical year without a break in power.

Table A-7. Lakeview Energy Audit Results by Southern California Edison (SCE) (2009)

	Recommendations
1.	Replace the Mercury Vapor lamps in the Senior Center Dining Room with more efficient lamps
2.	Replace the incandescent lamps in the Senior Center Dining Room with more efficient lamps

3. Replace the existing metal halide lamps in the Auditorium with more efficient lamps
4. Replace the existing incandescent spotlights in the Auditorium with more efficient lamps
5. Replace the incandescent Exit signs with LED Exit signs
6. Install occupancy sensors to turn off lights in areas such as offices, conference rooms and restrooms
7. Install IT software to automatically control the power settings of networked personal computers
8. Install vending machine controls to turn off lighting and compressors based on demand

Las Lomas Community Center

Las Lomas Community Center is a multi-use facility that offers a variety of classes for the community. It includes a multipurpose room, a small patio space, a warming kitchen, a craft room, two picnic shelters, and outdoor playground amenities.

Table A-8. DER Analysis at Las Lomas Community Center

Existing Facility Information			
Address	10 Federation Way		
Rate Tariff	AL-2 Flat Rate (Metered, Non-TOU)		
Square Footage	5,093		
Annual Electricity Consumption (kWh)	224,853		
Average Annual Electricity Bill	$58,358		
Annual Gas Consumption (Therms)	972		
Annual Gas Bill	$1,307		
Energy Usage Intensity	168.88		
EUI Building Type	Public Social / Meeting Hall		
National Average EUI (kBtu/ft²)	109.6		
Comparison to National Average	**+54%**		
Recommended Solar and Storage System			
Solar PV	98kW-DC		
Additional Battery Energy Storage System	111kW, 386kWh		
Net Present Value (25-year estimate)	$61,102		
Annual Power Bill savings	$42,264		
Simple Payback	10.3 years		
Solar needed to offset 100% electricity usage	145kW-DC		
Site #	**PV Installation Type**	**Area (Sq. ft.)**	**Estimated System Size (kW-DC)**
1	Carport	9,070	126
2	Carport	9,070	126

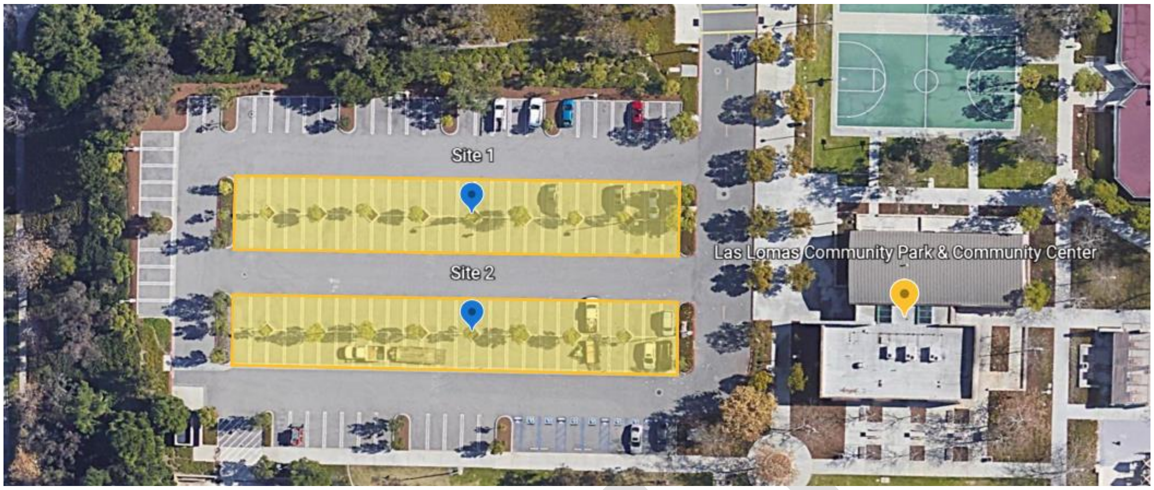
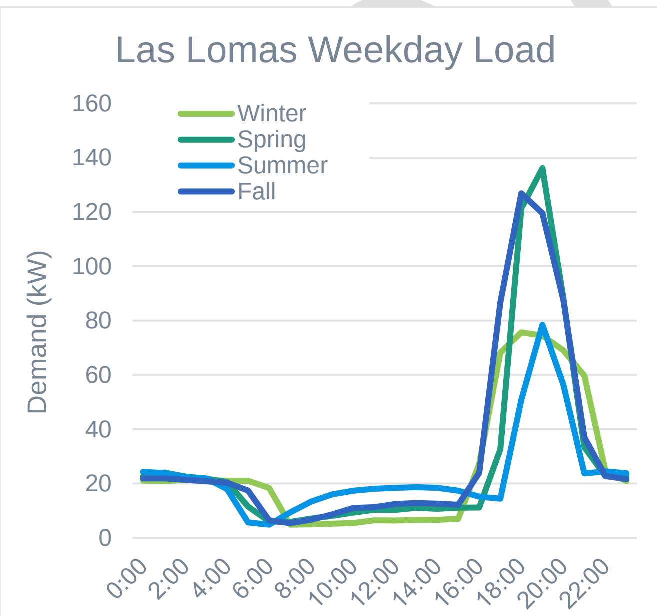


Figure A-9. Solar PV Siting at Las Lomas Community Center

Las Lomas operates from 9am-9pm weekdays, 9am-10pm Saturdays, and noon-6pm on Sunday. Las Lomas maintains a very low daytime load year-round, with a large spike in the evenings from 4-10pm. The nighttime load, though it looks small compared to the evening spike, is actually quite large at 21kW average and accounts for 27% of the total site load ($6,516). This load is likely parking lot and path lighting. The historical energy audit made several suggestions to address the exterior lighting loads.



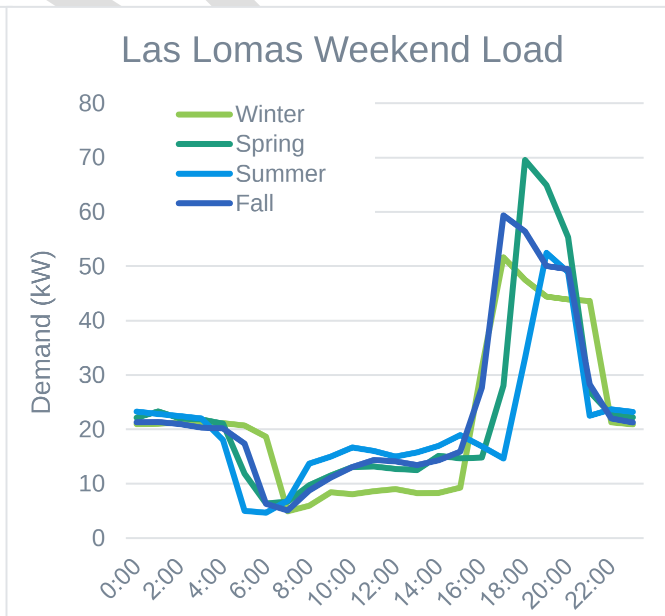


Table A-9. Las Lomas Existing Energy Audit Results by AESC

Recommendations
1. Install occupancy sensors throughout the community center to control interior lighting
2. Install daylight controls on the multipurpose room and offices to reduce lighting usage when daylight provides sufficient lighting
3. Install occupancy sensors to control the Basketball and Tennis Court lighting
4. Replace Exterior High-Pressure Sodium (HPS) Path and Parking Lot lighting with LED
5. Repair the Economizer functionality to each of the three Carrier units
6. Install controls to adjust heating and cooling in the Multipurpose Rooms based on occupancy
7. Install vending machine controls to turn off lighting and compressors based on demand

Northwoods Community Center

Northwood Community Center is a multi-use facility that offers a variety of classes for the community. It includes a multipurpose room, exercise room, meeting room, classroom, kitchen, and picnic area.

Table A-10. DER Analysis at Northwoods Community Center

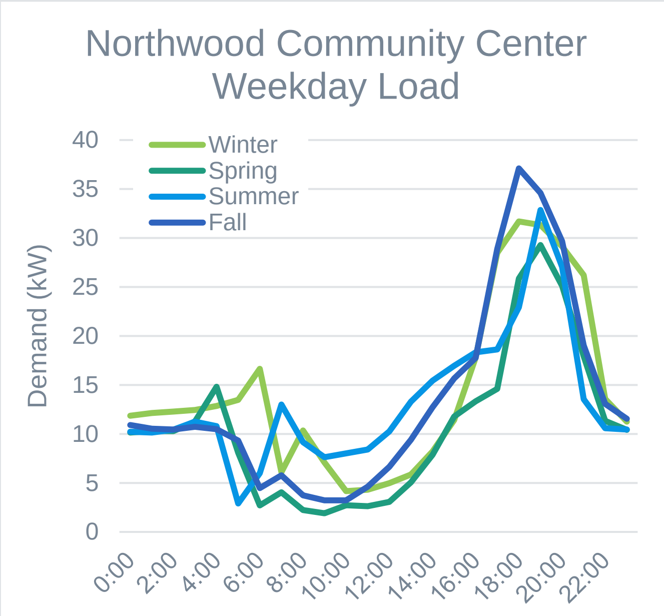
Existing Facility Information	
Address	4531 Bryan Ave
Existing Distributed Energy Resources	22.89kW-DC Solar PV
Rate Tariff	TOU-GS-2-E
Square Footage	7,560
Annual Electricity Consumption (kWh)	107,234
Average Annual Electricity Bill	$22,748
Annual Gas Consumption (Therms)	-
Annual Gas Bill	-
Energy Usage Intensity	50.32
EUI Building Type	Public Social / Meeting Hall
National Average EUI (kBtu/ft^2)	109.6
Comparison to National Average	**-51%**
Recommended Solar and Storage System	
Existing Solar PV	22.89kW-DC
Additional Solar PV	0kW-DC
Battery Energy Storage System	21kW, 112kWh
Net Present Value (25-year estimate)	$21,070
Annual Power Bill savings	$6,955
Simple Payback	2.34 years

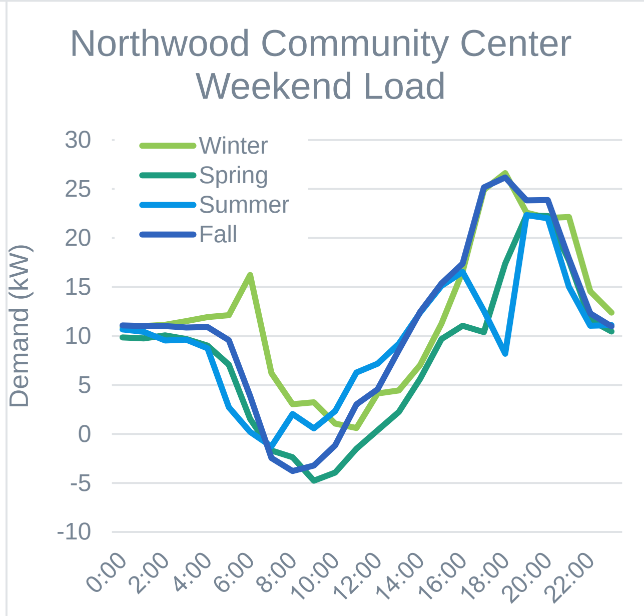
Solar needed to offset 100% electricity usage		68kW-DC	
Site #	**PV Installation Type**	**Area (Sq. ft.)**	**Estimated System Size (kW-DC)**
1	Carport	6,305	87
2	Carport	1,902	31

Figure A-11. Solar PV Siting at Northwoods Community Center

Northwood Community Center is open from 9am-9pm on weekdays, 9am-10pm Saturdays, and noon-6pm on Sunday. The effects of the existing solar can be seen by the dip in the middle of the day, with the system exporting some power on the weekends. The nighttime load is fairly large at 11kW and accounts for 30% of net load at the site ($4,717 at off-peak rates). This load is likely parking lot and path lighting. CSE recommends the City investigate if the overnight load could be reduced by adding proximity sensors or more efficient light fixtures.

Solar generation data only recorded 5,690kWh (5% of site load) of solar generation in 2019; analysis shows that it could have produced as much as 37,000kWh (33% of site load). CSE recommends inspecting the solar installation at Northwoods to ensure it is operating properly.





Turtle Rock Community Center

Turtle Rock Community Center is a multi-use facility that offers a variety of classes for the community. It includes a multipurpose room, a small patio space, a warming kitchen, a meeting room, a craft room, a picnic area, and outdoor playground amenities.

Table A-11. DER Analysis at Turtle Rock Community Center

Existing Facility Information	
Address	1 Sunnyhill Drive
Rate Tariff	TOU-GS-2-D
Square Footage	12,574
Annual Electricity Consumption (kWh)	232,496
Average Annual Electricity Bill	$46,542
Annual Gas Consumption (Therms)	1,949
Annual Gas Bill	$2,210
Energy Usage Intensity	80.4
EUI Building Type	Public Social / Meeting Hall
National Average EUI (kBtu/ft²)	109.6
Comparison to National Average	-27%
Recommended Solar and Storage System	

Solar PV	90kW-DC
Battery Energy Storage System	38kW, 128kWh
Net Present Value (25-year estimate)	$20,401
Annual Power Bill savings	$24,013
Simple Payback	10.47 years
Solar needed to offset 100% electricity usage	155kW-DC

Site #	PV Installation Type	Area (Sq. ft.)	Estimated System Size (kW-DC)
1	Carport	3,948	55
2	Carport	1,958	27
3	Carport	6,864	95

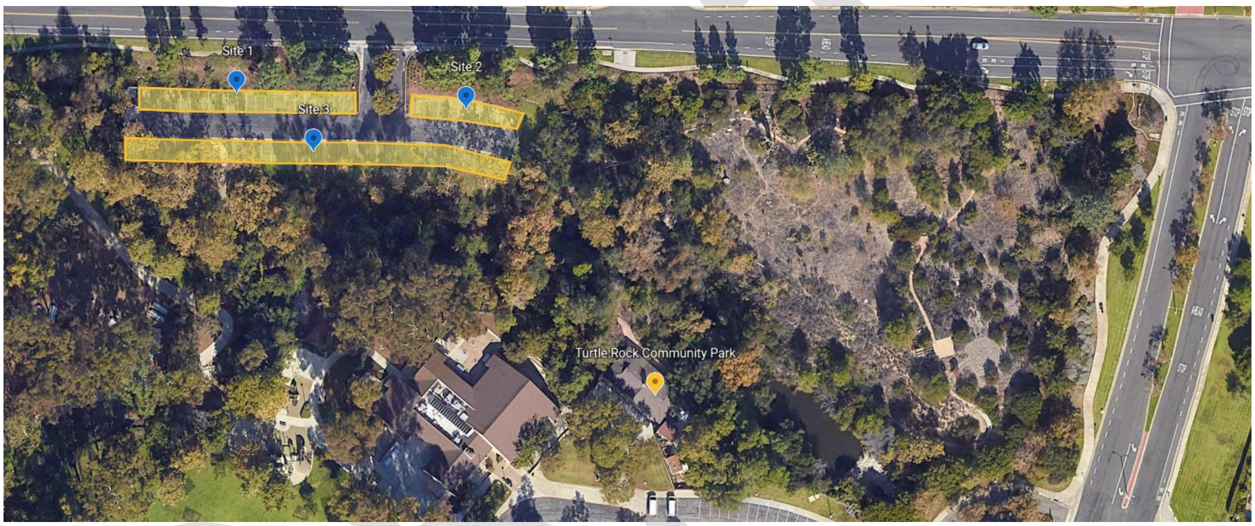
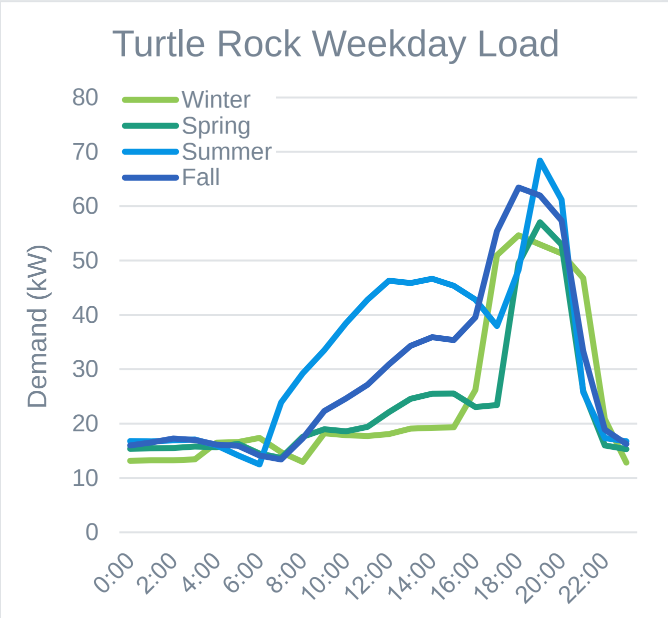
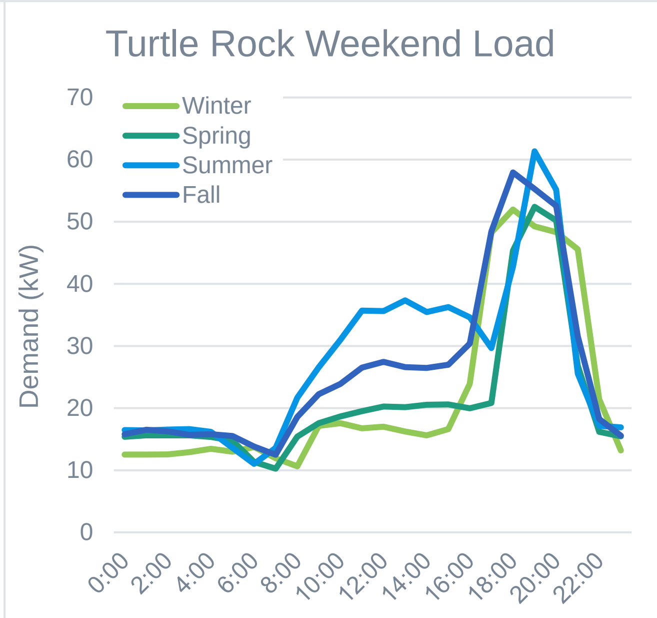


Figure A-13. Solar PV Siting at Turtle Rock Community Center

Turtle Rock operates from 9am-9pm on weekdays, 9am-10pm Saturdays, and noon-6pm on Sunday. Year round, the center experiences a large spike in demand in the evening, from 4-10pm. The addition of daytime air conditioning in the warmer months increases energy consumption by 30% from winter to summer.

Despite having shorter operating hours on weekends, the center maintains a very similar load profile as on weekdays. This suggests that the air conditioning schedule could be adjusted to follow operating hours more closely, particularly on Sundays.





University Community Center

University Community Center is a multi-use facility with two buildings that offer a variety of classes for the community. Building #1 includes a multipurpose room, craft room, and kitchen. Building #2 includes a multipurpose room and courtyard, a kitchen, and an exercise room. The center also features a variety of athletic fields and courts.

