East Bay
Regional Park District

EAST BAY REGIONAL PARK DISTRICT

Strategic Energy Plan

Final Report

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Newcomb|Anderson|McCormick
ENERGY ENGINEERING AND CONSULTING

PREFACE

This report was produced by Newcomb Anderson McCormick for the East Bay Regional Park District, headquartered in Oakland California.

Valuable assistance and direction was provided for this project by Jeff Rasmussen, Tonya Covarrubias, Steve Myli, and Dave Collins of the East Bay Regional Park District.

The project manager at Newcomb Anderson McCormick was Mike Anderson. Other engineers who assisted in this project include Michael Sontag, Ryan Sit, Kyle Manahan, Karen Lee, Dominic Molinari, Shira Zingman-Daniels and Simon Olivieri.

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SECTION 1:

EXECUTIVE SUMMARY

The East Bay Regional Park District (EBRPD) operates 65 regional parks, recreation areas, wilderness, shorelines, preserves and land bank areas in Alameda and Contra Costa Counties. These encompass over 114,000 acres, 1,200 miles of trails, 235 campsites, 3,700 picnic tables, two golf courses and four indoor rental facilities.

The EBPRD Board of Directors has created a Vision for the District:

> *The East Bay Regional Park District will preserve a priceless heritage of natural and cultural resources open space, parks and trails for the future and will set aside park areas for enjoyment and healthful recreation for generations to come. An environmental ethic guides us in all that we do.*

In keeping with the environmental ethic the District is creating a Strategic Energy Plan as a roadmap for future energy decisions. This plan shows how the District can significantly improve its energy efficiency, generate much of its needed energy on site, reduce its energy costs, and significantly reduce its greenhouse gas (GHG) emissions.

The energy efficiency projects identified in this report address the lighting, space heating, pumping and hot water systems operated by the District. Opportunities to improve control of these systems through occupancy sensors and programming are also included. In addition, the plan identifies opportunities to offset a significant portion of the remaining District electric load by generating electricity from photovoltaic systems, where it is recommended to install a large system in Shadow Cliffs Park. This combination of energy efficiency and renewable generation measures can significantly reduce the carbon footprint of the District.

The District currently spends $808,784 per year on electricity, natural gas and propane. The greenhouse gas emissions associated with this energy use are 1,156 tCO_2e/year. For an investment of approximately $8.4 million, the District could reduce its annual energy bill to $177,708, achieving cost savings of 78% within a simple payback period of 13.4 years. In addition, the District would reduce GHG emissions by 771 tCO_2e/year.

SECTION 2:
OVERVIEW

The Strategic Energy Plan quantifies the energy use of the park facilities and lays out steps to reduce energy use through investments in energy efficiency. The plan also shows how the District can generate a large part of its electricity use to further minimize its carbon footprint. These goals can be accomplished through an investment with a reasonable rate of economic return. This makes the Strategic Energy Plan a winning path for the District to pursue.

2.1 HISTORIC ENERGY PURCHASES

The District energy purchases for 2012 are listed in Table 2-1.

Table 2-1: Historical energy purchases for EBRPD owned buildings (2012)

Energy Source	Annual Energy Purchase		Annual Energy Cost		Source Energy Intensity (kBtu/sf-yr)[1]		GHG Emissions ($tCO2e$)[2]	
Electricity	3,863,668	kWh	$676,557	84%	49	84%	723	63%
Natural Gas	47,172	therm	$42,090	5%	6	10%	250	22%
Propane	31,977	gallon	$89,537	11%	3	6%	183	16%
Total			$808,184		58		1,156	

The total building area of the EBRPD facilities is approximately 850,000 square feet. The annual energy cost is $0.95 per square foot. The annual electricity use is 4.5 kWh/per square foot. Compared to the typical commercial building use of 10 to 20 kWh/sf-yr, the level of electric use intensity is fairly low for these facilities.

The combined natural gas and propane use at the District facilities is 0.055 th/sf-yr. Compared to the typical commercial building use of 1 to 2 th/sf-yr, the level of heating use in these facilities is also fairly low.

In addition, the District currently generates 97,500 kWh per year at the District Headquarters building through an existing photovoltaic system, making the total combined electricity use for all District buildings 3,966,000 kWh per year.

2.2 THE POTENTIAL FOR EFFICIENCY PROJECTS

Energy audits were conducted to identify energy efficiency opportunities that will reduce energy use while

[1] Conversion factor to source energy: electricity – 10,716 Btu/kWh; natural gas – 100,000 Btu/therm; propane – 92500 Btu/gallon

[2] GHG Emission factors: electricity – 0.000187 tC02e/kWh; natural gas – 0.00531 tCO2e/therm; propane – 0.00572 tCO2e/gallon

maintaining or improving the operation of District facilities. The following projects are recommended for implementation as the first step to achieve the District's goals. These efficiency projects will result in an overall reduction in the District energy bills of 18%. Table 2-2 below includes only those facilities where the District pays for utility services, and does not include projects in buildings where concessionaires currently pay their own energy bills. Concessionaire building projects are identified and listed separately in Section 5.

Table 2-2: EBRPD Efficiency Projects

Measure	Annual Electricity Savings (kWh)	Annual Natural Gas Savings (therms)	Annual Propane Savings (gallons)	Annual Monetary Savings	Construction Cost	Simple Payback Period (yr)
L1	29,200	-	-	$ 5,324	$ 78,181	14.7
L2	18,022	-	-	$ 3,296	$ 18,294	5.6
L3	845	-	-	$ 145	$ 6,273	43.1
L4	1,480	-	-	$ 247	$ 4,193	17.0
L9	27,047	-	-	$ 5,387	$ 3,092	0.6
L10	3,900	-	-	$ 760	$ 2,605	3.4
L12	92,055	-	-	$ 17,826	$ 261,905	14.7
S1	42,806	-	-	$ 7,847	$ 55,492	7.1
T1	10,686	342	650	$ 4,011	$ 8,683	2.2
T2	587	-	2,030	$ 5,787	$ 12,023	2.1
D1	31,073	-	2,834	$ 13,138	$ 79,509	6.1
P1	287,664	-	-	$ 50,992	$ 250,470	4.9
Extrapolation	26,892	-	935	$ 7,316	$ 50,033	6.8
Headquarters	271,043	2,826	-	$ 42,589	$ 232,220	5.5
Total	**843,301**	**3,168**	**6,449**	**$ 164,664**	**$ 1,062,973**	**6.5**

The savings and costs for these projects were generated based on equipment surveys and energy balances for the main facilities which the District operates. However, not all of the sites were inspected, and the Extrapolation row in the table above represents the anticipated magnitude of the projects if they were extended to include the uninspected buildings.

The Headquarters building, which is the largest individual energy user at the District, is currently being audited by kW Engineering through a California Energy Commission contract. The results listed here for that building are the results of that audit. Further details related to energy efficiency measures for the Headquarters building can be found in that report.