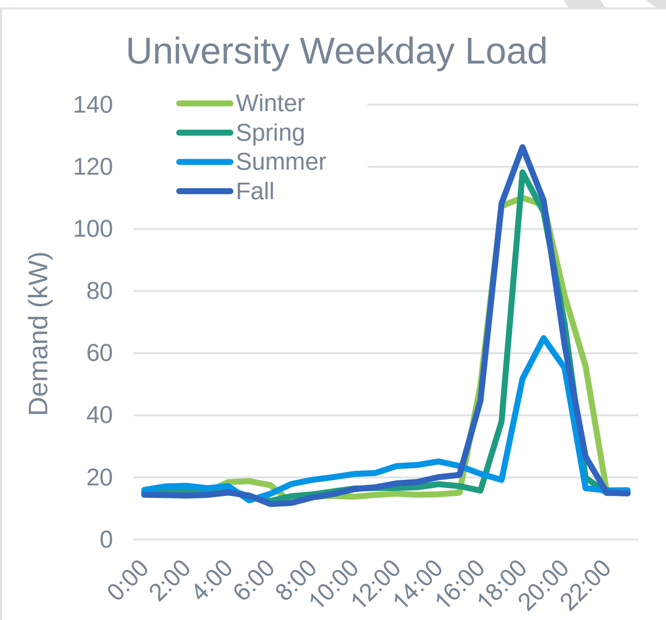
Table A-12. DER Analysis at University Community Center

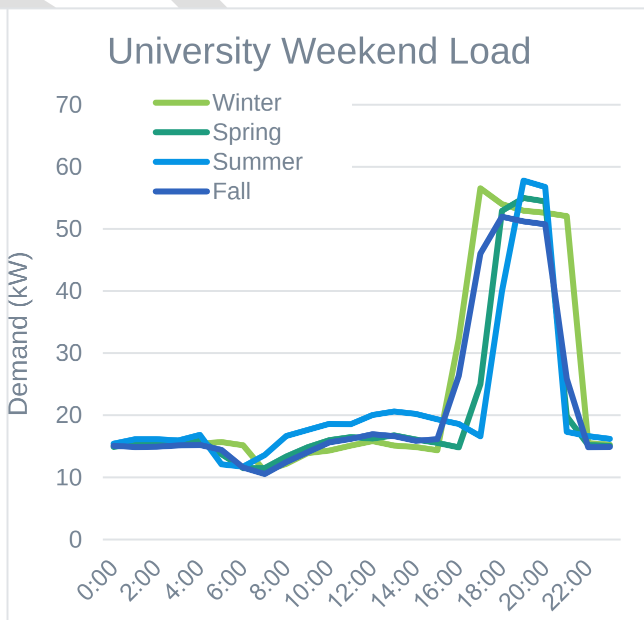
Existing Facility Information	
Address	1 Beech Tree Lane
Existing Distributed Energy Resources	3.7kW-DC Solar PV
Rate Tariff	AL-2 Outdoor Area Lighting (Metered, TOU)
Square Footage	9,131
Annual Electricity Consumption (kWh)	237,153
Average Annual Electricity Bill	$24,290
Annual Gas Consumption (Therms)	2,049
Annual Gas Bill	$2,275
Energy Usage Intensity	109.6
EUI Building Type	Public Social / Meeting Hall
National Average EUI (kBtu/ft²)	109.6
Comparison to National Average	**+2%**
Recommended Solar and Storage System	
Existing Solar PV	3.7kW-DC
Additional Solar PV	53kW-DC
Battery Energy Storage System	55kW, 242kWh
Net Present Value (25-year estimate)	$20,734
Annual Power Bill savings	$22,177
Simple Payback	10.49 years
Solar needed to offset 100% electricity usage	151kW-DC

Site #	PV Installation Type	Area (Sq. ft.)	Estimated System Size (kW-DC)
1	Carport	3770	65
2	Carport	7467	104
3	Roof	2356	32

Figure A-15. Solar PV Siting at University Community Center

University Community Center operates from 9am-9pm on weekdays, 9am-10pm Saturdays, and noon-6pm on Sunday. Despite having 3.7kW-DC of onsite solar, this system is so undersized as to not even register on its daily load profile. The center experiences a large spike in demand year-round from 4-10pm. These spikes only account for 41% of total load, with the 16kW baseload accounting for the rest. This baseload represents the largest opportunity for reducing electricity consumption.





Woodbury Community Center

Woodbury Community Center is a multi-use facility that offers a variety of classes for the community. It includes a multipurpose room, kitchen, courtyard, picnic shelters, and athletic fields and basketball courts.

Table A-13. DER Analysis at Woodbury Community Center

Existing Facility Information	
Address	130 Sanctuary
Rate Tariff	AL-2 Flat Rate (Metered, Non-TOU)
Square Footage	4,001
Annual Electricity Consumption (kWh)	100,254
Average Annual Electricity Bill	$18,493
Annual Gas Consumption (Therms)	400
Annual Gas Bill	$609
Energy Usage Intensity	91.23
EUI Building Type	Public Social / Meeting Hall
National Average EUI (kBtu/ft^2)	109.6
Comparison to National Average	-17%
Recommended Solar and Storage System	
Solar PV	11kW-DC
Battery Energy Storage System	9kW, 57kWh
Net Present Value (25-year estimate)	$4,323
Annual Power Bill savings	$4,655
Simple Payback	10.51 years
Solar needed to offset 100% electricity usage	61kW-DC

Site #	PV Installation Type	Area (Sq. ft.)	Estimated System Size (kW-DC)
1	Carport	6628	115
2	Roof	1248	21
3	Carport	1067	18

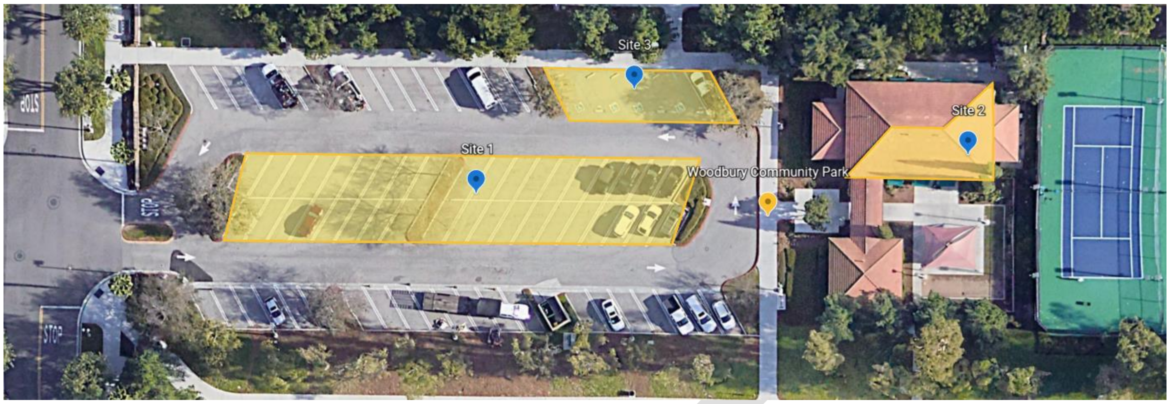
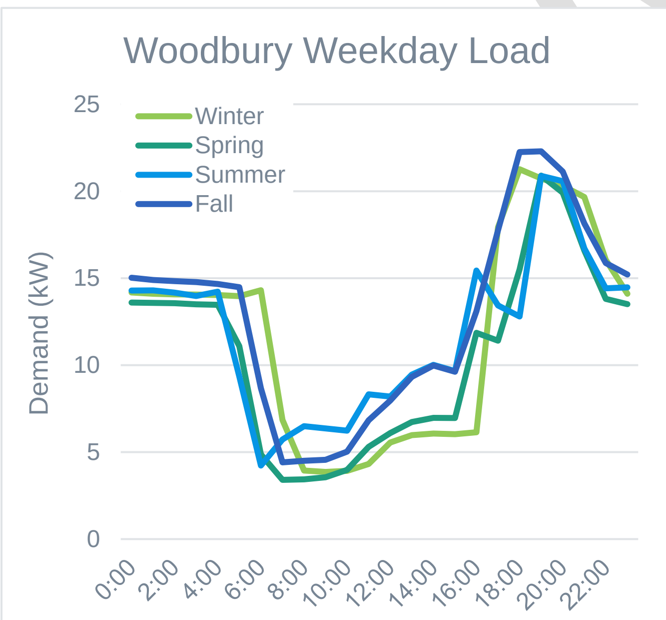


Figure A-17. Solar PV Siting at Woodbury Community Center

Woodbury Community Center operates from 9am-9pm on weekdays, 9am-10pm on Saturday, and noon-6pm on Sunday. Woodbury carries an excessively high nighttime load of 15kW year-round, much higher than the occupied daytime load for most of the day. This accounts for 41% of the Center's energy consumption ($4,400 annually). CSE suggests addressing the nighttime load to reduce overall energy consumption. This is likely due to exterior path and parking lot lighting, and the historical energy audit makes several suggestions to reduce the exterior lighting load.



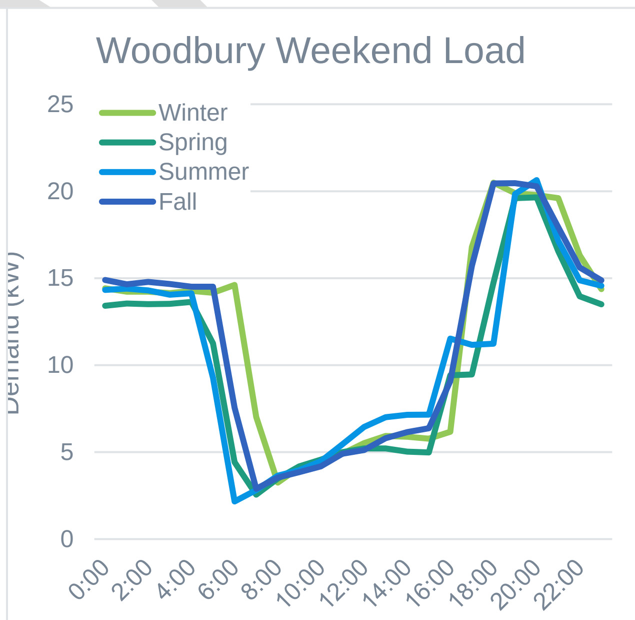


Table A-14. Woodbury Existing Energy Audit Results by AESC (2013)

Recommendations
1. Replace Metal Halide (MH) decorative lighting in the lobby with LED fixtures
2. Install daylight controls on the multipurpose room and offices to reduce lighting usage when daylight provides sufficient lighting
3. Install occupancy sensors in the restrooms
4. Install occupancy sensors on the exterior Basketball Court lighting
5. Replace exterior path and parking lot fixtures with LED
6. Install thermostat controls in the multipurpose room to adjust HVAC based on occupancy
7. Install vending machine controls to turn off lighting and compressors based on demand

Quail Hill Community Center

Quail Hill Community Center offers a variety of classes for the community. It includes one large classroom, a multipurpose room, an exercise room, a lobby, patio space, and outdoor and playground amenities.

Table A-15. DER Analysis at Quail Hill Community Center

Existing Facility Information	
Address	39 Shady Canyon
Existing Distributed Energy Resources	45.3kW-DC Solar PV
Rate Tariff	TOU-GS-2-E
Square Footage	15,277
Annual Electricity Consumption (kWh)	266,035
Average Annual Electricity Bill	$42,034
Annual Gas Consumption (Therms)	93
Annual Gas Bill	$294
Energy Usage Intensity	62.54
EUI Building Type	Public Social / Meeting Hall
National Average EUI (kBtu/ft²)	109.6
Comparison to National Average	**-43%**
Recommended Solar and Storage System	
Existing Solar PV	45.3kW-DC
Additional Solar PV	0kW-DC
Battery Energy Storage System	10kW, 63kWh
Net Present Value (25-year estimate)	$10,533
Annual Power Bill savings	$3,637
Simple Payback	5.86 years
Solar needed to offset 100% electricity usage	139kW-DC

Site #	PV Installation Type	Area (Sq. ft.)	Estimated System Size (kW-DC)
1	Roof	3348	58.4
2	Carport	4140	72.2
3	Carport	5207	90.8

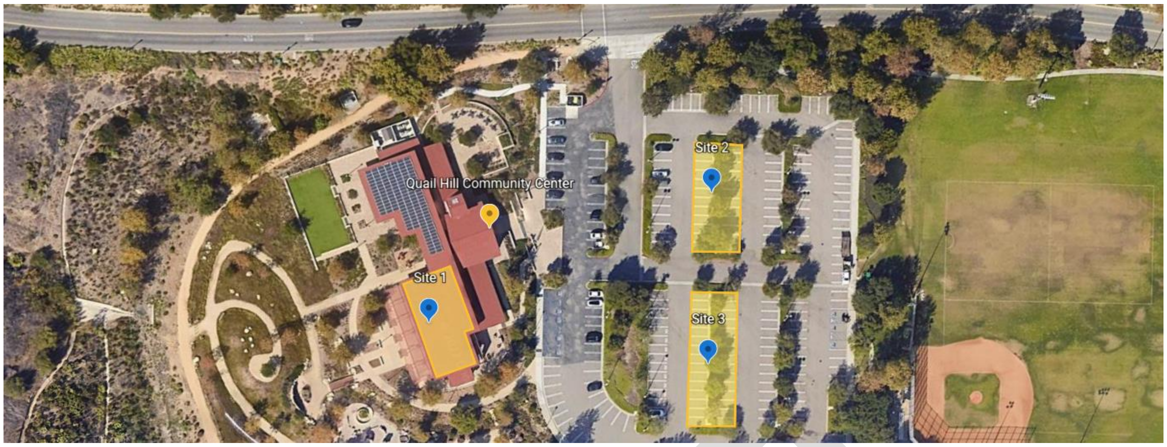
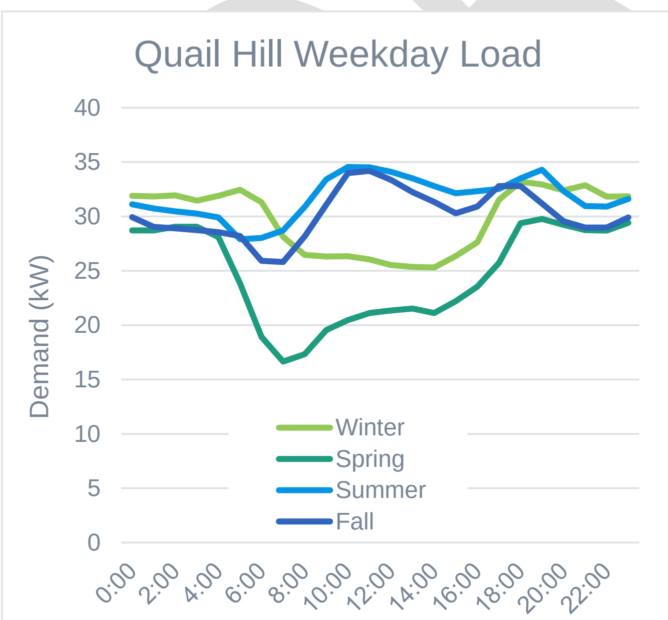
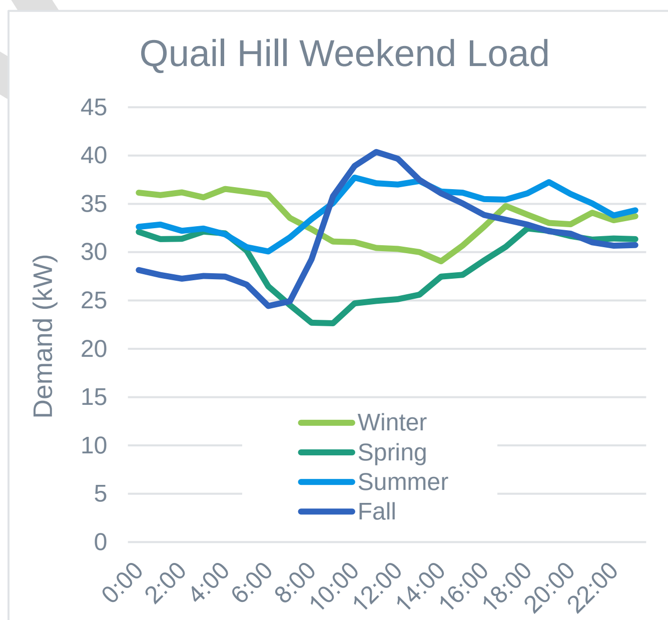


Figure A-19. Solar PV Siting at Quail Hill Community Center

Quail Hill Community Center operates from 9am-9pm on weekdays, 9am-10pm on Saturday, and noon-6pm on Sundays. The affect of the 45.3kW-DC solar system can be seen, reducing the daytime load to about the same level as the nighttime load. Despite having shorter operating hours on weekends, the center maintains a higher average load as on weekdays. This suggests that lighting and air conditioning schedules could be adjusted to follow operating hours more closely, particularly on Sundays.

Quail Hill maintains a large nighttime load of 31kW, accounting for 34% of the remaining load after solar ($13,619 annually at off-peak rates). This load is likely due to exterior parking lot and path lighting. CSE recommends the City investigate if the overnight load could be reduced by adding proximity sensors or more efficient light fixtures.





Portola Springs Community Center

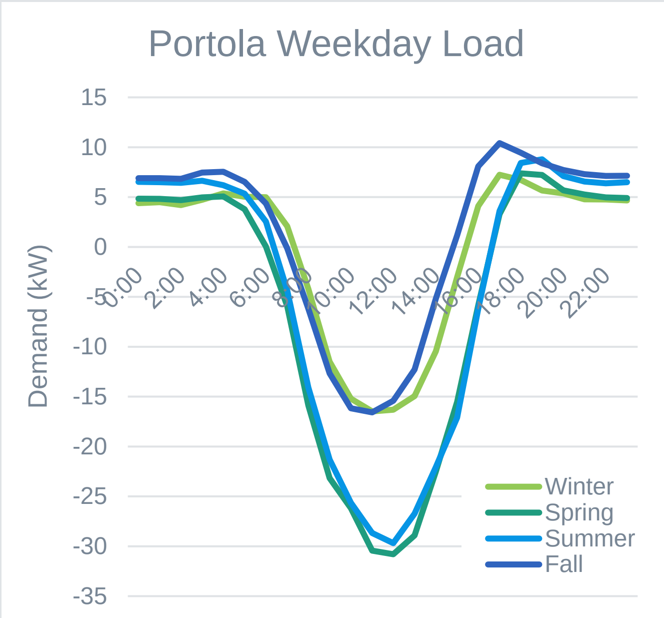
Portola Springs Community Center is a multi-use facility that offers a variety of classes for the community. It includes a multipurpose room, meeting room, Native American Wing: Acjachemen Room, patio space, and outdoor and playground amenities.

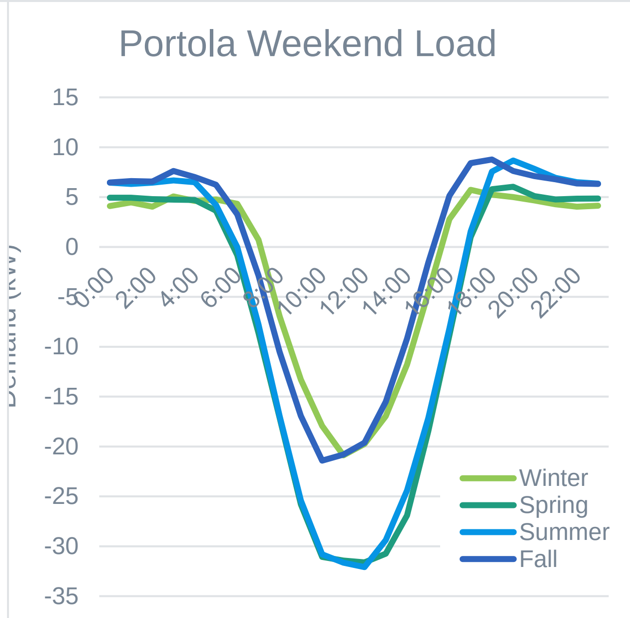
Table A-16. DER Analysis at Portola Springs Community Center

Existing Facility Information	
Address	900 Tomato Springs
Existing Distributed Energy Resources	58.85kW-DC Solar PV
Rate Tariff	TOU-GS-1-D
Square Footage	12,553
Annual Electricity Consumption (kWh)	34,071
Average Annual Electricity Bill	$7,087
Annual Gas Consumption (Therms)	1,233
Annual Gas Bill	$1,504
Energy Usage Intensity	17.10
EUI Building Type	Public Social / Meeting Hall
National Average EUI (kBtu/ft²)	109.6
Comparison to National Average	**-74%**
Recommended Solar and Storage System	
Existing Solar PV	58.85kW-DC
Additional Solar	0kW-DC
Additional Battery Energy Storage System	7kW, 22kWh
Net Present Value (25-year estimate)	$4,475
Annual Power Bill savings	$1,596
Simple Payback	0.51 years
Solar needed to offset 100% electricity usage	0kW-DC

No additional solar PV needed at Portola

Portola Springs Community Center operates from 9am-9pm on weekdays, 9am-10pm on Saturday, and noon-6pm on Sunday. The effect of the 58.85kW-DC Solar PV can be seen by the large midday dip, exporting a large amount of electricity. The solar PV at portola offsets 136% of electricity used by the Center. On average, Portola consumes 91kWh of grid energy per day while exporting 159kWh of solar energy per day. Grid energy consumed is highest in the fall at 109kWh per day on average, when air conditioning is still in use, but PV generation is decreasing. A battery energy storage system (BESS) in this range (91kWh -109kWh) paired with the solar could bring the net load of the site to zero and power Portola from 100% renewable energy.