2.3 THE POTENTIAL FOR RENEWABLE PROJECTS

The potential for generation of renewable energy was also evaluated at District facilities. The most economical source of renewable energy available to the District is photovoltaic power. The District could install one PV system with a capacity of about 1.96 MW to offset the electrical loads of up to 50 meters that are at other locations through a relatively new utility program referred to as RES-BCT. A potential site for this photovoltaic system is the parking lot in Shadow Cliffs Park where parking shade structures could be installed to support the photovoltaic modules. Table 2-3 shows the economics of this system.

Table 2-3: EBRPD Renewable Energy Projects

Park Name	System Size (kW)	Production (kWh)	Construction Cost	25 Yr Revenue	25 Yr Costs	25 Yr Net Benefit	Lifecycle Payback
RES-BCT (Shadow Cliffs)	1,960	2,993,612	$5,390,000	$14,711,486	$7,071,294	$7,640,192	13 years

2.4 IMPLEMENTATION OF EFFICIENCY AND RENEWABLE PROJECTS

The combined economics for implementing both the energy efficiency projects and the renewable energy projects are shown in the following table.

Table 2-4: Combined efficiency and renewable project economics

	EBRPD Construction Costs	Gen Req (15%)	O&P (10%)	Contingency (20%)	O&M Costs ($0.25/W)	Performance Guarantee ($0.07/W)	Construction Management	NAM Costs	Environmental Clearance Cost (5%)	Total Cost
Efficiency Measures	$584,635	$159,446	$106,297	$212,595	N/A	N/A	$53,000	$35,000	$53,149	$1,204,122
Solar Installations	$5,390,000	included	included	included	$627,794	$137,200	$500,000	$337,800	$269,500	$7,262,294
Grand Total	**$5,974,635**	**$159,446**	**$106,297**	**$212,595**	**$627,794**	**$137,200**	**$553,000**	**$372,800**	**$322,649**	**$8,466,416**

Energy consultants will be hired as owner's representative to provide implementation engineering support in the next phase.

It is projected that the implementation of these efficiency and renewable energy projects would reduce the District's energy bill by 78%. Energy efficiency projects will likely be built by both in-house electricians and individual small contracts.

Table 2-5: Summary of energy and GHG emission savings

Energy Source	Historical Annual Energy Purchase		Annual Energy Purchase Savings		GHG Emissions Savings (tC02e)
Electricity	3,863,668	kwh	3,836,913	kwh	718
Natural Gas	47,172	therm	3,168	therm	17
Propane	31,977	gallon	6,449	gallon	37
Total					771

Note that one gallon of propane is the equivalent to 0.91 therms of natural gas.

SECTION 3:

EBRPD FACILITIES

The District currently operates 65 regional parks and facilities in Alameda and Contra Costa counties. A map showing the location of each park is shown below in Figure 3-1.

Figure 3-1: Map of East Bay Regional Parks and Facilities

Energy use in the parks is concentrated around the structures in each park. There are 599 structures in the District, with a total building area of 851,053 square feet. The energy audit inspected 83% of this building area. Projects were extrapolated for the remaining building areas that were not inspected.

Note that the energy audit of the largest building, the District Headquarters, is being conducted by kW Engineering through the Energy Partnership Program of the California Energy Commission. The complete energy audit report is not available at the time of the writing of this Draft Final Report, but preliminary energy and cost savings have been included.

The majority of the energy usage at District facilities is due to interior lighting systems. The buildings also use energy for space heating and cooling, as well as domestic hot water heating. A relatively small portion of the District energy use is for exterior and parking lot lighting, as the park facilities tend to be shut down at sunset.

The interior lighting at most District facilities is fluorescent, typically controlled by manual switching. Fluorescent lighting is a very efficient source. Lamps and ballasts that are somewhat more efficient are typically recommended. In some areas incandescent lighting is currently used, which is less efficient than fluorescent. These areas include historic fixtures, such as at Ardenwood Historic Farm and museum displays. These lend themselves to LED lamps which are becoming available in a wide variety of shapes and sizes. Controlling interior lighting to switch off when no one is present is recommended for all interior lighting systems.

Exterior lights typically have HID sources, either high pressure sodium (HPS/yellowish light) or metal halide (MH/white light). These are both relatively efficient light sources, although the low quality of color rendition from HPS makes it a less desirable source.

The other major energy using systems at District facilities are pumping systems, comprising approximately half of the District's energy load. Pumps circulate water in some swimming lagoons and pools. Other pumps supply water, irrigate lawns or remove waste water from more remote parks. Swimming facilities pumps currently run at 24/7 when facilities are open for the season, and there exists an opportunity to use variable frequency drives (VFDs) to tune down pump speed at night, or when the facilities are not in use. Irrigation pumps are run on programmed schedules, and wastewater pumps typically cycle based on float valves in septic/holding tanks.

HVAC Systems tend to be residential sized units, and are interspersed throughout the park offices and event facilities. These systems use a variety of fuel types throughout the park depending on location. Most HVAC systems are controlled with programmable thermostats that are, on average, programmed efficiently. Occasionally units are controlled with manual thermostats switches. Some warehouse or shop locations have large ceiling-mounted gas space heaters that, in some cases, use expensive propane gas to heat large areas. Many facilities also contain window air conditioning units or portable electric space heaters. The majority of propane usage in the District serves HVAC loads.

Most parks contain domestic water heaters to provide hot water for sinks and staff showers, and occasionally public showers. Most water heaters are storage tank water heaters, with several newer instantaneous water heaters throughout the parks system. Many storage water heaters use propane or resistance heating as fuel sources. The remainder of propane usage in the District serves these domestic hot water loads.

Each of the buildings administered by the District is identified by a unique Structure Number. All buildings are referred to by their Structure Number in this report. Every effort was made throughout the auditing process to work with Tonya Covarrubias to correctly identify the location of each structure and determine which utility meter serves which structures. This has been documented in a database and used to determine the correlation between facility size and historical energy use.

The energy audit evaluated the energy use breakdown for each of the purchased utilities. The figures below show the relative magnitude of the major energy loads at the District.

Figure 3-2: Baseline and post-implementation electricity loads

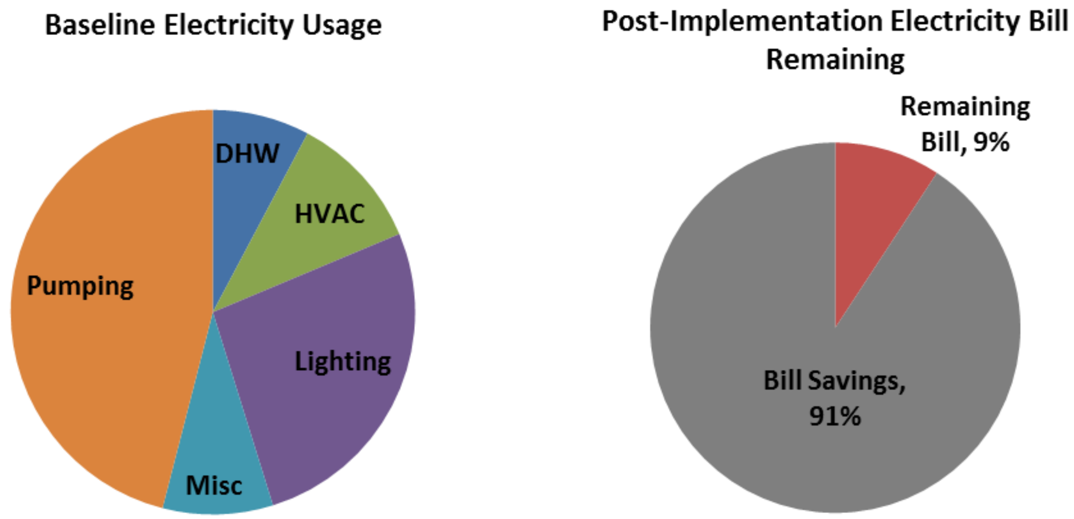


Figure 3-3: Baseline and post-implementation natural gas use

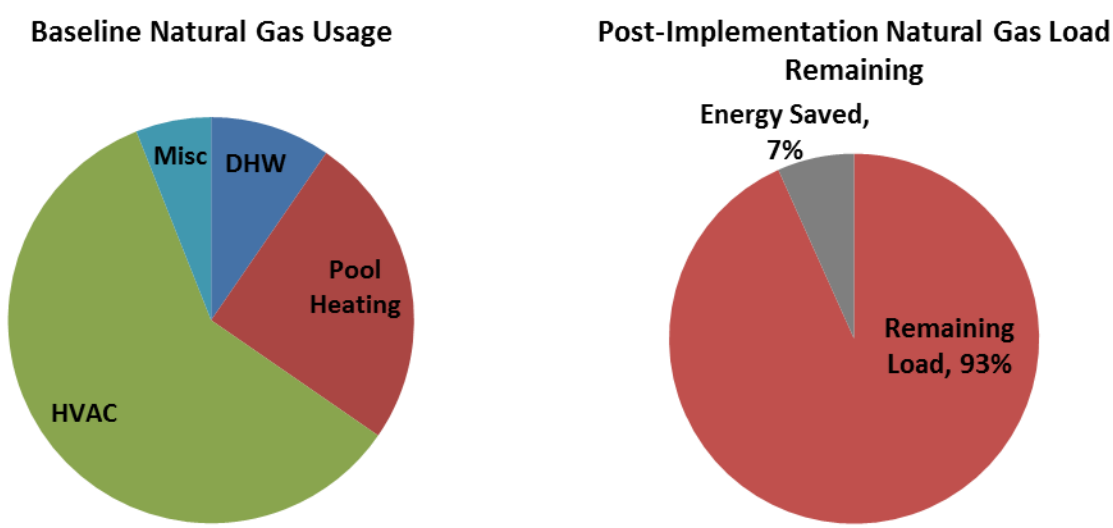
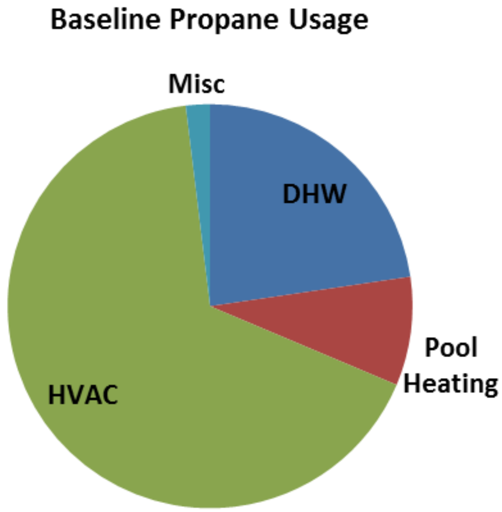
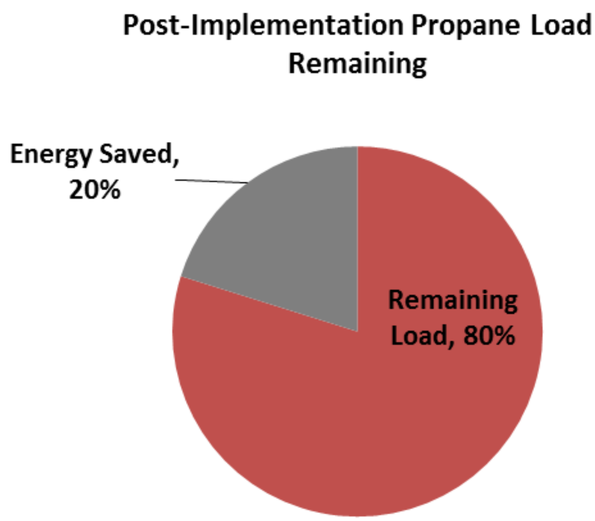


Figure 3-4: Baseline and post-implementation propane use





SECTION 4:

HISTORICAL ENERGY USE

The majority of the electricity and all of the natural gas purchased by the District is provided by PG&E. Sites in the City of Alameda purchase electricity from the Alameda municipal utility. The reported energy use in this report is a total of all of the utility bills that are paid by the District.

While the District owns all of the facilities in the parks, some of the energy use is paid for directly by concessionaires that operates particular facilities. In these cases the District does not have access to the associated energy bills, and the facilities' use is not included in the energy totals in this report. In other cases the District pays the utility bill and charges a negotiated amount to the concessionaire to more or less offset the energy cost. These utility bills are included in the total use reported here.

Energy efficiency projects are recommended for the concessionaire operated buildings because the buildings are owned by the District. In cases where the concessionaire pays the PG&E bills directly, it is the concessionaire that will benefit from energy cost savings.

There are also caretaker houses at several of the parks. The utility bills for these are paid for directly by the residents and are not included in the energy totals in this report.

4.1 ELECTRICITY

The annual electricity purchases by the District are shown in the following table. The 599 structures are served by 142 electric meters. The electric meters are primarily served by PG&E with the exception of Crown Beach, which is served by Alameda Power. The PG&E meters which serve these facilities are typically on A-1, A-6, and A-10 rate schedules. These accounts are typically split between Time of Use (TOU) and non-TOU versions of these rate schedules.

Table 4-1: Historical electricity use

Energy Source	Annual Energy Purchase (kWh)	Annual Energy Cost	Price Per Unit ($/kWh)	Number of Meters
Electricity	3,863,668	$676,557	$0.18	142

The twelve electric meters with the largest loads are listed in the following table. The Main Office, or District Headquarters, is the largest individual electric purchaser. Note that it has a PV system which generates 97,500 kWh per year, resulting in total annual electricity use of 778,620 kWh per year. Other large electric meters serve large pumping loads (Contra Loma, Coyote Hills, Cull Canyon, Don Castro, and Del Valle).