Los Olivos Community Center

Los Olivos Community Center is a multi-use facility that offers a variety of classes for the community. It includes a multipurpose room, warming kitchen, patio space, and outdoor and playground amenities.

Table A-17. DER Analysis at Los Olivos Community Center

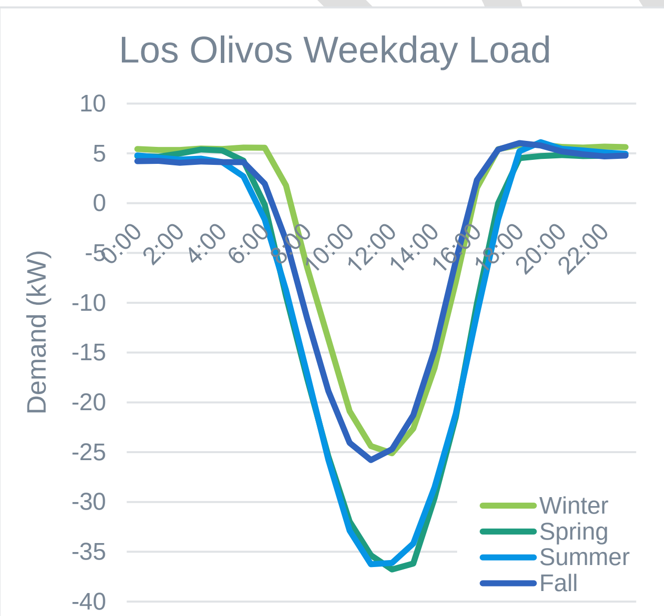
Existing Facility Information	
Address	101 Alfonso
Existing Distributed Energy Resources	58.85kW-DC Solar PV
Rate Tariff	TOU-GS-2-E
Square Footage	8,495
Annual Electricity Consumption (kWh)	24,745
Average Annual Electricity Bill	$3,100
Annual Gas Consumption (Therms)	5
Annual Gas Bill	$305
Energy Usage Intensity	39.11
EUI Building Type	Public Social / Meeting Hall
National Average EUI (kBtu/ft²)	109.6
Comparison to National Average	-64%
Recommended Solar and Storage System	

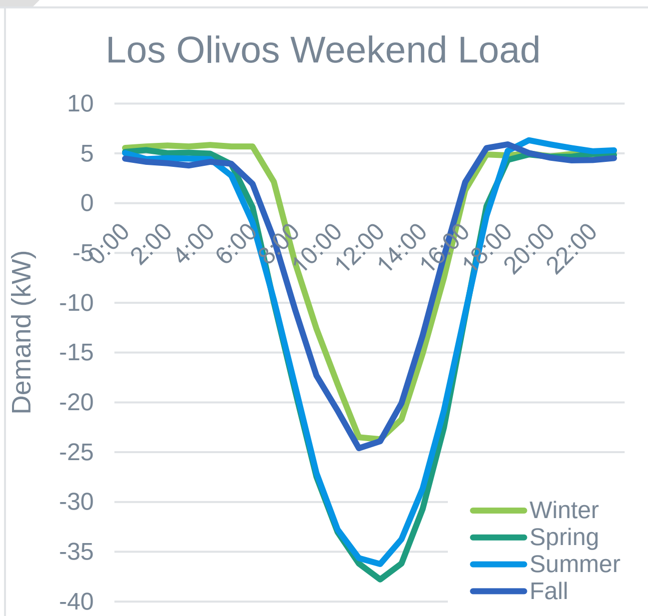
Existing Solar PV	58.85kW-DC
Additional Solar PV	0kW-DC
Battery Energy Storage System	4kW, 21kWh
Net Present Value (25-year estimate)	$2,988
Annual Power Bill savings	$1,227
Simple Payback	0.49 years
Solar needed to offset 100% electricity usage	0kW-DC

No additional solar PV needed at Los Olivos

Los Olivos Community Center is open from 9am-9pm weekdays, 9am-10pm Saturday, and noon-6pm on Sunday. Los Olivos is a fairly new building, opening its doors in early 2019, with the 58.85kW-DC solar PV system turned on in June 2019. With incomplete data from 2019 and 2020 data skewed by COVID-19 shutdowns, it is difficult to get an accurate picture of Los Olivos' energy usage. Based on available data, we estimate Los Olivos consumed 27% less electricity in 2020 compared to 2019.

Based on these assumptions, CSE estimates the average daily consumption at Los Olivos to be 181kWh, while the solar PV generates 266kWh per day, offsetting 147% of electricity consumption. On average the Center draws 68kWh of grid energy per day. Grid energy consumed is highest in the winter at 80kWh on average. A battery energy storage system (BESS) in this range (68kWh-80kWh) paired with the solar could bring the net load of the site to zero and power Los Olivos from 100% renewable energy.





Sweet Shade Ability Center

Sweet Shade Ability Center is the home of City of Irvine's Disability Services. The center features a multipurpose room, kitchen, courtyard, garden, and play area. The center provides Disability Services programs to the community.

Table 18. DER Analysis at Sweet Shade Ability Center

Existing Facility Information			
Address	15 Sweet Shade		
Rate Tariff	AL-2 Flat Rate (Metered, Non-TOU)		
Square Footage	3,000		
Annual Electricity Consumption (kWh)	72,519		
Average Annual Electricity Bill	$12,792		
Annual Gas Consumption (Therms)	-		
Annual Gas Bill	-		
Energy Usage Intensity	80.7		
EUI Building Type	Outpatient Rehab / Physical Therapy		
National Average EUI (kBtu/ft²)	138.3		
Comparison to National Average	-42%		
Recommended Solar and Storage System			
Solar PV	3kW-DC		
Battery Energy Storage System	3kW, 15kWh		
Net Present Value (25-year estimate)	$1,175		
Annual Power Bill savings	$1,261		
Simple Payback	10.5 years		
Solar needed to offset 100% electricity usage	46kW-DC		
Site #	**PV Installation Type**	**Area (Sq. ft.)**	**Estimated System Size (kW-DC)**
1	Roof	785	11
2	Carport	2,679	37.3

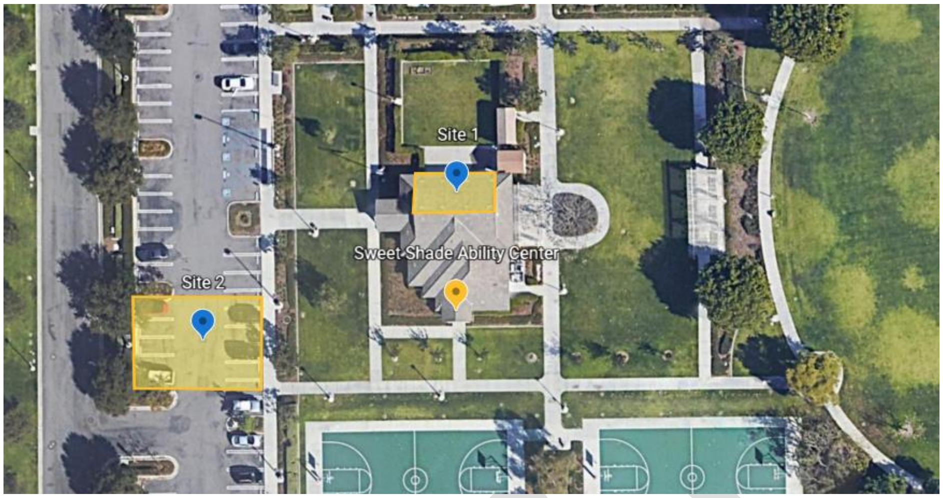
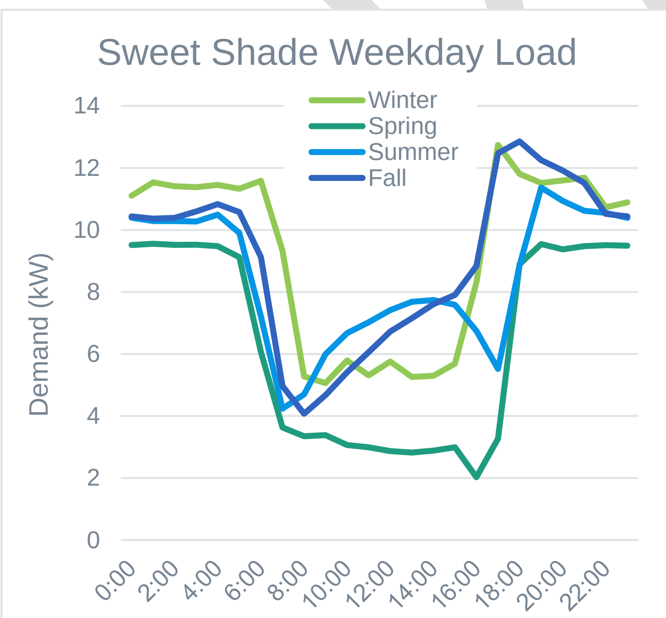
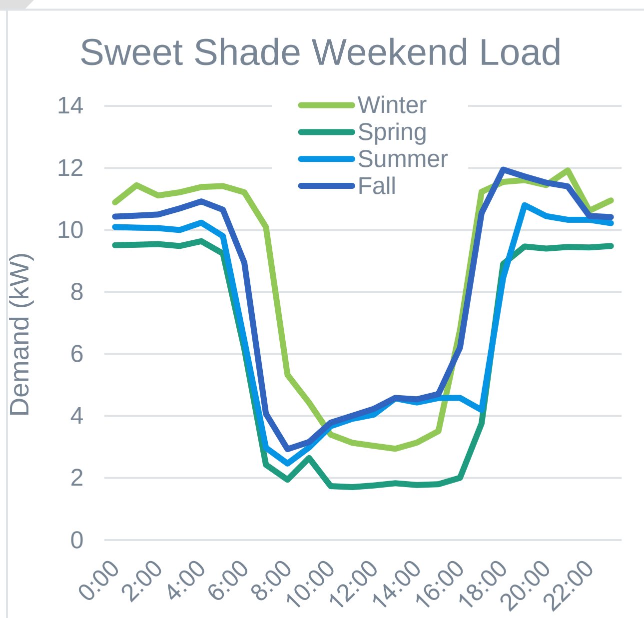


Figure A-23. Solar PV Siting at Sweet Shade Ability Center

Sweet Shade Ability Center operates from 10am-6pm Monday-Saturday. The center has a very small daytime load, even in the summer when air conditioning is most used. By comparison, it has an exceptionally high nighttime load, 10kW on average year-round. The nighttime load accounts for 43% of the center's electricity consumption ($3,237). This load is likely parking lot and path lighting.

Despite being closed after 6pm, the center experiences a small spike in demand from 5pm-10pm. This spike is most pronounced in the Winter and Fall. CSE recommends that both the evening peak and overnight load be investigated for energy efficiency opportunities.





Special Facilities

Rancho Senior Center

Rancho Senior Center is a multi-use facility that offers classes and activities catered to people ages 50 and older. This facility includes three multipurpose rooms, a ballroom, and a warming kitchen.

Table A-19. DER Analysis at Rancho Senior Center

Existing Facility Information	
Address	3 Ethel Coplen Way
Rate Tariff	TOU-GS-2-E
Square Footage	8,779
Annual Electricity Consumption (kWh)	91,744
Average Annual Electricity Bill	$17,808
Annual Gas Consumption (Therms)	368
Annual Gas Bill	$576
Energy Usage Intensity	38.11
EUI Building Type	Public Social / Meeting Hall
National Average EUI (kBtu/ft²)	109.6
Comparison to National Average	-65%
Recommended Solar and Storage System	
Solar PV	9kW-DC
Battery Energy Storage System	7kW, 37kWh
Net Present Value (25-year estimate)	$4,596
Annual Power Bill savings	$3,578
Simple Payback	9.73 years
Solar needed to offset 100% electricity usage	56kW-DC

Site #	PV Installation Type	Area (Sq. ft.)	Estimated System Size (kW-DC)
1	Roof	1428	19
2	Roof	2642	36

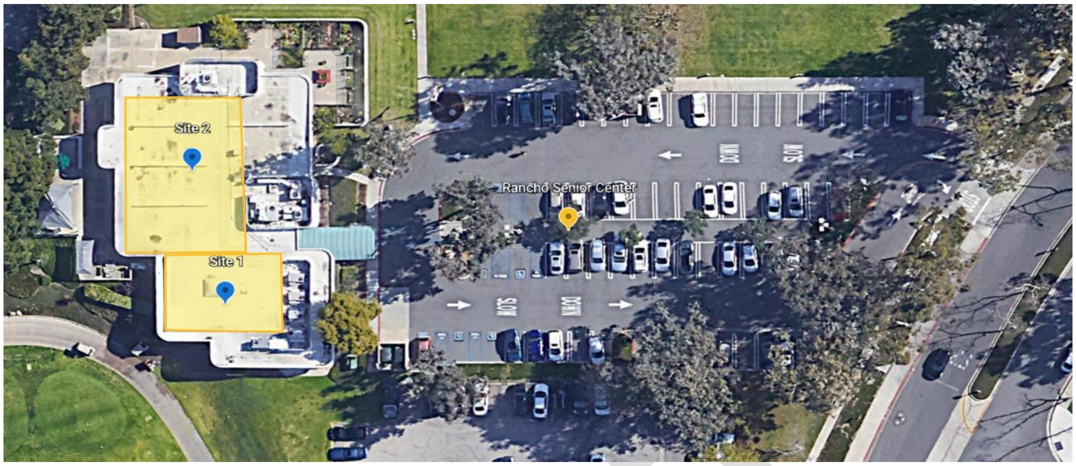
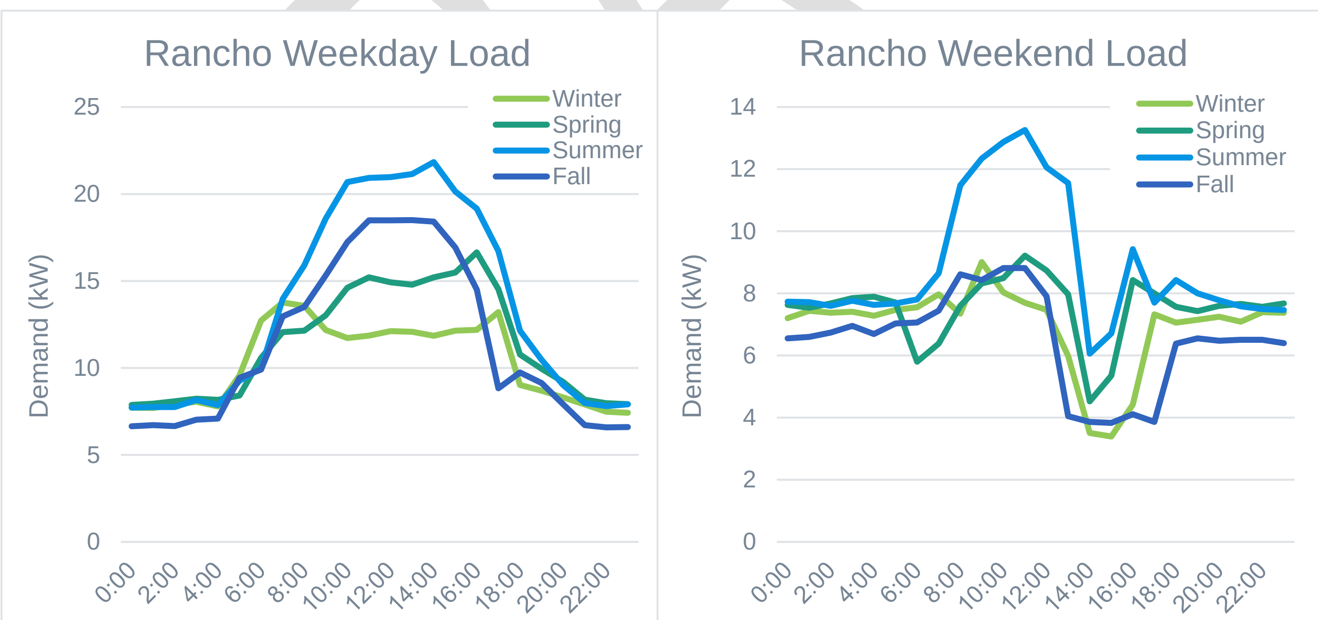


Figure A-25. Solar PV Siting at Rancho Senior Center

Rancho Senior Center is open from 8am-6pm on weekdays, but is reservable on weekday evenings 6-10pm, and on weekends 8am-10pm. Weekday load at the Center begins to pick up between 4-6am, indicating that there may be opportunities for energy efficiency by adjusting HVAC and lighting schedules to follow the operating hours more closely. The seasonal effect of air conditioning can be seen, increasing the daily peak demand from 14kW in winter to 22kW in summer, and increasing total energy consumption by 31%. Since most of the demand occurs in the daytime, installing solar PV could be an effective way to offset daytime load.



Northwood High School Aquatics Center

The Northwood Aquatics Center features a 50-meter pool. The Aquatic Center has shared use by the High School and public. The pool is used for instructional and recreational purposes, as well as competitive events.

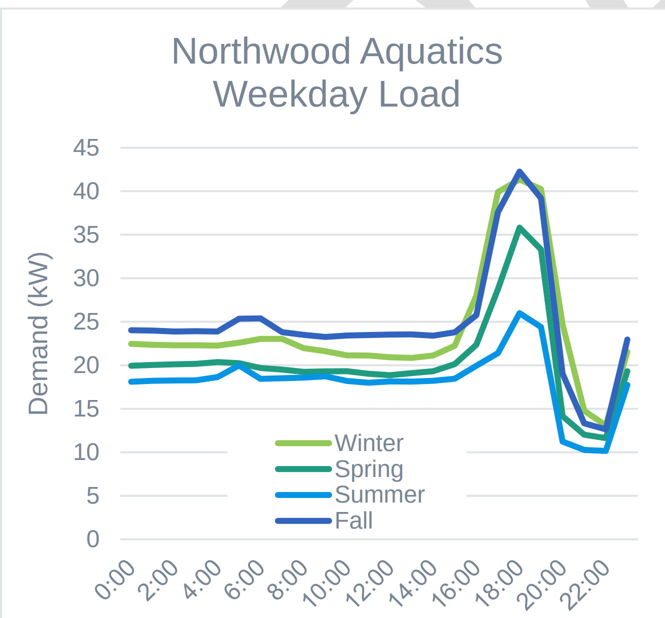
Table A-20. DER Analysis at Northwood High School Aquatics Center

<table>
<tr><th colspan="4">Existing Facility Information</th></tr>
<tr><td colspan="2">Address</td><td colspan="2">4515 Portola Parkway</td></tr>
<tr><td colspan="2">Rate Tariff</td><td colspan="2">TOU-GS-2-E</td></tr>
<tr><td colspan="2">Square Footage</td><td colspan="2">650</td></tr>
<tr><td colspan="2">Annual Electricity Consumption (kWh)</td><td colspan="2">185,148</td></tr>
<tr><td colspan="2">Average Annual Electricity Bill</td><td colspan="2">$31,202</td></tr>
<tr><td colspan="2">Annual Gas Consumption (Therms)</td><td colspan="2">59,100</td></tr>
<tr><td colspan="2">Annual Gas Bill</td><td colspan="2">$44,794</td></tr>
<tr><td colspan="2">Energy Usage Intensity</td><td colspan="2">279.87</td></tr>
<tr><td colspan="2">EUI Building Type</td><td colspan="2">Recreation – Swimming Pool</td></tr>
<tr><td colspan="2">National Average EUI (kBtu/ft²)</td><td colspan="2">112.0</td></tr>
<tr><td colspan="2">Comparison to National Average</td><td colspan="2">**+150%**</td></tr>
<tr><th colspan="4">Recommended Solar and Storage System</th></tr>
<tr><td colspan="2">Solar PV</td><td colspan="2">20kW-DC</td></tr>
<tr><td colspan="2">Battery Energy Storage System</td><td colspan="2">22kW, 104kWh</td></tr>
<tr><td colspan="2">Net Present Value (25-year estimate)</td><td colspan="2">$9,962</td></tr>
<tr><td colspan="2">Annual Power Bill savings</td><td colspan="2">$9,103</td></tr>
<tr><td colspan="2">Simple Payback</td><td colspan="2">9.8 years</td></tr>
<tr><td colspan="2">Solar needed to offset 100% electricity usage</td><td colspan="2">129kW-DC</td></tr>
<tr><th>Site #</th><th>PV Installation Type</th><th>Area (Sq. ft.)</th><th>Estimated System Size (kW-DC)</th></tr>
<tr><td>1</td><td>Roof</td><td>1523</td><td>21</td></tr>
<tr><td>2</td><td>Roof</td><td>896</td><td>12</td></tr>
</table>

Figure A-27. Solar PV Siting at Northwood High School Aquatics Center

Northwood Aquatics operates from 4:30-8pm on weekdays. The historical energy audit also indicates that the facility is used by Northwood High School from 6am-4pm. It is open on the weekends as needed. Northwoods maintains a consistent load around 21kW year-round from midnight until 7pm, when it has a large dip in demand, additionally, it experiences a large peak demand on weekdays from 4-9pm, the hours in which it is open to the public. The biggest impact to energy efficiency will be achieved by addressing this year-round baseload (73% of total energy consumption).