Table 4-2: Electric meters with largest loads

Park Name	Meter	Annual kWh Usage	% of Total
Main Office	01180R	681,120	18%
Contra Loma Regional Park	1003143286	439,400	12%
Lake Chabot	56R420	435,000	12%
Coyote Hills	1009487811	195,528	5%
Cull Canyon Regional Park	1006626032	174,195	5%
Don Castro	1003869697	167,930	5%
Pacheco Corp Yard	1009481326	145,931	4%
Roberts Park	0712R2	97,000	3%
Del Valle	03919R	96,494	3%
Lake Chabot	9961T5	93,120	2%
Del Valle	1006908991	86,480	2%
Tilden Park	9794T4	75,040	2%

Projects which save electric energy are evaluated in this report at the average electric purchase rate of $0.18 per kWh. This includes the effect of a demand charge on some of the larger meters.

4.2 NATURAL GAS

The annual natural gas purchases by the District are shown in the following table. The 599 structures are served by 20 gas meters. The natural gas meters are served by PG&E. The natural gas meters are typically on GNR-1 rate schedules. The average natural gas price of $ 0.89 is used to evaluate natural gas saving projects.

Table 4-3: Historical natural gas use

Energy Source	Annual Energy Purchase (therms)	Annual Energy Cost	Price per Unit ($/therm)
Natural Gas	47,172	$42,090	$0.89

The ten natural gas meters with the largest loads are listed in the following chart. The District Headquarters is the largest natural gas user, as well as the largest electricity user.

Table 4-4: Natural gas meters with largest loads

Park Name	Meter	Annual th Usage	% of Total
Main Office	45826198	13,270	28%
Roberts Park	46286592	12,176	26%
Pacheco Corp Yard	51383992	8,780	19%

Tilden Park	711703C	3,823	8%
Redwood Regional Park	33113993	2,258	5%
Temescal	52265103	1,773	4%
Big Break	61193577	1,238	3%
Temescal	3904108X	1,179	3%
Alvarado/Wildcat Canyon	28336924	649	1%
Ardenwood	35663925	618	1%

4.3 PROPANE

Propane is used at a number of District facilities which are located in areas where natural gas service is not available. The propane services are provided by Suburban Propane. Note that propane records come from records of tank deliveries, not monthly read meters—this leads to potentially inaccurate annual loads, as tank deliveries are not necessarily scheduled regularly. Propane is purchased in units of gallons as displayed below. For reference, 1 gallon of propane is equivalent to .91 therms.

Table 4-5: Historical propane use

Energy Source	Annual Energy Purchase (gallon)	Annual Energy Cost	Price per Unit ($/gallon)
Propane	31,977	$89,537	$2.80

The ten propane accounts with the largest annual use are listed in the following table. Lake Chabot represents over one third of the propane use in the District.

Table 4-6: Largest propane charges

Park Name	2012 Propane Charges	% Of Total
Lake Chabot	$33,566.74	37%
Coyote Hills	$10,472.06	12%
Del Valle	$8,646.21	10%
Tilden Park	$7,932.40	9%
Redwood Regional Park	$5,050.59	6%
Diablo Foothills	$4,911.71	5%
Las Trampas	$3,138.27	4%
Pleasanton Ridge	$2,972.58	3%
Sunol/Ohlone Wilderness	$2,005.26	2%
Anthony Chabot	$1,977.03	2%

4.4 RELATIVE ENERGY COSTS

Space heating and domestic hot water heating are provided throughout the District by different energy sources and a variety of equipment. This section identifies the relative cost of the different alternatives that are in use or are available for use.

Table 4-7: Relative energy costs

Heat Source	Energy Cost	Conversion	Effective Cost per Therm
Natural Gas	$0.89 / therm	75%	$1.19
Electric Heat Pump	$0.18 / kWh	COP = 2.5	$2.23
Propane	$3.08 / therm	75%	$4.11
Electric Resistance	$0.18 / kWh	100%	$5.57

Natural gas is typically used in furnaces, boilers or hot water heaters. It is the lowest cost source of heat. Natural gas, however, is not available at a number of the District facilities so a different source of heat is often required. A conversion efficiency of 75% is shown as typical for combustion losses and some standby losses. In cases where the load is small, for example a domestic hot water heater serving sinks or a shower that is rarely used, the conversion efficiency may be much worse.

Electricity is used for heating at some facilities. Electric resistance heating is the most expensive source of heating and should be avoided whenever possible. Electric resistance space heaters are sometimes built into the wall. In some instances, portable electric resistance heaters may be used to provide comfort at a facility with inadequate heating capacity. Electric resistance domestic hot water heaters were also observed occasionally.

Electric space heating and domestic hot water heating can be made much more efficient with the use of heat pumps. Heat pumps are available for both space heating (from window units, to package units, to ground source heat pumps) and for domestic hot water heating (relatively new technology). A heat pump space heater operates by moving heat from the outside of the building to the inside. A heat pump water heater operates by moving heat from the building or garage area into the water tank.

Propane heating is somewhat less expensive than electric resistance heating, but significantly more expensive than heat pump heating. Whenever the thermal loads are significant, (i.e., more significant than an occasional shower), heat pump systems are more cost-effective than propane. This assumes that the electrical capacity is available in the building to power the heat pump.

Note that occasionally natural gas, propane, and electrical resistance are used for radiant heating in vehicle service bays, high bays, or other non-enclosed applications. This involves a high temperature source radiating heat directly to people in a specific area which is often open to the outside. In these conditions it is not possible to keep the person warm by heating the air around them because warm air cannot be contained. Radiant heating in these applications is more efficient than conventional furnaces which heat the air. Heat pumps do not operate at these high temperatures and are not an acceptable solution for radiant heating applications.

SECTION 5:
ENERGY EFFICIENCY PROJECTS

5.1 LINEAR FLUORESCENT LIGHTING PROJECTS

5.1.1 L1 – Replace 32W T8 Lamps with 28W T8 Lamps

This measure involves the replacement of 32W T8 fluorescent lighting with more efficient, newer generation 28W T8 lamps.

Ownership	Measure	Electric Savings (kWh/yr)	Economic Savings ($/yr)	Post-Rebate Measure Cost ($)	Net Simple Payback (yr)
EBRPD	L1	29,200	5,323.78	78,181.47	14.7
Concession		3,881	787.55	12,396.33	15.7

28W T8 lamps are a more efficient lighting source than 32W T8s and provide comparable levels and quality of light. It is additionally recommended that ballasts are upgraded to programmed rapid start ballasts where they are not already in place, to better accommodate the proposed occupancy sensors. To allow for a conservative estimate, both the costs of the lamps and the ballasts were factored into the total project cost for this measure.

Within the District, replacement T8s are often purchased by park staff at local hardware stores. It is recommended that the District procure T8s in bulk and store and distribute them throughout the parks. T8s purchased in bulk from commercial suppliers are higher quality lamps, and often times much cheaper when purchased in bulk. These higher quality lamps will produce better light and last longer, saving the organization money on replacements.