Northwoods was also screened for Combined Heat and Power (CHP) but did not show a favorable outcome.



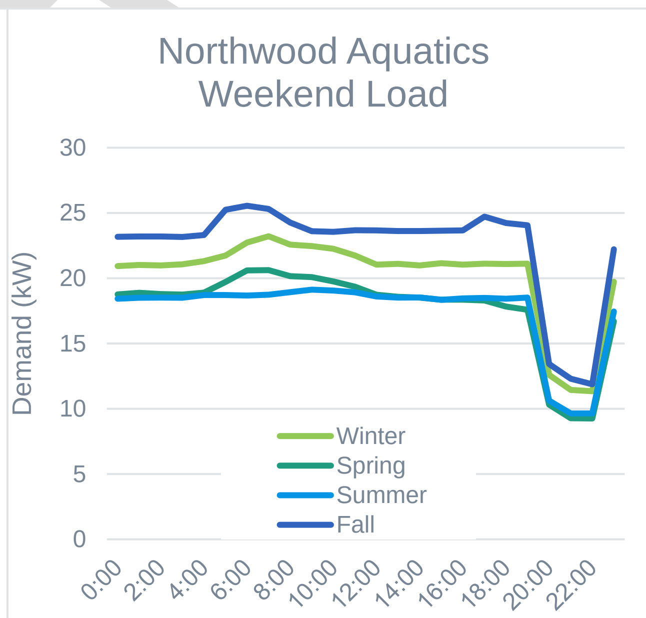


Table A-21. Northwood Aquatics Center Existing Energy Audit Results by Energy Network (2016)

Recommendations
1. Replace the existing Pool Boiler with a high efficiency indirect fire boiler
2. Install a Solar Thermal water heating system on the roof to supplement the boilers and reduce natural gas usage
3. Replace the shower water heaters with a high efficiency tankless water heater
4. Install low flow faucet aerators on the showers
5. Replace all exterior lighting and in-pool lamps with LED

William Woollett Jr. Aquatics Center

The world-renowned William Woollett Jr. Aquatics Center provides a world class venue for local, regional, and national competitive events and features two 50-meter pools and a 25-yard instruction pool. The pools, a multipurpose meeting room, and concession stand are also available for reservation.

Table A-22. DER Analysis at William Woollett Jr. Aquatics Center

Existing Facility Information			
Address		4601 Walnut Ave.	
Rate Tariff		TOU-GS-3-D	
Square Footage		13,000	
Annual Electricity Consumption (kWh)		1,212,846	
Average Annual Electricity Bill		$185,236	
Annual Gas Consumption (Therms)		151,336	
Annual Gas Bill		$105,677	
Energy Usage Intensity		1,458	
EUI Building Type		Recreation – Swimming Pool	
National Average EUI (kBtu/ft²)		112	
Comparison to National Average		**+1,202%**	
Recommended Solar and Storage System			
Solar PV		10kW-DC	
Existing Battery Energy Storage System		223kW, 446kWh	
Additional Battery Energy Storage System		18kW, 56kWh	
Net Present Value (25-year estimate)		$10,491	
Annual Power Bill savings		$5,646	
Simple Payback		8.6 years	
Solar needed to offset 100% electricity usage		728kW-DC	
Recommended Combined Heat and Power System			
CHP System		208kW*	
Site #	**PV Installation Type**	**Area (Sq. ft.)**	**Estimated System Size (kW-DC)**
1	Carport	2,636	36.8
2	Carport	7,618	132.8
3	Carport	602	10.5

*William Woollett was screened for Combined Heat and Power (CHP) and showed favorable results for a 208kW CHP system estimated to cost approximately $604,000 and have an estimated payback of about 9 years. Preliminary results show a potential for approximately $67,000 annual operating cost savings with an 11.1% return on investment (ROI). Please see the combined Heat and Power section of this report for the results and financial payback.

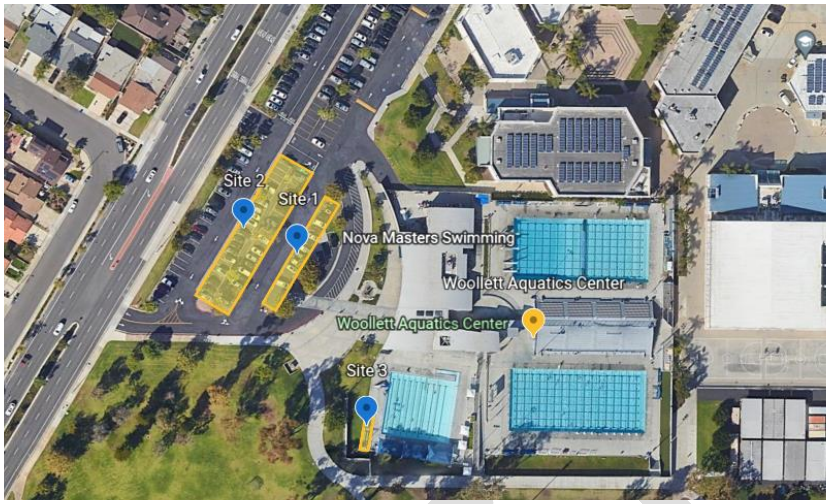
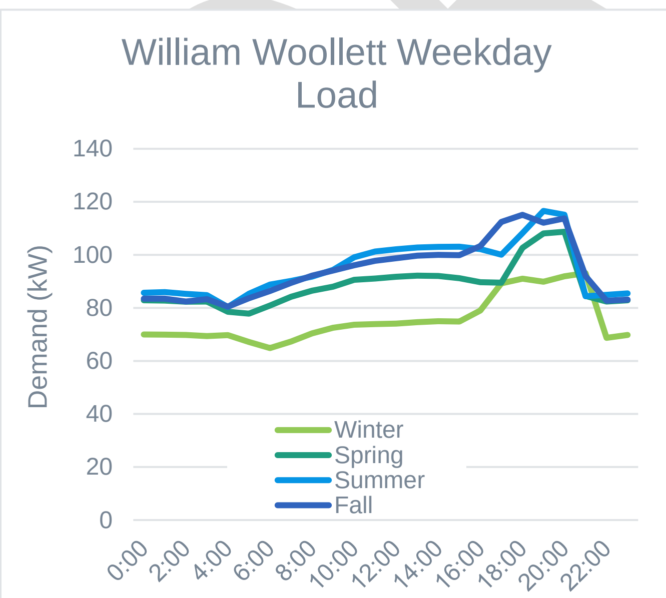
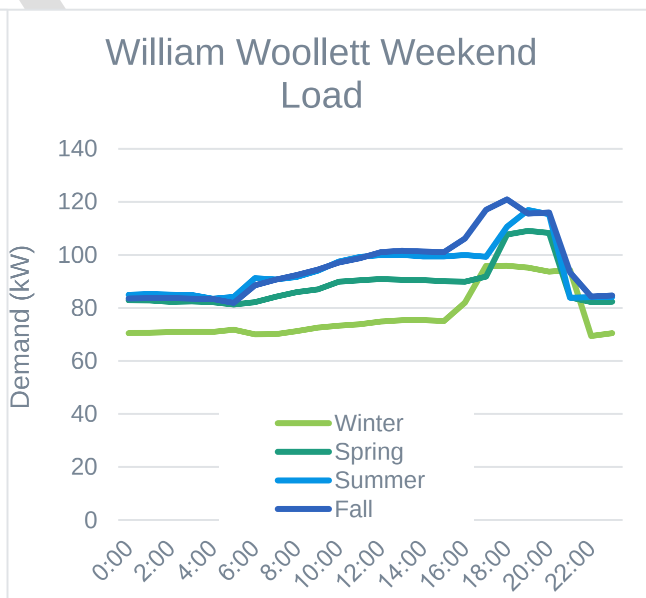


Figure A-29. Solar PV Siting at William Woollett Jr. Aquatics Center

William Woollett Jr. Aquatics Center is open from 6am-8pm on weekdays, and 8am-noon on weekends. William Woollett is the second largest energy consumer by the City, accounting for 10% of City-wide energy use. Due to the large amount of natural gas consumed to heat the pools, it is also responsible for 27% of all GHG emissions produced by City buildings.

Year round, William Woollett experiences a spike in demand from 4-9pm - including on weekends, when the center is not open. Overnight, the Center maintains a load of 80kW, accounting for 30% of electricity consumption ($25,719 at off-peak rates). Due to the large amount of energy consumption and lack of historical audit, CSE recommends William Woollett undergo a full on-site energy audit.





Curiously, when compared to utility bill consumption, interval data suggests that William Woollett only consumed around half of the electricity than what was shown on the utility bill for the same meter. CSE suggests working with SCE to determine if metering is being performed correctly at William Woollett.

Trabuco Center

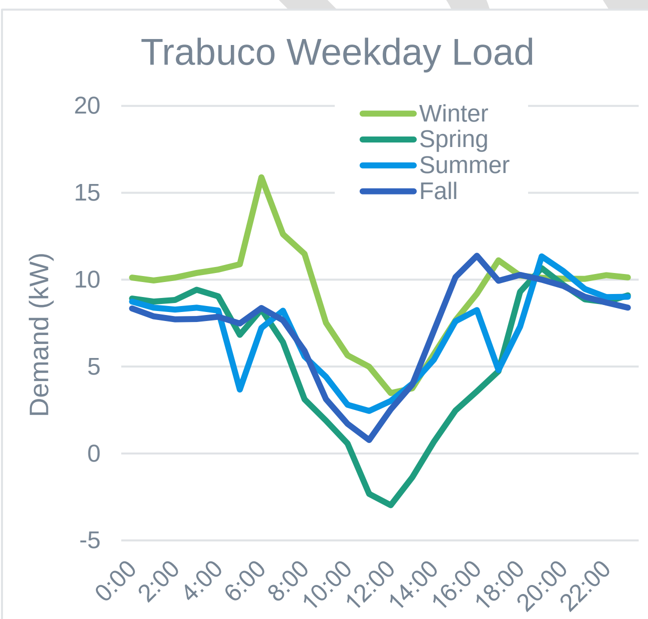
Trabuco Center is a multi-use facility that offers classes and activities catered to people ages 50 and older. This center includes a multipurpose room, classroom, warming kitchen, and patio.

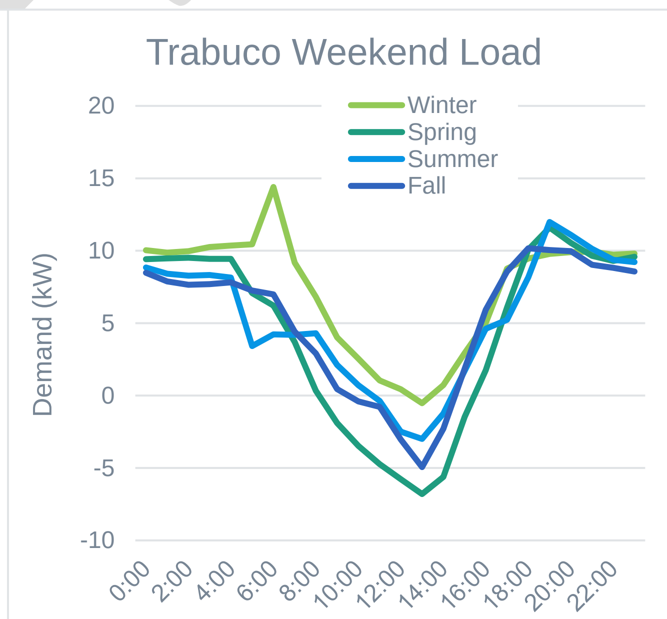
Table A-23. DER Analysis at Trabuco Center

Existing Facility Information			
Address		5701 Trabuco Road	
Rate Tariff		TOU-GS-2-E	
Square Footage		7,130	
Annual Electricity Consumption (kWh)		61,336	
Average Annual Electricity Bill		$12,208	
Annual Gas Consumption (Therms)		-	
Annual Gas Bill		-	
Energy Usage Intensity		38.63	
EUI Building Type		Public Social / Meeting Hall	
National Average EUI (kBtu/ft²)		109.6	
Comparison to National Average		**-65%**	
Recommended Solar and Storage System			
Existing Solar PV		35kW-DC	
Additional Solar PV		0kW-DC	
Battery Energy Storage System		10kW, 53kWh	
Net Present Value (25-year estimate)		$9,776	
Annual Power Bill savings		$3,299	
Simple Payback		0.81 years	
Solar needed to offset 100% electricity usage		36kW-DC	
Site #	**PV Installation Type**	**Area (Sq. ft.)**	**Estimated System Size (kW-DC)**
1	Carport	2,388	33
2	Roof	2,263	39

Figure A-31. Solar PV Siting at William Woollett Jr. Aquatics Center

Trabuco Center Operates from 8am-6pm on weekdays, and is reservable from 6-10pm on weekdays, 8am-10pm on weekends. The impact of the 35kW-DC solar PV can be seen by the large dip midday, exporting some power back to the grid in the spring. The solar at Trabuco offsets 27% of the electricity consumed by the site. The Center maintains a nighttime load around 9kW year-round, accounting for 43% of remaining electricity after solar ($3,867 annually at off-peak rates).





Great Park

The Orange County Great Park encompasses 1,300 acres of space, with 450 developed and 230 acres in progress. The park features a variety of venues, such as the visitors center, balloon, carousel, and sports arenas for soccer, tennis, volleyball, basketball, baseball, and softball.

The Great Park has six separate utility accounts to serve the various parts of the park. Due to the shared nature of the space and many open areas, the park may be best served by DERS as an NEM aggregate (NEM-A) arrangement. NEM-A is designed to offset energy consumption costs from multiple service accounts served by a single renewable generating system. In other words, energy from solar PV generated anywhere in the park would be shared amongst the six utility accounts. Note that this is purely a financial arrangement, and facilities will not be served directly by the solar PV.

The City could also expand upon this model by adding energy storage and a microgrid controller. This would allow the park to island in the event of an outage or Public Safety Power Shutoff (PSPS). The solar and storage would work in tandem to power the site, while the microgrid controller will prioritize the critical loads while cutting power to non-essential functions based upon the power available from DERS (this is known as load-shedding).

Table A-24. Summary of Solar and Storage Recommendations at Great Park Sites

Recommended Solar and Storage System	Admin	Soccer Stadium	Baseball	Basketball	Softball	Tennis	Total
Total Installed Solar	15kW-DC	65kW-DC	121kW-DC	98kW-DC	60kW-DC	144kW-DC	**503kW-DC**
Additional Battery Energy Storage System	17kW, 76kWh	148kW, 469kWh	225kW, 788kWh	165kW, 580kWh	63kW, 237kWh	72kW, 246kWh	**690kW, 2396kWh**
Net Present Value (25-year estimate)	$8,281	$107,659	$124,476	$78,317	$31,841	$24,901	**$242,718.00**
Annual Power Bill savings	$6,873	$46,474	$72,483	$53,574	$24,893	$39,516	**$136,892.00**
Simple Payback	10 years	7 years	10.8 years	9.43 years	9.75 years	10.83 years	**9.64 years**
Solar needed to offset 100% electricity usage	610kW-DC	256kW-DC	299kW-DC	222kW-DC	86kW-DC	154kW-DC	**1,627kW-DC**

Figure A-33. Solar PV Siting at Great Park

Table A-25. Potential Solar Sizing by Site at Great Park

Site #	PV Installation Type	Area (Sq. ft.)	Estimated System Size (kW-DC)
1	Carport	46,827	652
2	Carport	121,566	1,694
3	Carport	86,000	1,200
4	Carport	111,774	1,558

Table A-26. Great Park Energy Audit Results by SoCalREN (2021)

2021 Energy Audit Results by SoCalREN
1. Upgrade interior lighting to LED
2. Upgrade Art Gallery lighting to LED
3. Upgrade exterior lighting to LED
4. Upgrade sports lighting to LED
5. Upgrade Great Balloon lighting to LED
6. Building Retro Commissioning (RCx) in Buildings A, D, E, and G. This is a more extensive energy audit that could involve ongoing monitoring of temperature and pressure, installing additional sensors, and upgrading equipment to optimize HVAC control systems.

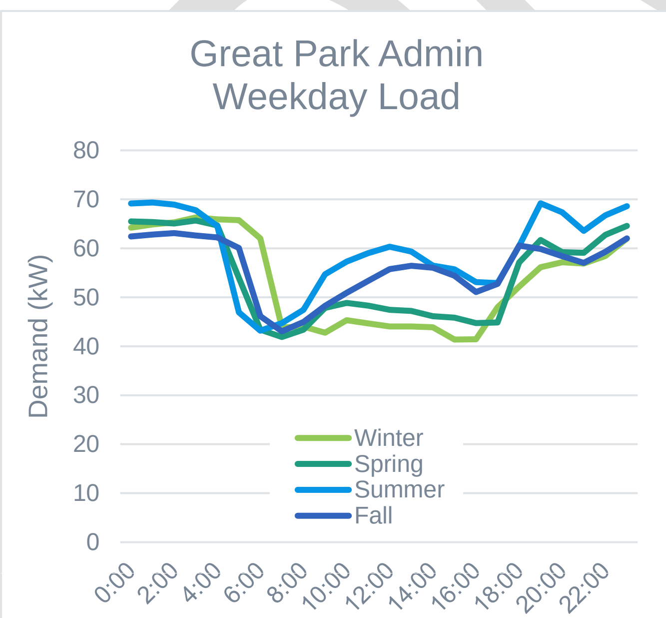
Great Park Visitors Center and Admin Buildings

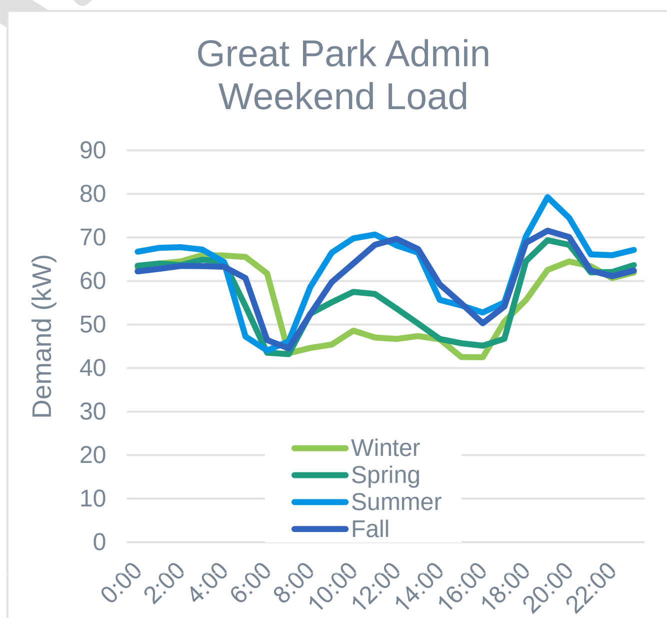
The Great Park Administration Building, Art Gallery, Artists Studio, Hangar 244, Visitors Center and Visitor Support Building all share electrical service. The Great Park Visitors Center is open from 10am-8pm Monday-Wednesday, 10am-10pm Thursday and Friday, and 9am-10pm on weekends. The remaining buildings are largely closed during the week and are open 10am-4pm on the weekends.

Table A-27. DER Analysis at Great Park Visitors Center and Admin Buildings

Existing Facility Information	
Address	8235 Great Park Blvd
Rate Tariff	TOU-GS-3-E
Square Footage	36,220
Annual Electricity Consumption (kWh)	917,815
Average Annual Electricity Bill	$142,518
Annual Gas Consumption (Therms)	-
Annual Gas Bill	-
Energy Usage Intensity	88.44
EUI Building Type	Other – Stadium
National Average EUI (kBtu/ft²)	112.0
Comparison to National Average	-21%

Demand at the Park buildings is highest at night, averaging 63kW year-round. This nighttime load accounts for 37% of energy consumption by these buildings ($25,906 at off-peak rates). The baseload of





the facilities is about 45kW, maintained year-round. The biggest impact to energy efficiency will be achieved by addressing this year-round baseload (77% of total energy consumption).

Curiously, when compared to utility bill consumption, interval data suggests that these facilities consumed much less electricity than what was shown on the utility bill for the same meter. CSE suggests working with SCE to determine if metering is being performed correctly.

Championship Soccer Stadium A and Support Facility B

The Championship Soccer Stadium located in the Irvine Great Park seats up to 5,000 fans. The Stadium is home to the Orange County Soccer Club and the California United Strikers Football Club. It features locker rooms, concession stands, and a box office.

Table A-28. DER Analysis at Great Park Soccer Stadium A and Support Facility B

Existing Facility Information	
Address	220 Corsair
Rate Tariff	TOU-GS-3-D
Square Footage	26,438
Annual Electricity Consumption (kWh)	400,522
Average Annual Electricity Bill	$105,473
Annual Gas Consumption (Therms)	5,516
Annual Gas Bill	$5,411
Energy Usage Intensity	71.76
EUI Building Type	Stadium
National Average EUI (kBtu/ft²)	112
Comparison to National Average	**-36%**

Events occur at the Stadium at a variety of times throughout the day but are concentrated mainly in the evenings between 4-9pm. The Stadium experiences a small spike in demand from 2am-7am on weekdays, year-round. The Stadium maintains a year-round baseload around 36kW. This baseload accounts for 73% of electricity consumed by the Stadium and represents the largest opportunity for reducing electricity consumption. CSE recommends that both the morning peak and continuous base load be investigated for energy efficiency opportunities.

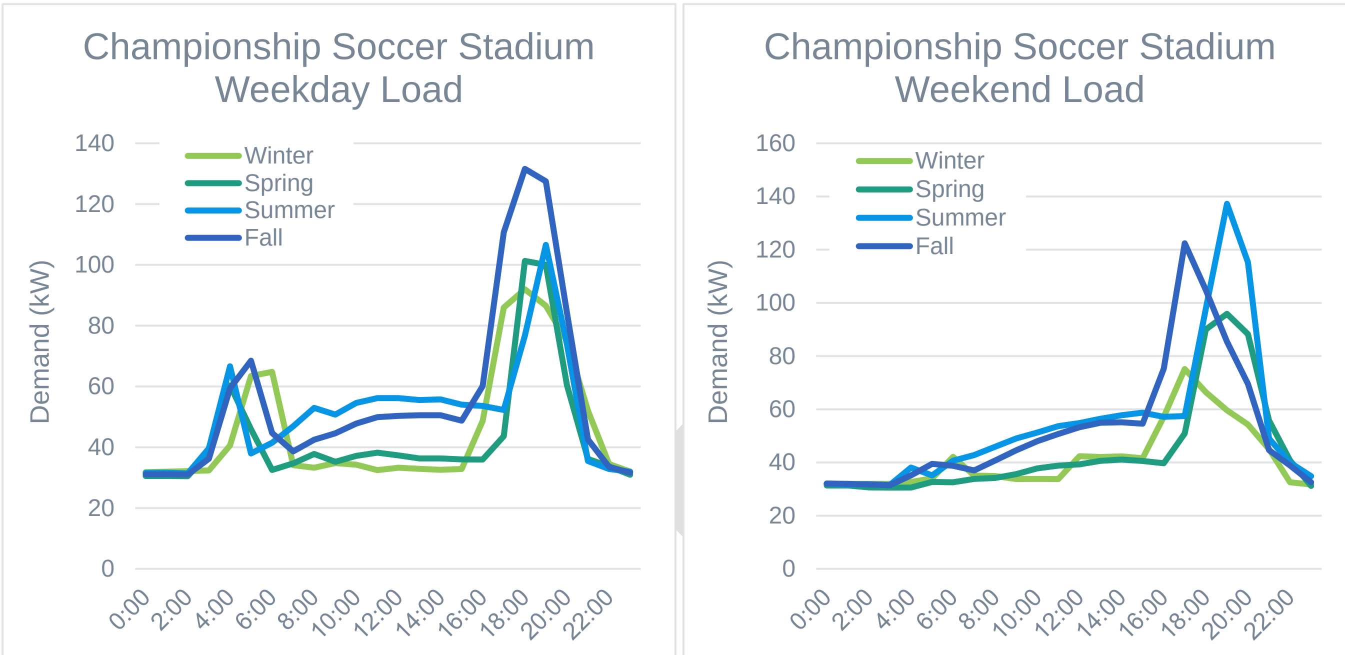


Figure A-35. Load Profiles at Great Park Championship Soccer Stadium and Support Facility

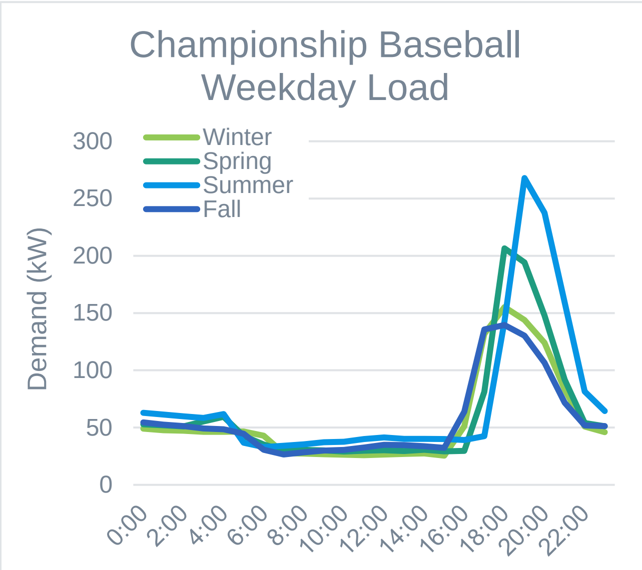
Championship Baseball Stadium E, Soccer Restrooms C, Baseball Support F

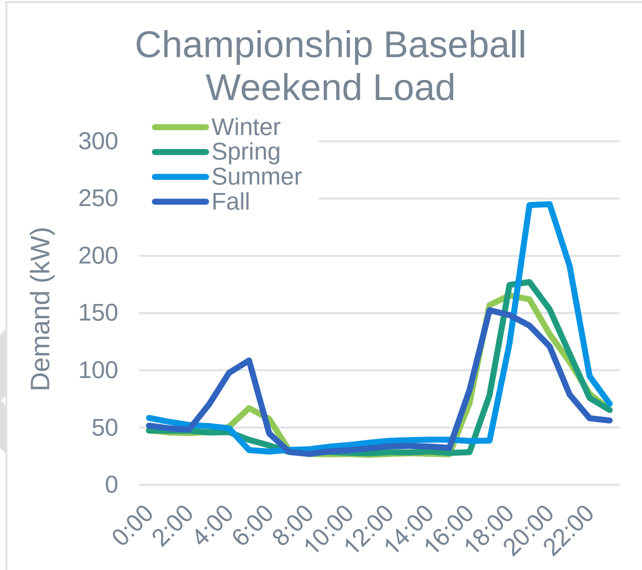
The Championship Baseball Stadium at the Great Park includes underground locker rooms, indoor luxury boxes, broadcast booths and large video screens. Also sharing service with the stadium is a restroom and support building. The Stadium is the future home of the Orange County Riptide baseball team.

Table A-29. DER Analysis at Great Park Baseball Stadium, Soccer Restrooms and Baseball Support

Existing Facility Information	
Address	230 Corsair
Rate Tariff	AL-2 Flat Rate (Metered, Non-TOU)
Square Footage	25,539
Annual Electricity Consumption (kWh)	517,993
Average Annual Electricity Bill	$159,325
Annual Gas Consumption (Therms)	-
Annual Gas Bill	-
Energy Usage Intensity	61.57

EUI Building Type	Stadium
National Average EUI (kBtu/ft²)	112.0
Comparison to National Average	**-45%**





Events at the Stadium are concentrated mainly in the evenings from 4-10pm. On weekends, the Stadium experiences a small spike in demand from 2am-7am. This spike is most pronounced in the winter and fall (Baseball season is typically in the spring). The Stadium maintains a year-round baseload around 31kW. This baseload accounts for 50% of electricity consumed by the Stadium and represents the largest opportunity for reducing electricity consumption. CSE recommends that both the morning peak and continuous base load be investigated for energy efficiency opportunities.

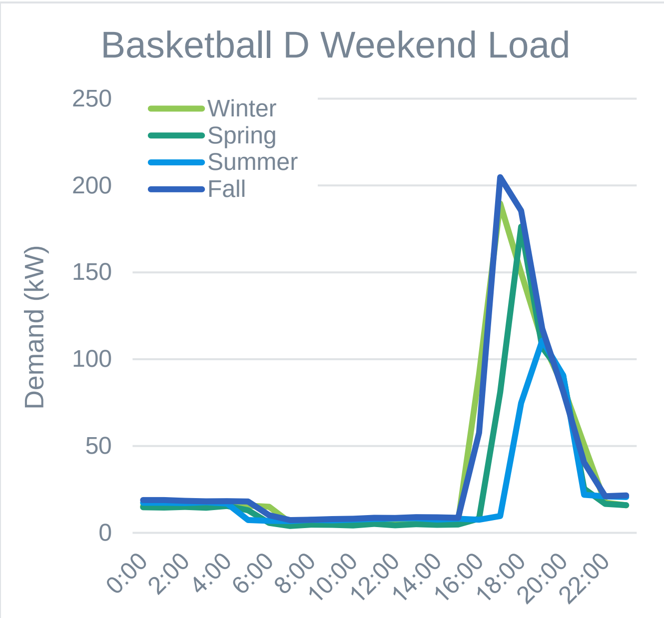
Basketball/Soccer Restrooms and Office D

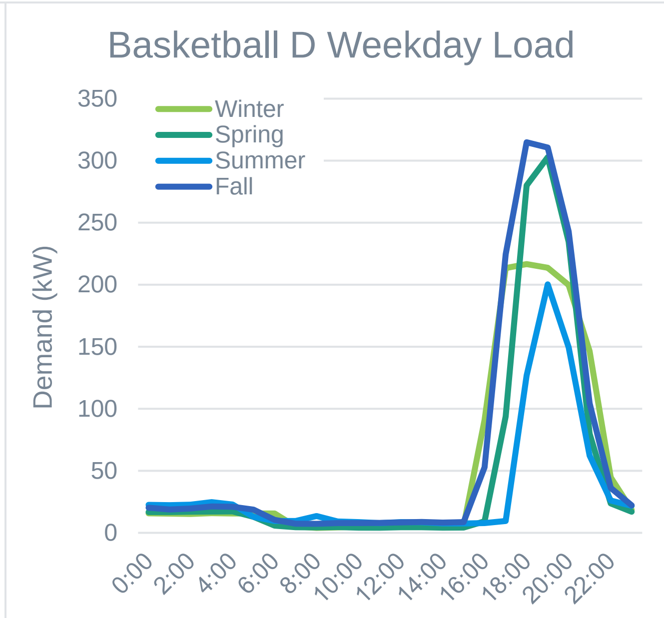
The Great Park features four lighted outdoor basketball courts sharing service with nearby restrooms. The Basketball Courts are available for walk-on use from 8am until the park closes at 10pm.

Table A-30. DER Analysis at Great Park Basketball and Soccer Restrooms

Existing Facility Information	
Address	7301 Marine Way
Rate Tariff	AL-2 Flat Rate (Metered, Non-TOU)
Square Footage	3,248
Annual Electricity Consumption (kWh)	391,547
Average Annual Electricity Bill	$144,798
Annual Gas Consumption (Therms)	-
Annual Gas Bill	-

Energy Usage Intensity	360.36
EUI Building Type	Stadium
National Average EUI (kBtu/ft²)	112.0
Comparison to National Average	**+222%**





The majority of the demand on the courts comes from lighting, which turns on between 3-5pm seasonally and turn off at 10pm. The sun sets in the summer around 8pm and 5pm in the winter, so there may be an opportunity for energy efficiency by adjusting the timing controlling the lighting.

Championship Softball Stadium G

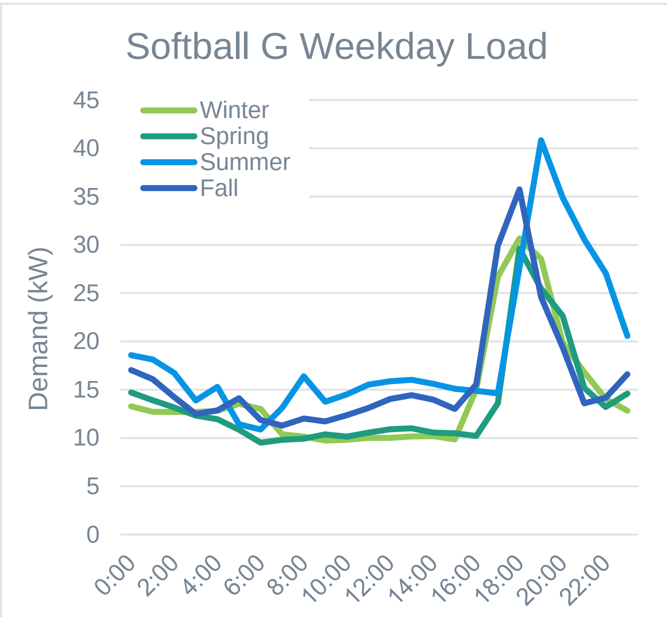
The Great Park features five Softball fields including the Championship Softball Stadium. The Softball Stadium and fields are accessible for City programs and public reservations. Events at the Stadium are concentrated mainly in the evenings from 4-11pm.

Table A-31. DER Analysis at Great Park Softball Stadium G

Existing Facility Information	
Address	971 Skyhawk
Rate Tariff	AL-2 Flat Rate (Metered, Non-TOU)
Square Footage	7,660
Annual Electricity Consumption (kWh)	140,703
Average Annual Electricity Bill	$52,321
Annual Gas Consumption (Therms)	933

Annual Gas Bill	$1,194
Energy Usage Intensity	71.61
EUI Building Type	Stadium
National Average EUI (kBtu/ft²)	112.0
Comparison to National Average	**-36%**

On weekends, the Stadium experiences a small spike in demand from 4am-7am. This spike is most pronounced in the winter and fall. The Stadium maintains a year-round baseload around 10kW. This



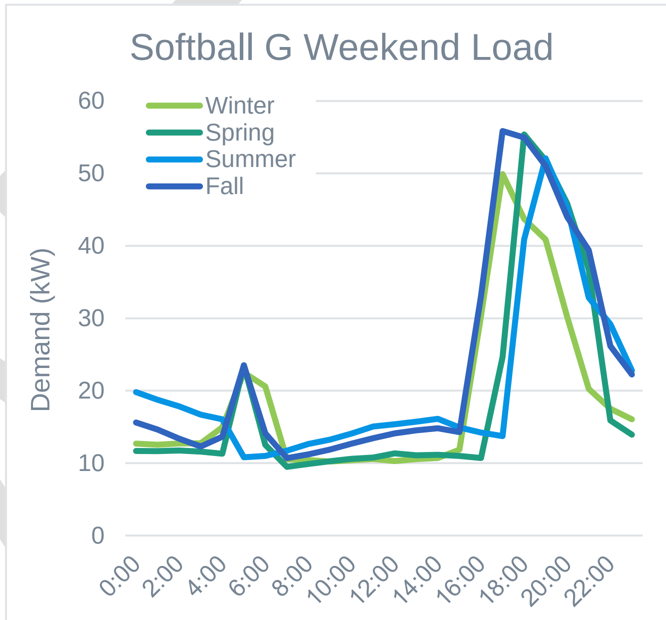


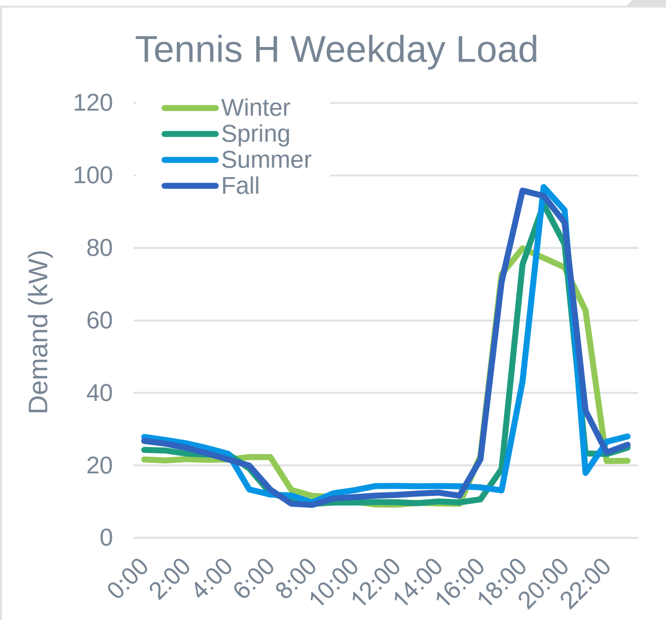
Figure A-38. Load Profiles at Great Park Softball Stadium G

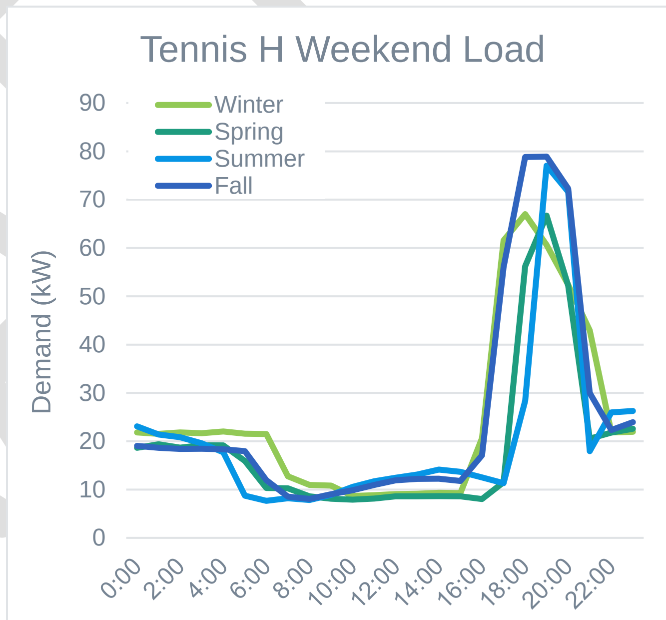
baseload accounts for 61% of electricity consumed by the Stadium and represents the largest opportunity for reducing electricity consumption. CSE recommends that both the morning peak and continuous base load be investigated for energy efficiency opportunities.

Tennis Facilities H

The Great Park Tennis Center features a conference room, concession stand and 25 tennis courts. The courts are used for kids' camps, lessons, teams, and recreational programs, leagues, matches and championship tournaments. The Championship court has seating for 132 spectators, and all courts are lighted. Tennis courts are available from 6am-10pm and are available for reservation and drop-in.

Table A-32. Great Park Tennis Facilities H





Existing Facility Information	
Address	8250 Great Park Blvd
Rate Tariff	AL-2 Flat Rate (Metered, Non-TOU)
Square Footage	4,472
Annual Electricity Consumption (kWh)	257,375
Average Annual Electricity Bill	$60,058
Annual Gas Consumption (Therms)	-
Annual Gas Bill	-
Energy Usage Intensity	181.09

EUI Building Type	Office
National Average EUI (kBtu/ft²)	116.4
Comparison to National Average	+56%

The majority of the demand on the courts comes from lighting, which turns on between 3-5pm seasonally and turn off at 10pm. The sun sets in the summer around 8pm and 5pm in the winter, so there may be an opportunity for energy efficiency by adjusting the timing controlling the lighting. The nightime demand when the courts are unavailable is fairly high at 22kW year-round, accounting for 28% of facility energy consumption ($6,822 annually).

Heritage Park

Like the Great Park, Heritage Community park includes several facilities in a shared area with a large open space. Heritage Park may also be best served by an NEM Aggregate (NEM-A) or microgrid arrangement. Heritage Park has utility service for the Community Center, Child Resource Center, and the Irvine Fine Arts Center.