LED technology is starting to be applied in settings that have typically been dominated by linear fluorescents. Currently no LED tube exists to directly replace a linear fluorescent bulb in an effective manner, but there are LED solutions that replace an entire linear fluorescent fixture and have similar outside dimensions. These LED solutions include troffers and drop-lighting fixtures, and can produce very high quality light. LED fixtures can also be integrated into automatic controls more seamlessly than linear fluorescents. LED technology is developing rapidly for this setting, so costs and fixture wattages are difficult to predict, but current costs tend to be much higher than a T8 retrofit, as the entire fixture will have to be replaced to install LED lighting. With the current $/watt of LED fixtures, it may not make sense to replace a functioning T8 fixture. However, if an entire fixture is being replaced or brand new fixtures are installed, the incremental savings of an LED fixture likely justify the incremental costs of upgrading to LED fixtures.

5.1.2 L2 – Replace T12 Fixtures with 28W T8 Lamps

This measure involves the replacement of 34W T12 fluorescent lighting with more efficient, newer generation 28W T8 lamps.

Ownership	Measure	Electric Savings (kWh/yr)	Economic Savings ($/yr)	Post-Rebate Measure Cost ($)	Net Simple Payback (yr)
EBRPD	L2	18,022	3,295.85	18,294.03	5.6
Concession		9,832	1,836.97	9,433.32	5.1

T12 fluorescent lighting was found interspersed throughout the District, in small amounts. It is clear that the District realizes the obsolescence of T12 lighting and the organization appears to be making strides in replacing T12s. The remaining T12s should be replaced with efficient T8 fixtures (new lamps and ballasts) in high use areas. Many T12s are currently found in unused areas such as supply closets or mechanical rooms. As the lamps are rarely used, a lighting retrofit will not pay for itself over a reasonable number of years. For low use areas, it is recommended that they be retrofit with T8 lamps upon burnout.

5.1.3 L3, L4 – Replace 8' Linear Fluorescents with 4' 28W T8 Lamps

This measure involves the replacement of 8' linear fluorescent lighting with more efficient, 4' T8 lamps.

Ownership	Measure	Measure Description	Electric Savings (kWh/yr)	Economic Savings ($/yr)	Post-Rebate Measure Cost ($)	Net Simple Payback (yr)
EBRPD	L3	Replace 8' T8s with 2x4'T8s	845	145.48	6,272.69	43.1
Concession			-	-	-	-

Ownership	Measure	Measure Description	Electric Savings (kWh/yr)	Economic Savings ($/yr)	Post-Rebate Measure Cost ($)	Net Simple Payback (yr)
EBRPD	L4	Replace 8' T12s with 2x4'T8s	1,480	247.27	4,193.46	17.0
Concession			1,800	353.42	12,347.41	34.9

In some parks, especially in warehouse areas, there are 8' linear fluorescent lamps, which are inefficient and can be difficult to source. To help streamline lamp purchasing, it is recommended that 8' lamp fixtures be retrofit with fixtures that use 4' T8 lamps.

5.2 INCANDESCENT LIGHTING PROJECTS

5.2.1 L9 – Replace Incandescent Lighting with Efficient CFL Lighting

This measure involves the replacement of some incandescent lighting with CFLs.

Ownership	Measure	Electric Savings (kWh/yr)	Economic Savings ($/yr)	Post-Rebate Measure Cost ($)	Net Simple Payback (yr)
EBRPD	L9	27,047	5,386.65	3,091.87	0.6
Concession		23,148	4,661.72	4,328.22	0.9

As incandescent bulbs become more obsolete and more difficult to obtain, the District needs to consider replacing the remaining incandescent fixture with CFLs or LED lamps. CFLs provide a ready solution at a reasonable price, as currently recommended in this measure. LED lamps are still developing in technology, but quickly becoming economically viable. Compared to CFLs, LED lamps use approximately 50-80% of the energy that an equivalent CFL would use, but at a higher upfront cost. If the District can find a standard LED bulb that is has good light quality and a reasonable cost/lamp, it would be a more efficient and preferred lighting source. To help gauge the quality of new LED lamps in a rapidly developing market, the Design Lights Consortium (DLC) approves LED fixture for light quality and durability. It is recommended that any potential LED lamps be DLC-Approved.

5.2.2 L10 – Replace Incandescent Lighting with LED Lighting

This measure involves the replacement of some incandescent lighting with new LED options.

Ownership	Measure	Electric Savings (kWh/yr)	Economic Savings ($/yr)	Post-Rebate Measure Cost ($)	Net Simple Payback (yr)
EBRPD	L10	3,900	759.91	2,604.89	3.4
Concession		-	-	-	-

LED lighting can be a very effective replacement for some incandescent applications, such as halogen track lighting. LED lamps in a track light use about 20% of the power of halogen equivalents and can be used in existing track lighting fixtures. Some visitor centers throughout the District have already converted track lighting to LED, and have found that the LED light functions very well with displays and exhibits. It is recommended that the remaining halogen track lighting be replaced with LED track lights.

5.3 HID LIGHTING PROJECTS

5.3.1 L12 – Replace HID Lighting with LED Lighting

This measure involves the replacement of exterior and interior HID lighting with new LED options.

Ownership	Measure	Electric Savings (kWh/yr)	Economic Savings ($/yr)	Post-Rebate Measure Cost ($)	Net Simple Payback (yr)
EBRPD	L12	92,055	17,826.18	261,904.62	14.7
Concession		13,559	2,478.87	46,948.06	18.9

LED lighting is a developing market that allows for significant energy reduction in HID settings, while maintaining light quality. As LED lighting is still a developing technology, quality fixtures can be expensive, but they tend to pay for themselves over their lifetime as they last significantly longer than standard HID lighting (HPS, Metal Halide, etc.). LED light fixtures can often utilize existing light poles, just changing out the fixture head for a given application.

As an added benefit, exterior LED fixtures have an instantaneous start sequence which allows for bi-level lighting controls to be implemented fairly easily. Bi-level lighting controls are connected to occupancy sensors and reduce exterior lighting levels to minimum amounts, until the sensors are triggered. As many of the parks are in remote areas, where exterior lighting at night may go un-utilized, exterior lighting controls can further reduce the district wide lighting load.

In cases where LED lighting may seem too expensive, induction lamps are a viable alternative, as they have lower up-front costs, but do not operate quite as effectively.

5.4 CONTROLS PROJECTS

5.4.1 S1 – Install Lighting Occupancy Sensors

This measure involves the installation of lighting occupancy sensors to turn lights off when spaces are unoccupied.

Ownership	Measure	Electric Savings (kWh/yr)	Economic Savings ($/yr)	Post-Rebate Measure Cost ($)	Net Simple Payback (yr)
EBRPD	S1	42,806	7,846.82	55,492.43	7.1
Concession		10,148	2,043.93	14,599.14	7.1

Occupancy sensors are one of the most cost-effective technologies for reducing energy use in buildings. Installation of occupancy sensors complements lamp lighting retrofits to provide additional savings and eliminate wasted lighting energy.

5.5 HVAC PROJECTS

5.5.1 T1 – Install Programmable Thermostats

This measure involves the replacement of manual thermostats with programmable thermostats.