Table A-33. Summary of Solar and Storage Recommendations at Heritage Park Sites

Recommended Solar and Storage System	Community Center	Child Resource Center	Fine Arts Center	Total
Total Installed Solar	157kW-DC	19kW-DC	25kW-DC	**201kW-DC**
Additional Battery Energy Storage System	28kW, 84kWh	1kW,6 kWh	15kW, 81kWh	**44kW, 105kWh**
Net Present Value (25-year estimate)	$25,985	$742	$13,491	**$40,218**
Annual Power Bill savings	$34,057	$3,570	$9,185	**$46,812**
Simple Payback	10.1 years	10.55 years	9.29 years	**9.98 years**
Solar needed to offset 100% electricity usage	209kW-DC	19kW-DC	112kW-DC	**340kW-DC**

Figure A-40. Solar PV Siting at Heritage Park

Table A-34. Potential Solar Sizing at Heritage Park Sites

Site #	PV Installation Type	Area (Sq. ft.)	Estimated System Size (kW-DC)
1	Carport	7,650	106
2	Carport	9,985	139
3	Carport	3,335	46
4	Carport	5,250	73

Heritage Park Community Center

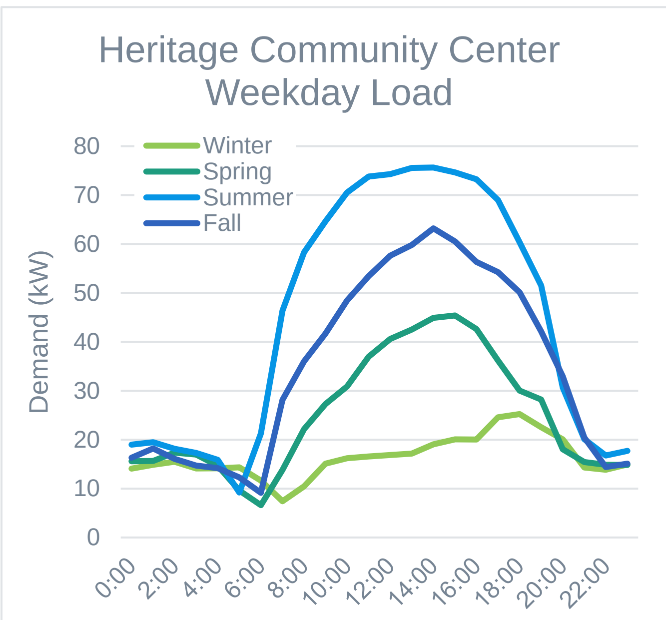
Heritage Park Community Center is located inside scenic Heritage Community Park, with ample open park space, lake views, and playground amenities. The center offers a variety of classes to the community. It includes a craft room; gazebo; kitchen; lounge; multipurpose room; picnic shelter; and nearby baseball, softball, and soccer fields. The Heritage Park Community Center operates from 9am-9am on weekdays, 9am-10pm Saturdays, and noon-6pm on Sunday.

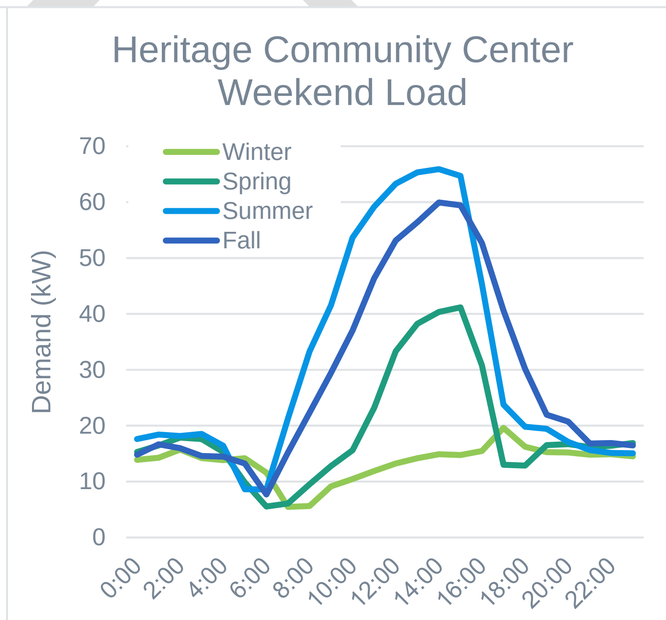
Table A-35. DER Analysis at Heritage Park Community Center

Existing Facility Information	
Address	14301 Yale Ave.
Rate Tariff	TOU-GS-2-D
Square Footage	11,296
Annual Electricity Consumption (kWh)	247,775
Average Annual Electricity Bill	$47,199
Annual Gas Consumption (Therms)	436

Annual Gas Bill	$638
Energy Usage Intensity	101.24
EUI Building Type	Public Social / Meeting Hall
National Average EUI (kBtu/ft²)	109.6
Comparison to National Average	-8%

The Heritage Park Community Center operates from 9am-9am on weekdays, 9am-10pm Saturdays, and noon-6pm on Sunday. While the load profile at Heritage does seem to follow the operating hours, it seems to have an exceptionally large air conditioning load. The average daily consumption increases by 150% from winter to summer and increases the daily peak demand from 25kW to 76kW. CSE recommends examining the temperature setpoints to maintain a reasonable level of cooling in the warmer months.





The historical energy audit also makes a variety of recommendations to lower the HVAC load at Heritage. Since most of the demand occurs in the daytime, installing solar PV could also be an effective way to offset daytime load.

Table A-36. Heritage Community Center Existing Energy Audit Results by AESC (2011)

Recommendations
1. Program fans to shut down during non-operating hours
2. Restore economizer functionality to provide optiumum start/stop control. Add relief hoods or motorized louvers to discharge air to optimize economizer function.

3. Add demand-controlled ventilation; reduced heating and cooling when rooms are not used at full capacity
4. Add lockout to the boiler so that it does not operate when the outside air temperature is above 70°F
5. Install variable frequency drives (VFDs) to the AHU fans to modulate air flow rates
6. Replace exterior wall fixtures and light poles with more efficient fixtures with photocells.
7. Retrofit interior lighting throughout the building with more efficient lamps
8. Install lighting occupancy sensors for rooms not in continuous use throughout the day, such as restrooms and offices
9. Install a time clock for the fountain pumps to shut off during night hours

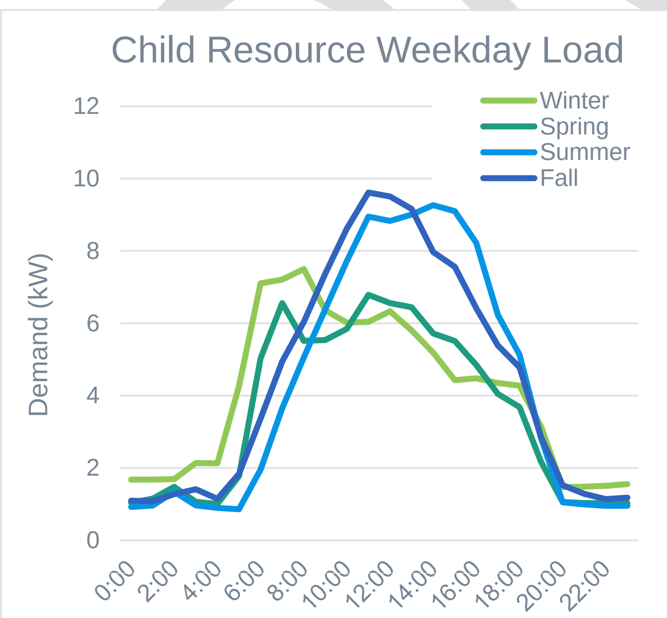
Child Resource Center (at Heritage Park)

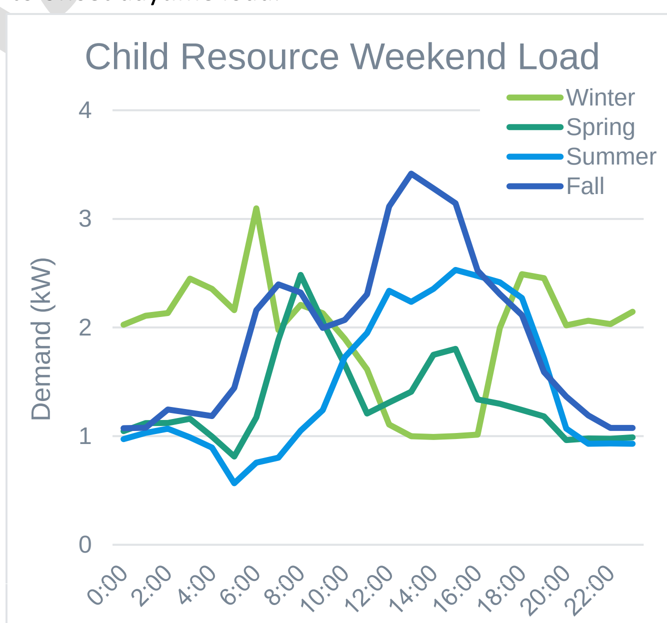
The Child Resource Center (CRC) is a member-based lending library for families and early childhood education professionals. The Child Resource Center operates from noon-7pm Monday-Thursday and is closed on weekends.

Table A-37. DER Analysis at Child Resource Center

Existing Facility Information	
Address	14341 Yale Avenue
Rate Tariff	TOU-GS-1-E
Square Footage	3,000
Annual Electricity Consumption (kWh)	29,713
Average Annual Electricity Bill	$5,243
Annual Gas Consumption (Therms)	69
Annual Gas Bill	$249
Energy Usage Intensity	35.77
EUI Building Type	Library
National Average EUI (kBtu/ft^2)	143.6
Comparison to National Average	**-75%**

Demand at the center begins around 5am and continues until 8pm. CSE recommends that lighting and HVAC schedules at the Center be examined to align more closely with the operating hours. Despite being closed on weekends, the Center maintains a weekend load of around 2kW year-round, accounting for 14% of electricity consumption at the Center. Since most of the demand at the Center occurs in the daytime, installing solar PV could be an effective way to offset daytime load.





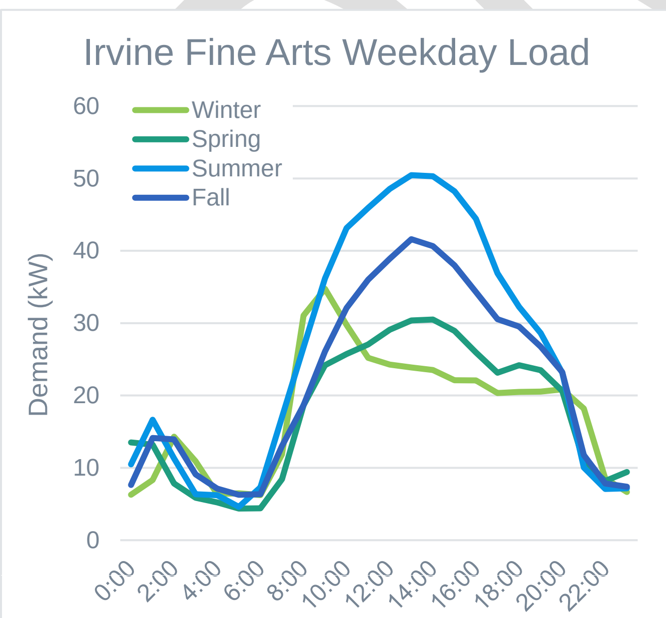
Irvine Fine Arts Center

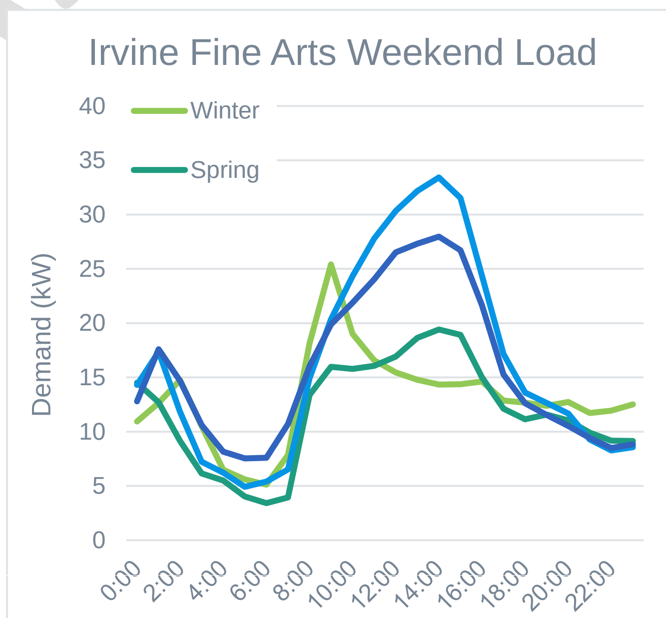
The Irvine Fine Arts Center provides art classes, open studio programs, events, and exhibitions for all ages in fully equipped art studios. Irvine Fine Arts Center is open from 10am-9pm Monday-Thursday, 10am-5pm Fridays, 9am-5pm Saturdays, and closed on Sundays.

Table A-38. DER Analysis at Irvine Fine Arts Center

Existing Facility Information	
Address	14321 Yale Ave
Rate Tariff	TOU-GS-2-E
Square Footage	17,662
Annual Electricity Consumption (kWh)	164,617
Average Annual Electricity Bill	$34,123
Annual Gas Consumption (Therms)	10,067
Annual Gas Bill	$8,946
Energy Usage Intensity	90.33
EUI Building Type	Performing Arts
National Average EUI (kBtu/ft²)	112.0
Comparison to National Average	**-19%**

Demand at the Center runs from 6am-9pm year-round, indicating there may be energy efficiency opportunities by adjusting HVAC schedules or installing lighting timers to better align with the Center's operating hours. The Center also experiences a spike in demand from midnight-3am year-round; CSE recommends investigating what is causing this unusual spike in demand. Since the largest demand at the Center occurs in the daytime, installing solar PV could be an effective way to offset daytime load.





OSF and Animal Care

Due to the proximity of these sites, an NEM aggregate or microgrid model should be considered for the OSF and Animal Care Center. Note that the future EV charging service at the OSF could also be included in this system.

Table A-39. Summary of Solar and Storage Recommendations at the OSF/Animal Care Center Site

Recommended Solar and Storage System	OSF	Animal Care	EV Charging	Total
Total Installed Solar	274kW-DC	23kW-DC	173kW-DC	**470kW-DC**
Additional Battery Energy Storage System	25kW, 70kWh	13kW, 79kWh	24kW, 143kWh	**62kW, 292kWh**
Net Present Value (25-year estimate)	$47,481	$10,041	$50,637	**$108,159**
Annual Power Bill savings	$152,177	$8,201	$45,122	**$205,500**
Simple Payback	9.75 years	9.82 years	9.15 years	**9.57 years**
Solar needed to offset 100% electricity usage	411kW-DC	160kW-DC	175kW-DC	**746kW-DC**

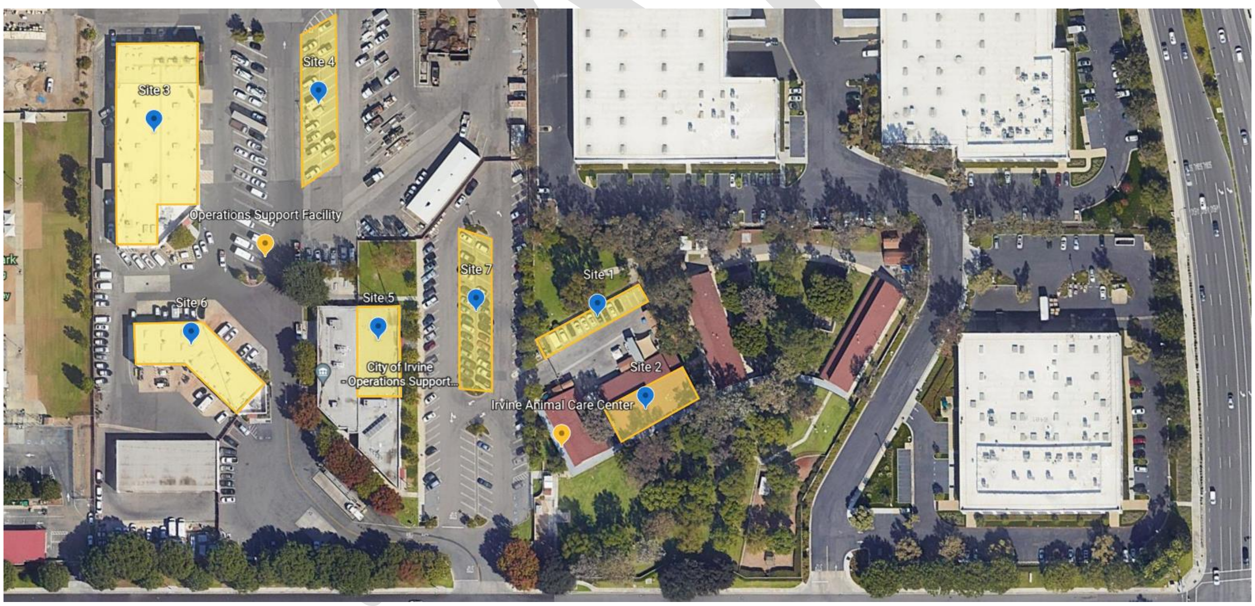


Figure A-44. Solar PV Siting at OSF and Animal Care Center

Table A-40. Potential Solar Sizing at OSF and Animal Care Center Sites

Site #	PV Installation Type	Area (Sq. ft.)	Estimated System Size (kW-DC)
1	Carport	2,872	40
2	Roof	4,583	63
3	Roof	21,573	300

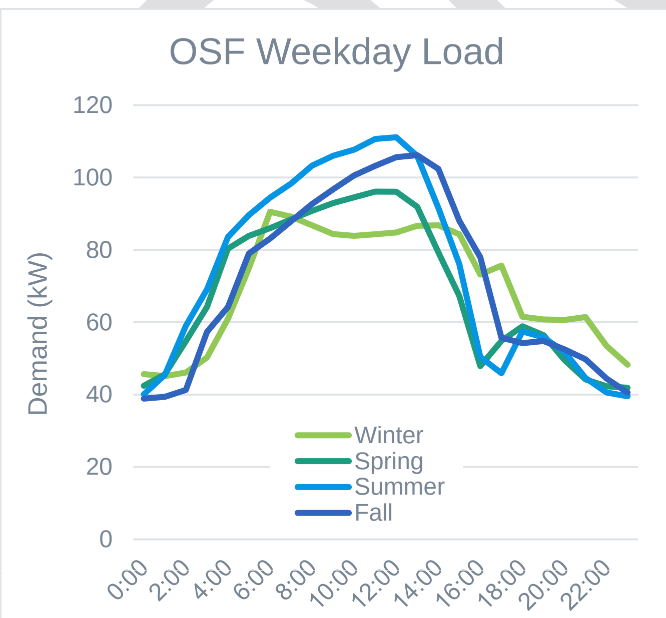
Site #	PV Installation Type	Area (Sq. ft.)	Estimated System Size (kW-DC)
4	Carport	7,069	98
5	Roof	6,606	92
6	Roof	7,865	109
7	Carport	7,216	100

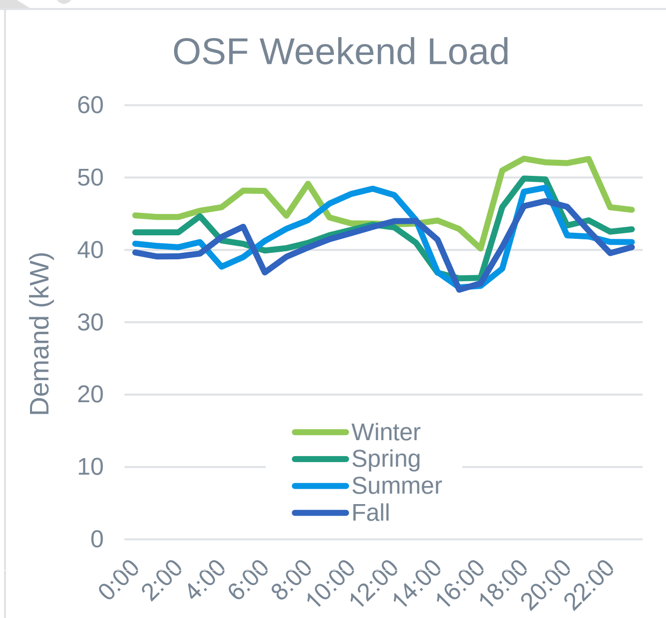
Operation Support Facility (OSF)

The City of Irvine Operational Support Facility houses the Department of Public Works and a provides fueling and fleet maintenance for City and public vehicles. The OSF will serve as a hub for electric vehicle charging. The OSF does not have published hours but according to the historical energy audit, maintains hours from 7am-5pm Monday-Thursday, 7am-4pm Fridays, and is closed on weekends.