Ownership	Measure	Electric Savings (kWh/yr)	Natural Gas Savings (th/year)	Propane Savings (gal/year)	Economic Savings ($/yr)	Post-Rebate Measure Cost ($)	Net Simple Payback (yr)
EBRPD	T1	10,686	342	650	4,011.43	8,682.96	2.2
Concession		2,746	-	74	712.05	941.16	1.3

A majority of facilities visited controlled HVAC sources with programmable thermostats. On average these thermostats were programmed effectively, with reasonable setpoints and accurate schedules. Some facilities, however, still have manual thermostats the control furnaces or air conditioners. It is recommended that these sites retrofit these thermostats with simple programmable thermostats.

Programmable thermostats not only help reduce heating a cooling load during unoccupied hours, but they can also be used to pre-heat or pre-cool facilities for when staff or visitors arrive. It is often observed in locations with manual thermostats, that occupants will arrive on cold mornings, turn the heat up to the maximum level and leave the room without remembering to turn the heat back down. Programmable thermostats will help prevent this, and the District has proven an aptitude for programming thermostats effectively once installed.

5.5.2 T2 – Replace Propane Space Heaters with Radiant Heating

This measure involves the installation of radiant heaters in place of propane ceiling-mounted space heaters in garage settings.

Ownership	Measure	Electric Savings (kWh/yr)	Natural Gas Savings (th/year)	Propane Savings (gal/year)	Economic Savings ($/yr)	Post-Rebate Measure Cost ($)	Net Simple Payback (yr)
EBRPD	T2	587	-	2,030	5,786.66	12,022.56	2.1
Concession		-	-	-	-	-	-

Several parks contain warehouses and service yards with large gas space heaters ("unit heaters"). Space heaters that utilize propane gas can be costly to operate and ineffectively heat large spaces. It is recommended that these spaces be retrofit with propane ceiling-mounted radiant heating. These radiant heaters (sometimes called ceramic heaters) can provide focused heat on work stations, to more effectively warm occupants, without heating lofty open spaces.

It was noted during in-field inspections that some garages have large open-bay doors that are either left open or are needed to remain open due to the nature of the work being performed. On cold days with the doors open, hot air escapes from the garage, and can run up energy usage without occupants noticing. Since radiant heat doesn't rely on transferring heat by heating air, radiant heaters can continue to effectively and efficiently heat occupants even with doors open.

Furthermore, since radiant heat is felt more quickly upon start-up than convective heat, radiant heaters can be coupled with occupancy sensors to effectively keep occupants warm when present at work stations, and shut off when they leave.

5.6 DOMESTIC HOT WATER PROJECTS

5.6.1 D1 – Replace Storage Water Heaters with Heat Pump Water Heaters

This measure involves the replacement of inefficient domestic hot water heaters with heat pump water heaters.

Ownership	Measure	Electric Savings (kWh/yr)	Natural Gas Savings (th/year)	Propane Savings (gal/year)	Economic Savings ($/yr)	Post-Rebate Measure Cost ($)	Net Simple Payback (yr)
EBRPD	D1	31,073	-	2,834	13,137.66	79,508.80	6.1
Concession		(16,366)	-	3,422	6,622.27	34,075.20	5.1

Many parks throughout the District provide hot water for staff or park visitors, and typically utilize storage tank water heaters to do so. Some of these water heaters use propane heating or electric resistance heating which, as discussed earlier, can be expensive and inefficient sources of heat energy. It is recommended that higher use propane and electric water heaters be replaced with heat pump water heaters. New water heaters can be specified as similar capacity and thermal output as the heaters in place.

5.7 PUMPING PROJECTS

5.7.1 P1 – Install Variable Frequency Drives on Swim Facility Pumps

This measure involves the installation of VFDs on swimming facility circulation pumps.

Ownership	Measure	Electric Savings (kWh/yr)	Natural Gas Savings (th/year)	Propane Savings (gal/year)	Economic Savings ($/yr)	Post-Rebate Measure Cost ($)	Net Simple Payback (yr)
EBRPD	P1	287,664	-	-	50,992.15	250,470.00	4.9
Concession		14,909	-	-	2,609.11	20,872.50	8.0

Several parks host swimming pools or swimming lagoons with large circulation pumps that currently run at full speed, whenever the pool or lagoon contains water. At parks such as Contra Loma—which has a full lagoon throughout the off-season—this circulation pumping load accounts for a significant majority of the park's annual usage.

With advances in pumping controls, a full pumping load isn't necessary when the facilities aren't in use. Per California's Title 22, pools can reduce recirculation flow to as low as 65% when the pool is unoccupied. Scheduled pump speed will have to be tuned to each facility, but since pump input power scales exponentially with pump speed, even a reduction of 10-20% in pump speed can produce significant savings.

It is recommended that these pumps be outfitted with VFDs to scale back circulating pump speed when the facilities aren't in use (e.g. night, off-season, etc.). Not only will this cut back on energy usage, but this reduce load and wear on the circulation pumps, requiring less maintenance and extending their useful life.

Due to the high impact of this project, coupled with a smaller scope, it is recommended that this project be pursued earlier than most other proposed projects.

5.8 EXTRAPOLATING EFFICIENCY PROJECTS

To estimate additional potential costs and savings, the costs and savings from the audited parks were extrapolated to the 15 remaining parks with significant load and the District Headquarters

Measure	Electric Savings (kWh/yr)	Natural Gas Savings (th/year)	Propane Savings (gal/year)	Economic Savings ($/yr)	Post-Rebate Measure Cost ($)	Net Simple Payback (yr)
Remaining Parks	26,892	-	935	7,315.60	50,033.24	6.8
Headquarters	136,578	2,661	-	22,145.65	132,873.92	6.0

Based on observations from in-field audits, the 15 remaining parks are likely to have similar lighting, HVAC and domestic hot water heating as the majority of the audited parks. It is recommended that any lighting fixtures or equipment at these parks that are similar to those in the recommended measures be retrofit as well. These potential projects should be applied to equipment that is frequently used and not older equipment that is sitting dormant. Cost and savings estimates were calculated based on average savings and payback periods from the audited parks.

The projects recommended in the Executive Summary apply to the buildings where the District pays the energy bills, the majority of the buildings in the District. Projects were also evaluated for buildings where the concessionaires pay the energy bill, as listed separately in the tables in this report section. The following table is a summary of all projects recommended for buildings, independent of who pays the bills. Including the concessionaire buildings in the total project list increases the project cost by approximately 16%.