Table A-41. DER Analysis at OSF

Existing Facility Information	
Address	6427 Oak Canyon
Existing Generator	520kW
Rate Tariff	TOU-GS-2-D
Square Footage	21,877
Annual Electricity Consumption (kWh)	553,661
Average Annual Electricity Bill	$81,004
Annual Gas Consumption (Therms)	2,047
Annual Gas Bill	$2,243
Energy Usage Intensity	108.08
EUI Building Type	Office





National Average EUI (kBtu/ft²)	116.4
Comparison to National Average	-7%

Load at the OSF begins to pick up between 1-3am year-round, indicating that the suggestion in the historical Audit to update the heating and cooling schedules was likely not acted upon. The OSF maintains an average weekend load of 43kW, accounting for 20% of the facilities energy consumption. This load is also maintained overnight on weekdays. The biggest impact to energy efficiency will be achieved by addressing this year-round baseload (68% of total energy consumption). Since the largest demand at the Center occurs in the daytime, installing solar PV could be an effective way to offset daytime load.

Table A-42. OSF Existing Energy Audits (2015)

Recommendations
1. Update the heating and cooling schedules to run from 7:00am to 5:00pm.
2. Change the unoccupied temperature setpoints to 55°F for heating and 85°F cooling
3. Replace all exterior lighting with LED. Exterior lighting accounts for 24% of building energy consumption

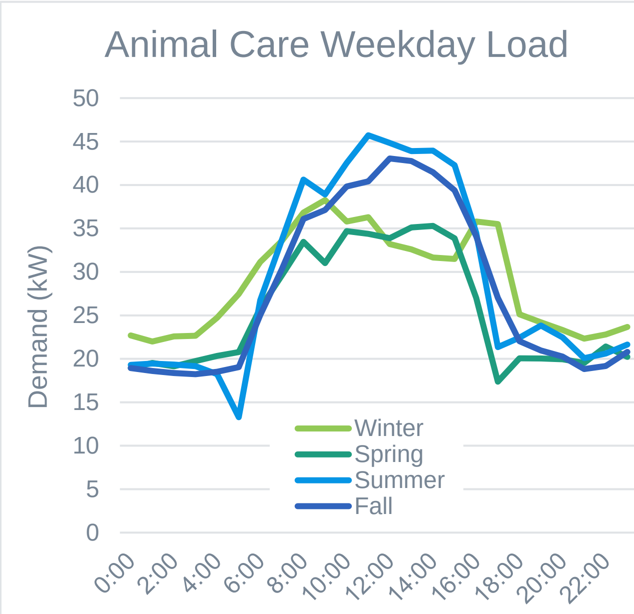
Animal Care Center

The Irvine Animal Care Center provides sheltering, care, and enrichment for homeless, neglected, abused, or unwanted animals. Services include licensing for Irvine residents, pet adoptions, and events.

Table A-43. DER Analysis at Animal Care Center

Existing Facility Information	
Address	6443 Oak Canyon
Rate Tariff	TOU-GS-2-E
Square Footage	4,995
Annual Electricity Consumption (kWh)	240,791
Average Annual Electricity Bill	$40,425
Annual Gas Consumption (Therms)	13,298
Annual Gas Bill	$11,812
Energy Usage Intensity	434.64
EUI Building Type	Veterinary Office
National Average EUI (kBtu/ft²)	145.8
Comparison to National Average	+198%

The Animal Care Center has published operating hours of noon-6pm on weekdays, and 10am-4pm on weekends, though it has round-the-clock operation caring for and housing animals. The Center maintains a consistent load year-round, with demand beginning around 5am and dropping off at 5pm. The historical energy audit offers a variety of suggestions for ways to decrease the load from day-to-day operations at the Center, and CSE suggest following up with these items to verify that they have been implemented. Since most of the demand occurs in the daytime, installing solar PV could be an effective way to offset daytime load.



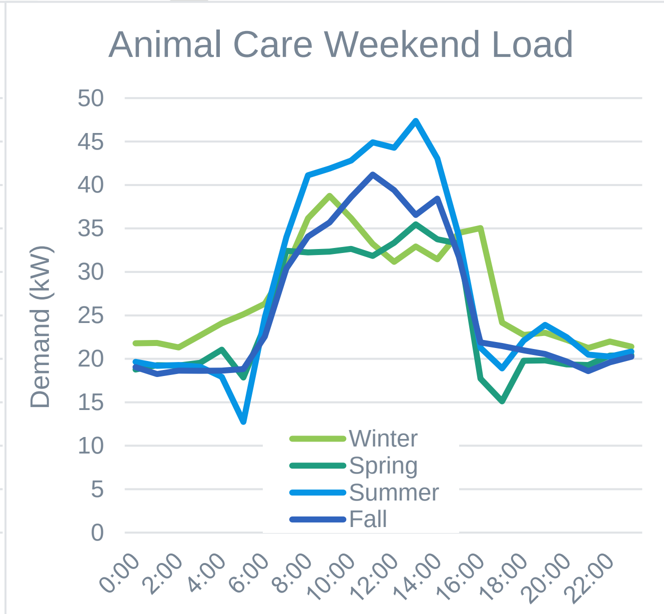


Table A-44. Animal Care Center Existing Energy Audit by AESC (2013)

	Recommendations
1.	Install reduced wattage lighting, reduce the number of lamps, and install lighting reflector kits in the Administration Building, Small Animal Intake, and dog kennels
2.	Install interior lighting occupancy sensors in each of the Animal Care Center buildings
3.	Upgrade the HVAC in the Admin and Small Animal Intake by installing Indirect Evaporative Cooling and repairing the existing economizer.
4.	Adjust Thermostat Setpoints in the Admin and Small Animal Intake: 68°F-74°F when occupied and 64°F-78°F when unoccupied
5.	Remove the 85-gallon electric water heater and replace it with the 75-gallon unit being removed from the dog kennel
6.	Install a new control system to manage the furnace, exhaust fans, and automatic windows in the dog kennels
7.	Install tankless gas water heater in the eastern dog kennel

Civic Center and ICDC

Due to the proximity of these sites, an NEM aggregate or microgrid model should be considered for the Irvine Civic Center and Irvine Child Development Center (ICDC).

Table A-45. Summary of Solar and Storage Recommendations at the Civic Center and ICDC Site

Recommended Solar and Storage System	Irvine Civic Center	ICDC	Total
Total Installed Solar	124kW-DC	11kW-DC	**135kW**
Additional Battery Energy Storage System	68kW, 200kWh	8kW, 42kWh	**76kW, 242kWh**
Net Present Value (25-year estimate)	$57,266	$5,535	**$62,801**
Annual Power Bill savings	$37,819	$4,161	**$41,980**
Simple Payback	8.3 years	9.62 years	**8.96 years**
Solar needed to offset 100% electricity usage	2,294kW-DC	59kW-DC	**2,353kW-DC**

Figure A-47. Solar PV Siting at Civic Center and ICDC Site

Table A-46. Potential PV Sizing at Civic Center and ICDC Sites

Site #	PV Installation Type	Area (Sq. ft.)	Estimated System Size (kW-DC)
1	Carport	51860	929
2	Roof	20680	287

Irvine Civic Center

Irvine Civic Center encompasses Irvine City Hall and the Irvine Police Department. City Hall has limited space available for public reservations, including a Conference and Training Center, Lobby, Council Chamber, two meeting rooms, an outdoor piazza, and lawn.

Table A-47. DER Analysis at Civic Center

Existing Facility Information	
Address	1 Civic Center Plaza
Existing Generator	750kW
Rate Tariff	TOU-8-D
Square Footage	130,997
Annual Electricity Consumption (kWh)	3,274,178
Average Annual Electricity Bill	$438,378
Annual Gas Consumption (Therms)	31,854
Annual Gas Bill	$36,554
Energy Usage Intensity	79.64
EUI Building Type	Office
National Average EUI (kBtu/ft²)	116.4
Comparison to National Average	**-32%**

The Civic Center's operating hours are 4-9pm Monday-Thursday, and 8am-5pm on Fridays, though those are just the hours the Center is open to the public. During the weekday, the daytime load runs from about 3am-7pm. On weekends, the Civic Center maintains a baseload of around 300kW year-round. This weekend load represents over 20% of the Civic Center's electricity consumption at a time when we would expect the Civic Center to be largely unoccupied. CSE recommends investigating the weekend load for energy efficiency opportunities, such as automatically powering down IT equipment during non-operating hours.

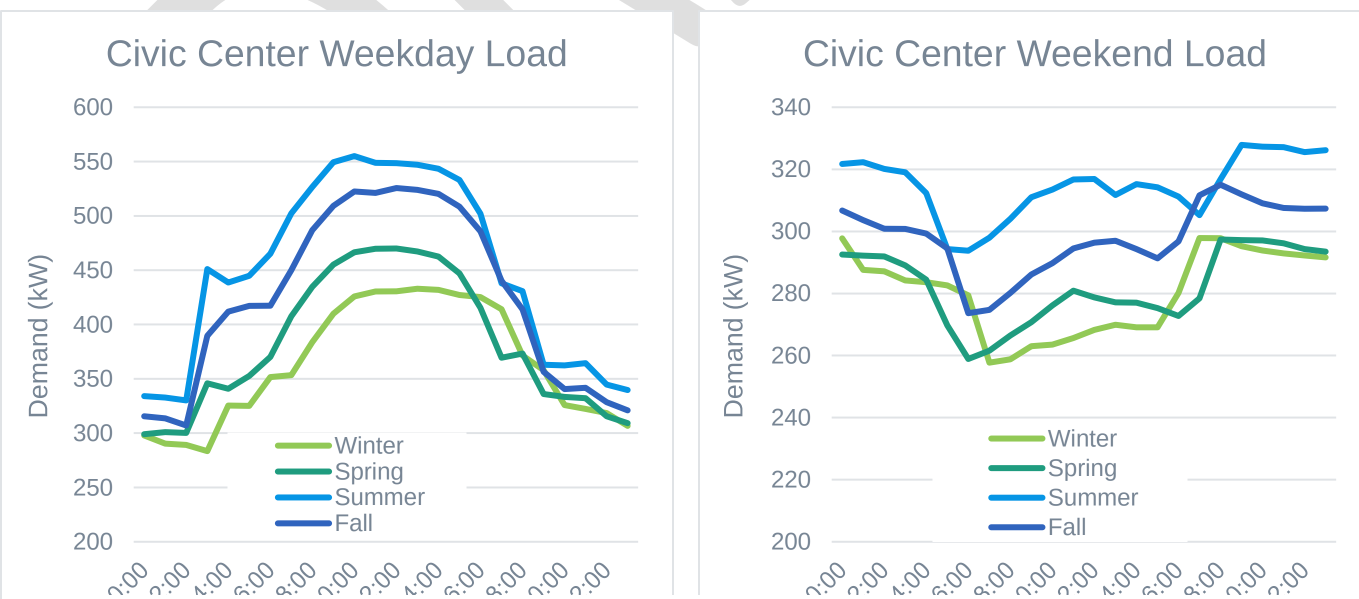


Figure A-48. Load Profiles at Civic Center

The Civic Center was also screened for Combined Heat and Power (CHP) but did not show a favorable outcome.

Table A-48. Civic Center Existing Energy Audit Results (2015)

Recommendations
1. Program the building management system to compare inside/outside enthalpy to optimize HVAC start and stop times. Stagger the startup routine to prevent the AHUs from starting at the same time and creating a large peak demand
2. Recommends 85°F nighttime or unoccupied cooling setpoint
3. Recommends 55°F unoccupied heating setpoint
4. Implement various plug load management strategies. Install plug load controllers to power off equipment in standby mode. Verify that IT equipment has Energy Star features such as automatic sleep or shut off modes activated. Assign employees to manually power down equipment at the end of each workday
5. Upgrade the exterior high-pressure sodium (HPS) light fixtures to LED

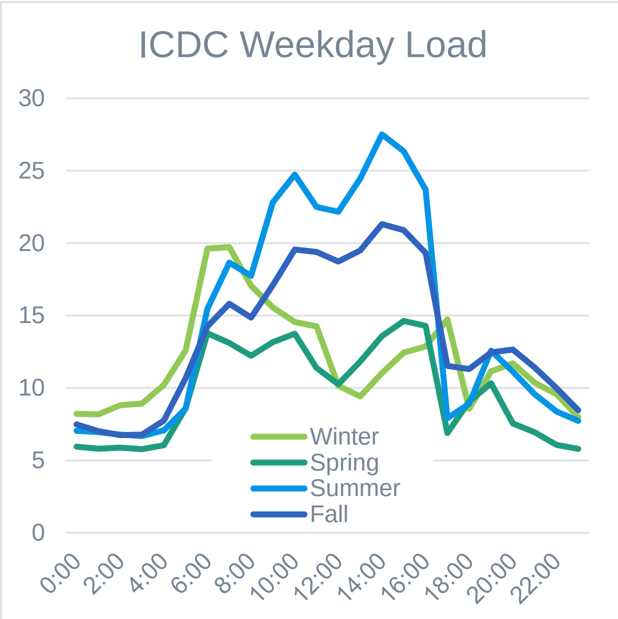
Irvine Child Development Center (ICDC)

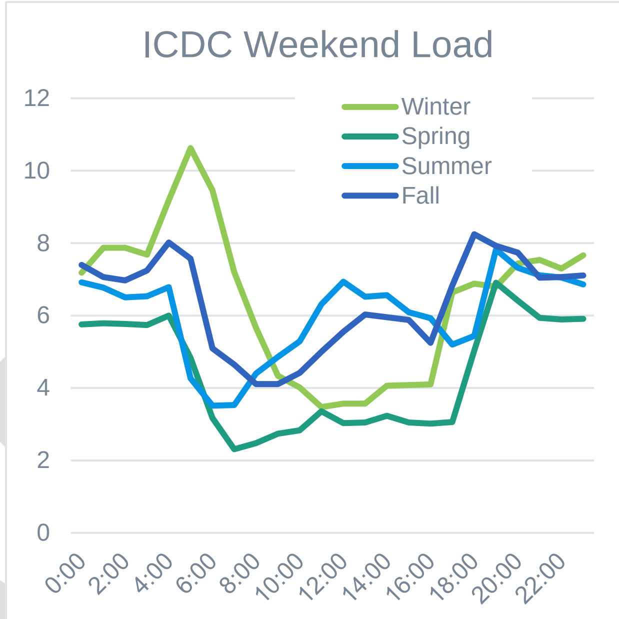
Established in 1988, the Irvine Child Development center is a daycare and learning facility for infants through preschool. Preschool classes range in size from 12-22 children.

Table A-49. DER Analysis at Irvine Child Development Center (ICDC)

Existing Facility Information	
Address	2 Civic Center Plaza
Rate Tariff	TOU-GS-2-E
Square Footage	11,108
Annual Electricity Consumption (kWh)	91,516
Average Annual Electricity Bill	$19,918
Annual Gas Consumption (Therms)	491
Annual Gas Bill	$700
Energy Usage Intensity	32.53
EUI Building Type	Pre-school / Day Care
National Average EUI (kBtu/ft^2)	131.5
Comparison to National Average	**-75%**

The ICDC operates from 6:30am-6PM on weekdays and is closed on weekends. The load profile at the Center closely matches these operating hours, drawing significantly less energy on the weekends. The use of air-conditioning in the summer increases weekday energy consumption by 24% and increases the daily peak demand from 20kW to 29kW. Since the largest demand at the Center occurs in the daytime, installing solar PV could be an effective way to offset daytime load. Despite being closed on weekends, the center maintains an average 6kW load, accounting for 16% of electricity consumption at the center.





Appendix B – Community Park ICA Analysis

Table B-1. Cypress Community Park ICA

Distribution Segment	Solar PV Capacity (MW)	Added Load Capacity (MW)
1	0	0

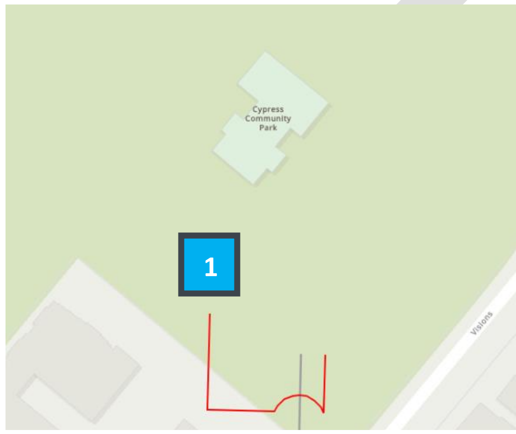


Figure B-1. Cypress Community Park ICA

Table B-2. Woodbury Park ICA

Distribution Segment	Solar PV Capacity (MW)	Added Load Capacity (MW)
1	0	0
2	0	0
3	0	0

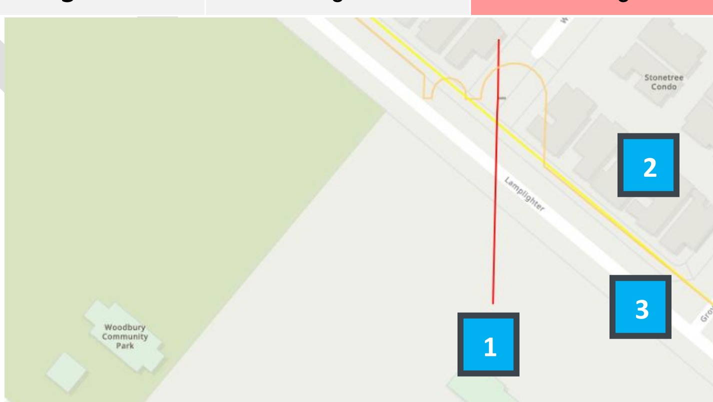


Table B-3. Heritage Park ICA

Distribution Segment	Solar PV Capacity (MW)	Added Load Capacity (MW)
1	0	1.21
2	0	1.35
3	0	1.6
4	0	1.6

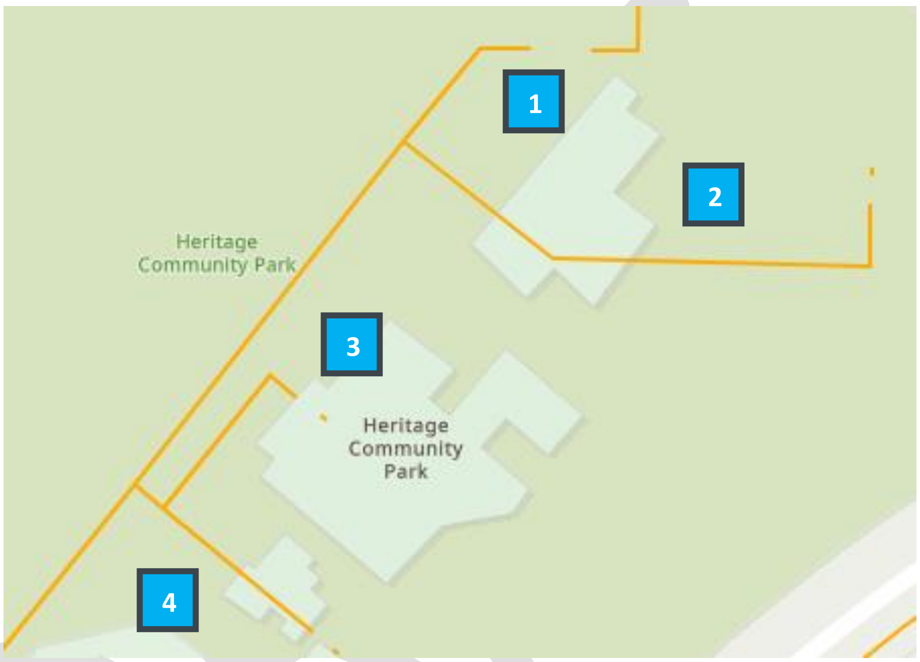


Table B-4. Turtle Rock ICA

Distribution Segment	Solar PV Capacity (MW)	Added Load Capacity (MW)
1	0	3.49
2	0	3.54

Figure B-4. Turtle Rock ICA

Table B-5. Portola ICA

Distribution Segment	Solar PV Capacity (MW)	Added Load Capacity (MW)
1	0	0

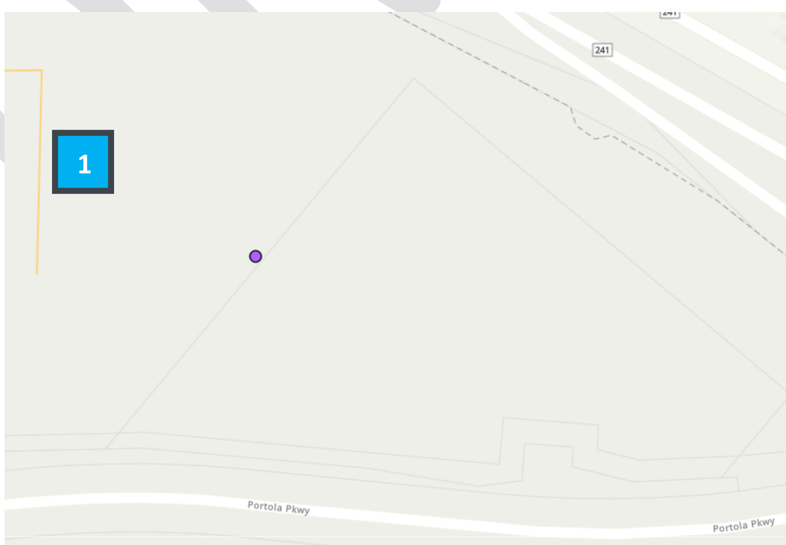


Table B-6. University ICA

Distribution Segment	Solar PV Capacity (MW)	Added Load Capacity (MW)
1	0	1.53

Appendix C - DER Siting for Top Community Consumers

UC Irvine

UC Irvine was the largest consumer of both electricity and natural gas in the City. The existing 4.2 MW of solar PV on campus was included in the analysis. In addition, there is also a 19,560kW combined cycle Combined Heat and Power (CHP) system with battery storage (not included in this analysis). The analysis suggested a 3,743kW-DC solar system and a 309kW/780 kWh battery storage system, with a simple payback of 7.85 years. UC Irvine has a goal of carbon neutrality by 2025, and this includes a goal to provide 100% clean electricity for all facilities. UCI is already planning a second phase of carport solar.