Table 5-1: Summary of efficiency measures for both EBRPD and Concessionaire owned-bills

Measure	Measure Description	Annual Electricity Savings (kWh)	Annual Natural Gas Savings (therms)	Annual Propane Savings (gallons)	Annual Monetary Savings	Construction Cost	Simple Payback Period (yr)
L1	Replace 32W T8's with 28W T8's	33,081	-	-	$6,111	$90,578	14.8
L2	Replace T12's with 28W T8's	27,854	-	-	$5,133	$27,727	5.4
L3	Replace 8' T8's with 2X 28W T8	845	-	-	$145	$6,273	43.1
L4	Replace 8' T12's with 2X 28W T8	3,280	-	-	$601	$16,541	27.5
L9	Replace Incandescent Lamps with CFL's	50,196	-	-	$10,048	$7,420	0.7
L10	Replace Incandescent Lamps with LED	3,900	-	-	$760	$2,605	3.4
L12	Replace HID Lighting with LED	105,614	-	-	$20,305	$308,853	15.2
S1	Install Lighting Occupancy Sensors	52,953	-	-	$9,891	$70,092	7.1

T1	Install Programmable Thermostats	13,433	342	724	$4,723	$9,624	2.0
T2	Replace Overhead Gas Heaters with Radiant Heating	587	-	2,030	$5,787	$12,023	2.1
D1	Replace Electric and Propane Water Heaters with Heat Pump Water Heating	14,707	-	6,256	$19,760	$113,584	5.7
P1	Install VFD's on Swim Facility Circulation Pumps	302,573	-	-	$53,601	$271,343	5.1
Extrapolation	Anticipated Costs and Savings	26,892	-	935	$7,316	$50,033	6.8
Headquarters	Anticipated Costs and Savings	271,043	2,826	-	$42,589	$232,220	5.5
Total		**906,958**	**3,168**	**9,944**	**$186,770**	**$1,218,915**	**6.5**

5.9 ADDITIONAL BEHAVIORAL CHANGES

During field-audits, it was also observed that there is room for energy savings through some behavioral changes in the District. In some parks, some refrigerators remained on even when empty, or contained a small amount of food items; often times these refrigerators were paired with a second, more often used refrigerator in a nearby room. A standard refrigerator uses between 500 and 1,000 kWh in a year, which translates to $100 to $200 annually in energy bills.

It was further noticed in seasonal facilities (e.g. Lifeguard offices), that some appliances and vending machines are left on during the winter months, when those facilities are not in use. Extra care should be taken in properly un-plugging electric loads during the off-season.

SECTION 6:
RENEWABLE ENERGY PROJECTS

Renewable energy projects can be used to generate the energy required to operate the facility following the implementation of energy efficiency retrofits. The most common type of renewable energy project for these types of facilities is the generation of electricity with photovoltaic (PV) modules and DC to AC inverters. PV projects will be discussed in detail in this section. Solar thermal projects are also discussed at the end of the section.

6.1.1 Photovoltaic Projects

It is anticipated that following the implementation of the efficiency projects identified above, the District facilities will still require a significant amounts of electricity. The best path to a low carbon footprint is to perform cost-effective energy efficiency measures and then meet a significant amount of the remaining electric load with self-generation, typically PV.

Historically the California Solar Initiative (CSI) has provided incentives for customers of PG&E to install PV systems. However, there are no incentives currently available, as all of the funds have been spent. In addition, the incentive levels were stepped down over previous years, and have not provided a significant amount of funding for several years. Fortunately, while the incentives are no longer available the price for PV modules has been consistently decreasing.

The installation of PV systems to offset most of the electricity used at a site often requires a significant area for the PV modules. These can be installed on the roof of the structure they are serving. However, this design was not pursued for this project because of the wide variation of roof conditions encountered in the review of the facilities. The roofs tend to be small, irregularly shaped, old and in uncertain condition, and often shaded.

It was determined that PV would be investigated only where it could be installed on new shade structures in parking lots. This avoids the issue of having to deal with unknowns when bidding out roof mounted systems. During the design process specific roofs could be identified as fit for PV installation. Installing PV on roofs is typically slightly cheaper than installing it on shade structures.

The District indicated that they preferred the use of PV parking shade structures to more general shade structures which might shade picnic tables or other areas. As a result, for the purposes of this report only parking area shade structures were investigated. During design other types of shade structures could also be investigated.

The parking shade structures are typically T shaped (covering two rows of parking from a central point) or L shaped (covering one row of parking), depending on the configuration of the lot. In determining what areas were available for parking shade structures, parking areas covered by mature trees were not included. Parking areas with small trees were included in the count. It is recommended that these parking lots be investigated further to confirm which trees can be removed. Placing PV systems in parking lots often means modifying the lighting on poles. However, since the parks close at sunset, most parking lots in the District do not have lighting.

6.1.2 Net Energy Metering

PV systems that tie into PG&E are allowed to utilize net metering to calculate the savings to the customer. This means that the PV system can be sized to offset all or most of the annual electric load, even though during peak sunlight hours electricity is likely to be flowing out of the meter to PG&E rather than into the meter. Net Energy Metering (NEM) not only allows power to flow from the customer to the grid, but allows the customer to be compensated for the electricity at their marginal cost of electricity. PV systems generate most of their power during the more expensive times of the year, peak and part peak hours during the summer. Since electricity is more expensive during these hours, the price the utility pays back to the customers during these hours is higher. This improves the economics of the PV system.

One approach to providing PV power to the District is to install a PV system at every meter and tie into that meter through Net Energy Metering. This would allow the electricity use at every site to be offset by generation at that site.

Note that PV systems are not typically designed to offset 100% of the energy used at a given meter. The typical target is to offset 90% of the electricity purchased after implementation of the efficiency projects. This 10% cushion makes up for the fact that the value of the electricity produced by the PV system (typically on or part peak) is higher than the average cost of electricity (which contains some cheaper off peak electricity). Once the PV has offset the purchase cost of the electricity, making more will not result in any extra income until the site becomes a net exporter of electricity.

As an example, a site may purchase 100,000 kWh per year of electricity at an average cost of $0.14 per kWh, for a total bill of $14,000. The PV system would be sized to produce 90,000 kWh of electricity, which at a higher value of $0.155 per kWh would offset all of the $14,000 bill. The site does not get compensated for any electricity it produces between 90,000 and 100,000 kWh. If it puts in a larger system than needed and produces more than 100,000 kWh/yr, it gets compensated for everything beyond 100,000 kWh at the lower rate of $0.035/kWh. As a result, it is recommended to install enough PV capacity to offset 90% of the site use after efficiency projects.

If the District pursues PV power using Net Energy Metering, it would mean a PV system tied to all but the smallest of the 142 electric meters. This requires PV systems that range from approximately 4 kW (a residential size) to 300 kW (typical for a small school). This approach is not recommended.

6.1.3 Net Energy Metering Aggregation (NEMA)

In the last few months PG&E has responded to state law by releasing a new tariff for Net Energy Metering Aggregation. This is a version of Net Energy Metering which may benefit the District. This tariff allows one customer to link up to 50 meters on the same or adjacent parcels to one generating meter with up to 1 MW of PV capacity installed. The generating meter can export enough power to offset the use of all of the other linked meters.

Many parks have multiple meters. Using Net Energy Metering an individual PV system would be installed and tied into every meter. Using Net Energy Metering Aggregate (NEMA), one larger PV system would be installed in the best location and tied into one electric meter. It would offset electricity use of all of the adjacent meters. This is a form of consolidation that will lower the price of the PV system without affecting the monetary savings available.