South facing rooftops are generally the first choice for solar, however, carport solar is becoming increasingly popular. Trenching and upgrading electric infrastructure in parking lots creates an additional opportunity for the installation of Electric Vehicle Supply Equipment. Many customers enjoy the shade provided to parked vehicles throughout the day.

Table C-1. DER Analysis at UC Irvine

Recommended Solar and Storage System	
Existing Solar PV	4.2MW-DC
Additional Solar PV	3,743MW-DC
Additional Battery Energy Storage System	309kW, 780kWh
Net Present Value (25-year estimate)	$2,183,018
Annual Power Bill savings	$914,380
Simple Payback	7.85 years
Solar needed to offset 100% electricity usage	6,079kW-DC

Figure C-1. Solar PV Siting at UC Irvine

Table C-2. Potential Solar PV Sizing at UC Irvine Sites

Site #	Type	Area (Sq. ft.)	System Size (kW-DC)
1	Carport	94,000	1,318
2	Carport	41,000	580
3	Carport	68,000	958
4	Carport	63,000	887

OC Irvine Hospital Campus

The OC Irvine Hospital Campus has an existing carport solar system estimated to be 2MW. The existing solar was taken into consideration when doing the optimal financial payback analysis. For potential solar sites, solar carports were chosen as the hospital had very limited roof space. The analysis suggested an additional 2,111-kW-DC solar system and a 175kW/381kWh battery storage system, with a simple payback of 8.25 years.

Table C-3. DER Analysis at OC Irvine Hospital Campus

Recommended Solar and Storage System	
Total Installed Solar	4,111kW-DC (2,111kW-DC New)
Additional Battery Energy Storage System	175kW, 381kWh
Net Present Value (25-year estimate)	$990,417
Annual Power Bill savings	$488,872
Simple Payback	8.25 years

Solar needed to offset 100% electricity usage	13,752kW-DC

Figure C-2. Solar PV Siting at OC Irvine Hospital Campus

Table C-4. Potential Solar PV Sizing at OC Irvine Hospital Sites

Site #	Type	Area (Sq. ft.)	System Size (kW-DC)
1	Carport	34,000	475
2	Carport	70,000	980
3	Carport	47,000	656

Park Place Tower (Park Place I)

Park Place Tower was the third highest consumer of energy in Irvine and consists of eight buildings spread across a campus. Due to the amount of open roof space, rooftop solar was selected for most of the sites with carports on top of three parking structures and a parking lot at the north of the site. The optimal financial analysis suggested a 4,879kW-DC solar system and a 384kW/669kWh battery storage system, with a simple payback of 8.4 years.

Table C-5. DER Analysis at Park Place Tower

Recommended Solar and Storage System	
Total Installed Solar	4,879kW-DC

Additional Battery Energy Storage System	384kW, 669kWh
Net Present Value (25-year estimate)	$2,095,283
Annual Power Bill savings	$1,101,990
Simple Payback	8.4 years
Solar needed to offset 100% electricity usage	10,428kW-DC

Figure C-3. Solar PV Siting at Park Place Tower

Table C-6. Potential Solar PV Sizing at Park Place Tower Sites

Site #	Type	Area (Sq. ft.)	System Size (kW-DC)
1	Carport	70,564.08	983.70
2	Carport	51,292.92	715.00
3	Rooftop	40,855.72	569.50
4	Rooftop	34,066.16	474.90
5	Rooftop	39,080.32	544.80
6	Rooftop	40,511.40	564.70
7	Rooftop	43,362.80	604.50
8	Rooftop	43,222.92	602.60
9	Carport	54,779.16	763.60
10	Carport	51,766.36	721.60

Center Pointe Apartments

Center Pointe Apartments was the fourth highest energy consumer, and due to no open spaces, such as parking, rooftop solar was the only available option for solar. The optimal financial analysis suggested a 761kW-DC solar system and a 68kW/194kWh battery storage system, with a simple payback of 8.79 years.

Table C-7. DER Analysis at Center Pointe Apartments

Recommended Solar and Storage System	
Total Installed Solar	761kW-DC
Additional Battery Energy Storage System	68kW, 194kWh
Net Present Value (25-year estimate)	$249,372
Annual Power Bill savings	$167,029
Simple Payback	8.79 years
Solar needed to offset 100% electricity usage	2,453kW-DC

Figure C-4. Solar PV Siting at Center Pointe Apartments

Table C-8. Potential Solar PV Sizing at Center Pointe Sites

Site #	Type	Area (Sq. ft.)	System Size (kW-DC)
1	Rooftop	18,830.00	210.00
2	Rooftop	15,376.04	171.44
3	Rooftop	16,290.64	181.68
4	Rooftop	17,786.28	198.32

36311 – Irvine Distribution Center

The site is a non-refrigerated warehouse/distribution center. Due to a large amount of unobstructed roof space, rooftop solar was chosen for two of the buildings onsite, in addition to a small parking lot to the top right of the site that was also deemed as a good site for a carport solar system. The optimal financial analysis suggested an 8,531kW-DC solar system and a 707kW/1,692kWh battery storage system, with a simple payback of 8.87 years.

Table C-9. DER Analysis at Irvine Distribution Center

Recommended Solar and Storage System	
Total Installed Solar	8,531kW-DC
Additional Battery Energy Storage System	707kW, 1,692kWh
Net Present Value (25-year estimate)	$2,650,274
Annual Power Bill savings	$1,839,024
Simple Payback	8.87 years
Solar needed to offset 100% electricity usage	8,531kW-DC

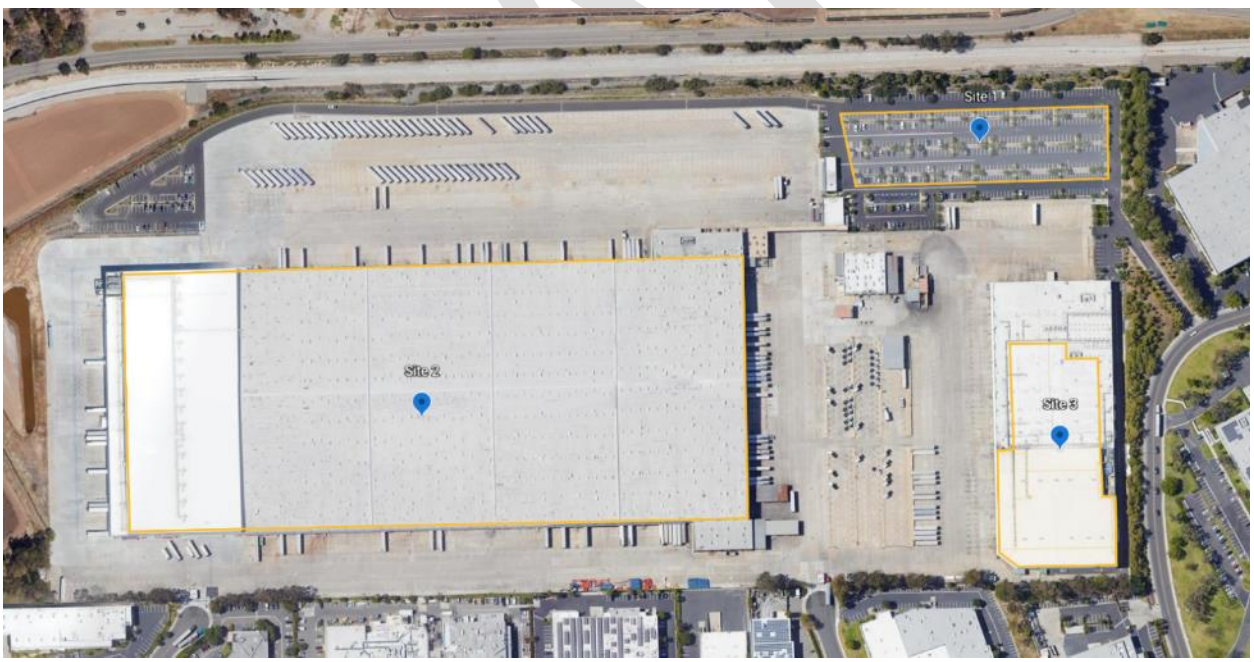


Figure C-5. Solar PV Siting at Irvine Distribution Center

Table C-10. Potential Solar PV Sizing at Irvine Distribution Center Sites

Site #	Type	Area (Sq. ft.)	System Size (kW-DC)

1	Carport	121,000	1,680
2	Rooftop	878,000	12,000
3	Rooftop	122,000	1,700

Hotel Irvine

Hotel Irvine is the sixth highest energy consumer. Due to a limited amount of roof top space, two solar carport systems were selected as possible solar system sites, and one small roof top system was chosen. The optimal financial analysis suggested a 1,016kW-DC solar system and a 100kW/204kWh battery storage system, with a simple payback of 8.79 years.

Table C-11. DER Analysis at Hotel Irvine

Recommended Solar and Storage System	
Total Installed Solar	1,016kW-DC
Additional Battery Energy Storage System	100kW, 204kWh
Net Present Value (25-year estimate)	$334,877
Annual Power Bill savings	$222,176
Simple Payback	8.79 years
Solar needed to offset 100% electricity usage	3,807kW-DC

Figure C-6. Solar PV Siting at Hotel Irvine

Table C-12. Potential Solar PV Sizing at Hotel Irvine Sites

Site #	Type	Area (Sq. ft.)	System Size (kW-DC)
1	Carport	30,000	416
2	Carport	28,000	400
3	Rooftop	18,000	200

Park Place Apartments

Park Place Apartments, a large multifamily complex, was the seventh highest consumer. The site is located across the street from two of the other highest consumers - Park Place Tower, and the Royce Apartments. Due to the large amount of open roof space, rooftop solar makes up the majority of the potential solar sites, with only a single carport site at the top left of the complex. The optimal financial analysis suggested a 1,947kW-DC solar system and an 81kW/226kWh battery storage system, with a simple payback of 9.18 years.

Table C-13. DER Analysis at Park Place Apartments

Recommended Solar and Storage System	
Total Installed Solar	1,947kW-DC
Additional Battery Energy Storage System	81kW, 226kWh
Net Present Value (25-year estimate)	$489,691
Annual Power Bill savings	$397,429
Simple Payback	9.18 years
Solar needed to offset 100% electricity usage	2,190kW-DC

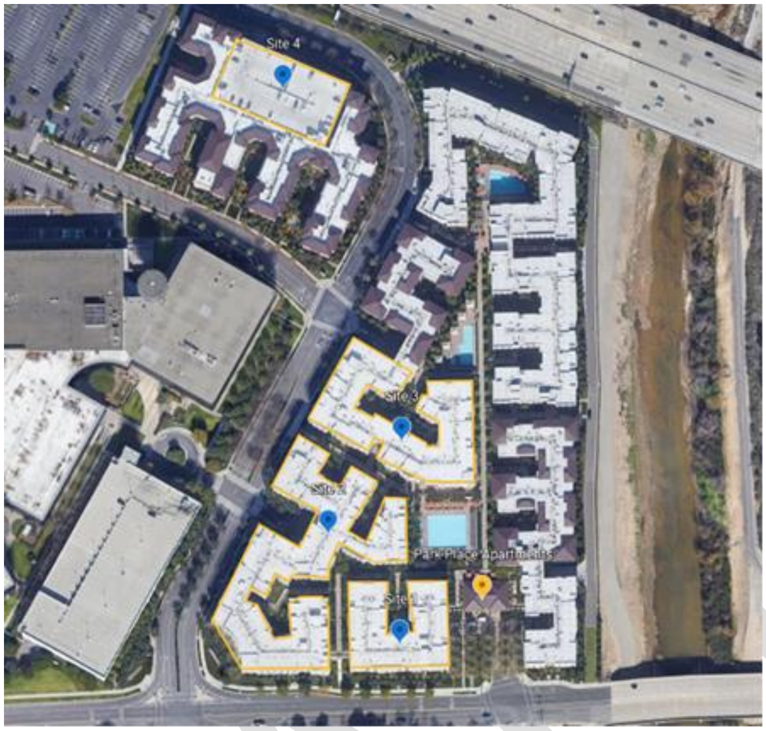


Figure C-7. Solar PV Siting at Park Place Apartments

Table C-14. Potential Solar PV Sizing at Park Place Apartments

Site #	Type	Area (Sq. ft.)	System Size (kW-DC)
1	Rooftop	27,072.16	302.00
2	Rooftop	67,863.32	756.80
3	Rooftop	42,017.80	468.56
4	Carport	30,074.20	419.20

1 & 3 Glen Bell Way

1 & 3 Glen Bell Way is the 8th highest energy consumer. The site has a large parking structure and two office buildings. Due to limited roof space, only carports were selected as a potential site for solar. The optimal financial analysis suggested a 1,640kW-DC solar system and a 247kW/511kWh battery storage system, with a simple payback of 8.13 years.

Table C-15. DER Analysis at 1 & 3 Glen Bell Way

Recommended Solar and Storage System	
Total Installed Solar	1,640kW-DC
Additional Battery Energy Storage System	247kW, 511kWh

Net Present Value (25-year estimate)	$828,143
Annual Power Bill savings	$399,953
Simple Payback	8.13 years
Solar needed to offset 100% electricity usage	3,922kW-DC

Figure C-8. Solar PV Siting at 1 & 3 Glen Bell Way

Table C-16. Potential Solar PV Sizing at 1 & 3 Glen Bell Way Sites

Site #	Type	Area (Sq. ft.)	System Size (kW-DC)
1	Carport	63,000	879
2	Carport	54,000	760

The Royce Apartments

The Royce Apartment Complex is the ninth highest energy consumer and is a large multifamily complex. It is located next to two other top consumers - Park Place Tower and Park Place Apartments. Due to the absence of any onsite parking lots, only rooftop solar systems were selected for potential sites. The optimal financial analysis suggested a 1,140kW-DC solar system and a 54kW/169kWh battery storage system, with a simple payback of 9.13 years.

Table C-17. DER Analysis at Royce Apartments

Recommended Solar and Storage System	
Total Installed Solar	1,140kW-DC
Additional Battery Energy Storage System	54kW, 169kWh

Net Present Value (25-year estimate)	$295,346
Annual Power Bill savings	$235,181
Simple Payback	9.13 years
Solar needed to offset 100% electricity usage	1,630kW-DC

Figure C-9. Solar PV Siting at Royce Apartments

Table C-18. Potential Solar PV Sizing at Royce Apartment Sites

Site #	Type	Area (Sq. ft.)	System Size (kW-DC)
1	Rooftop	39,370.84	439.12
2	Rooftop	28,029.80	312.56
3	Rooftop	34,754.80	387.60

Irvine Marriott

The Irvine Marriott is the tenth highest consumer of energy. Due to having ample amounts of both roof and ground space, both rooftop and carport were selected as potential solar sites. The optimal financial analysis suggested a 1,134kW-DC solar system and a 69kW/147kWh battery storage system, with a simple payback of 8.86 years.

Table C-19. DER Analysis at Irvine Marriott

Recommended Solar and Storage System	
Total Installed Solar	1,134kW
Additional Battery Energy Storage System	69kW, 147kWh
Net Present Value (25-year estimate)	$357,873
Annual Power Bill savings	$241,039
Simple Payback	8.86 years
Solar needed to offset 100% electricity usage	2,532kW-DC

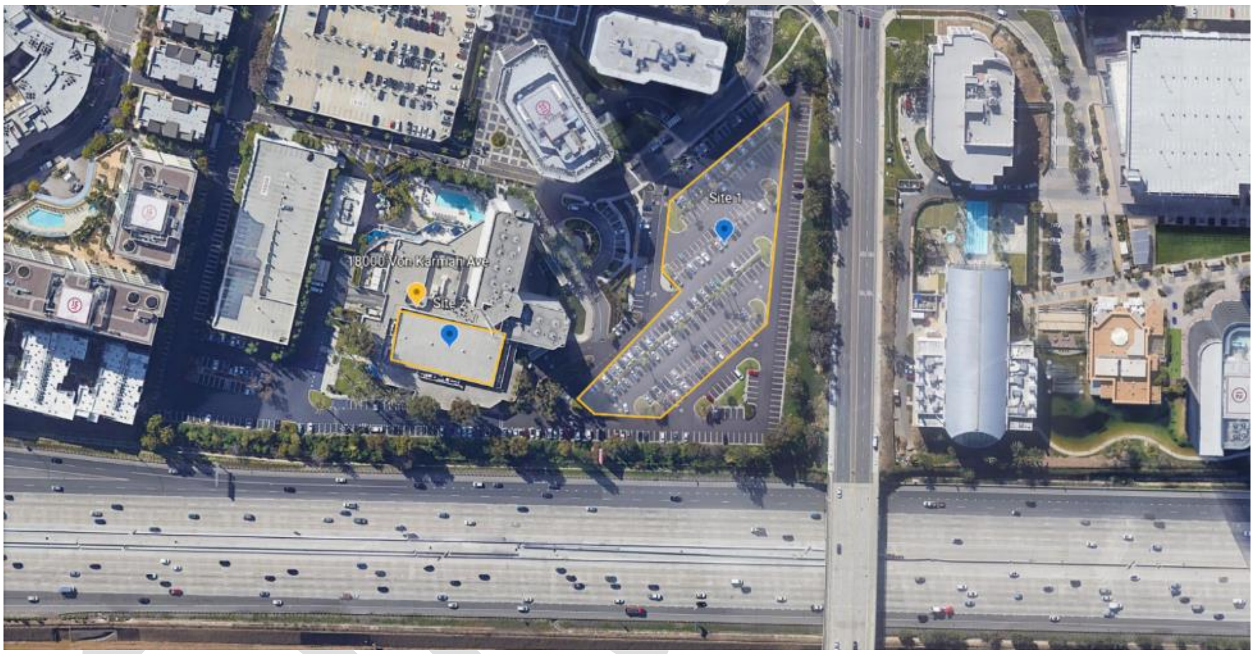


Figure C-10. Solar PV Siting at Irvine Marriott

Table C-20. Potential Solar PV Sizing at Irvine Marriott

Site #	Type	Area (Sq. ft.)	System Size (kW-DC)
1	Carport	66,000	927
2	Rooftop	14,800	207

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