The cost of a large NEMA project for the District is conservatively projected to be $4.00 per Watt.

The installation of PV systems on one meter at each park would include the conversion of that meter to the A-6 rate schedule. This rate schedule is commonly used for PV systems because it concentrates the charges on energy use, rather than demand charges. Demand charge savings from PV systems are uncertain because one cloudy day a month can significantly reduce them. When the rate schedule is converted to A6 the savings will not be significantly diminished by a cloudy day.

The sizing for NEMA PV systems generally leads to the installation of one PV system at each park, serving the multiple meters in that park. Occasionally two parks are contiguous, which could lead to the consolidation of two PV systems into one. Occasionally one park has two separate components, which could lead to the need for an additional separate PV system. There is space in the parking lots at every park to generate the electricity needed to offset purchased electricity in the park.

Note that the size of the PV system needed to serve the entire District is on the order of 2 MW. The potential capacity for PV installed as shade structures in District parking lots is on the order of 20 MW, or ten times the system capacity needed to offset most of the District's electricity use.

It is worth noting that the Crown Beach park's utility is Alameda Municipal Power.

6.1.4 Renewable Energy Self-Generation – Bill Credit Transfer (RES-BCT)

The District has another option available for the installation of PV systems, RES-BCT. This rate schedule allows a local government to install one PV system with a capacity of up to 5 MW to offset the electrical loads of multiple meters that are at other locations. Unlike NEMA, the meters are not required to be on the same or contiguous properties. The "Arrangement" includes one generating account and up to 50 "Benefitting" accounts.

Installing one or two large PV systems to offset District energy use is an attractive approach, particularly in terms of first cost. The cost for a single, large RES-BCT system is projected to be $2.75 per Watt, significantly less expensive than the NEMA PV systems needed at each park.

The disadvantage to RES-BCT is that this rate schedule does not completely offset the electric costs at the 50 Benefitting accounts. It only offsets the generation portion of the electric bill. This represents roughly half of the cost of electricity. The District would still pay transmission and distribution costs, taxes, and so on. The RES-BCT approach benefits from economies of scale by constructing a larger, centralized solar system. The lower price point for a RES-BCT system overcomes the lower utility offset possible.

There are several possible locations to install a large RES-BCT system. It is suggested that the park best suited for this system is Shadow Cliffs due to its large parking lot and sunny location. Figure 6-1 shows an example layout of such a system with approximately 130,520 sq. ft. of solar carports to construct a 1.96 MW solar system.

Figure 6-1: Shadow Cliffs sample layout for solar system

The RES-BCT system analysis is presented in Table 6-1.

Table 6-1: RES-BCT solar system analysis

Park Name	System Size (kW)	Production (kWh)	Construction Cost	25 Yr Revenue	25 Yr Costs	25 Yr Net Benefit	Lifecycle Payback
RES-BCT (Shadow Cliffs)	1,960	2,993,612	$5,390,000	$14,711,486	$7,071,294	$7,640,192	13

A hybrid approach with installation of both NEMA systems and RES-BCT systems is also possible, whereby a NEM/NEMA system is built at Park HQ, and the next 50 largest meters are RES-BCT systems. The meters at Lake Chabot would not be included in the RES-BCT system, as it is possible to fold solar energy production into the Lake Chabot re-build project as an integrated component, and not constructed as a stand-alone project. Figure 6-2 shows a sample layout of the solar PV system at Park HQ, with approximately 19,200 sq. ft. of solar carports, which is ample space to construct a 178 kW solar system.

Figure 6-2: Park HQ sample layout for solar system

The solar system installed at the Park HQ will be located in the existing parking lot, which is terraced on a south-southwest sloping hillside on the south side of the building.

Park Name	System Size (kW)	Production (kWh)	Construction Cost	25 Yr Revenue	25 Yr Costs	25 Yr Net Benefit	Lifecycle Payback	Split System Premium Cost
Park HQ	178	266,550	$710,800	$1,859,220	$900,993	$958,227	14	$71,080
RES-BCT (Shadow Cliffs)	1,610	2,459,038	$4,427,500	$12,084,435	$5,808,563	$6,275,872	13	$0
Total	**1,788**	**2,725,588**	**$5,138,300**	**$13,943,654**	**$6,709,556**	**$7,234,099**	**14**	**$71,080**

6.1.5 Ownership Options

PV systems typically have 25-year life spans so the choice to install one requires addressing a number of long-term issues. The District has several options for ownership of the PV system.

The first option is to purchase the system with bond or other funding. This is typically the most cost-effective approach, assuming the District can get access to the capital. This requires that the District perform operation and maintenance on the system, although this can typically be contracted out. This also requires that the District be responsible for repairs on the system. If it is down for any extended period of time, the savings are not accumulating and the District may not be earning the money needed to pay off the bond. The District must also be careful accepting the system to ensure that it is performing up to spec. The District can buy a guarantee from the contractor to cover losses should the system not perform properly over its life.

An alternative approach is to utilize a Power Purchase Agreement (PPA). This is a financing mechanism that allows a third party to own and operate a PV system on the owner's property. The third party would lease space from the District for the installation of the system. The third party would sell the power produced by the PV system to the District at a rate somewhat lower than the current PG&E rates. The advantages of this approach include that the District does not need to raise the money for construction and that the third party takes full responsibility for operations. If the system is down for an extended period of time the third party typically compensates the Owner for the increased electricity costs. However, as explained earlier, the PG&E NEMA tariff requires that the solar system owner and the land owner be the same entity. This rule precludes utilizing a PPA with NEMA. In a PPA, the system owner is a solar vendor, not the landowner. It should be noted that parks which have only one large meter could still be eligible to use a PPA since a NEM interconnection would be viable.

PPA's allow the third party to claim significant tax deductions in the construction of the project. These typically do not result in significantly lower electric rates as the added revenue is used by the third party to cover contingencies, replace failed equipment, guarantee performance, and as part of the project profit.

The District has expressed an interest in ownership of the system, rather than a PPA, so that is the path that is investigated in this report.

6.1.6 Solar Thermal Projects

PV systems address the electrical use of the District, as described above. The District still has significant fuel uses in the forms of natural gas and propane. Projects have been identified to reduce the use of these fuels through efficiency projects, such as HVAC and instantaneous heater projects, or through fuel switching projects such as heat pump water heaters. An alternative to some of these measures is the use of solar thermal energy to provide the heat source.

Solar thermal systems are most efficient when used to heat low temperature loads with internal storage, such as swimming pools. Solar thermal panels are already in place at the District to heat the swimming pool at Camp Arroyo. The other two heated swimming pools at the District are at Roberts and Castle Rock Regional Recreation Areas. These could be candidates for solar thermal heaters as well. However, the annual heating bills indicate relatively short heating seasons (Roberts uses natural gas and costs $10,000 per year to heat. Castle Rock uses propane and costs $5,000 per year to heat.) In addition, both sites are surrounded by mature trees, making sitting of a solar system difficult. Note that all of these swimming pools already use pool covers, which is the most important step to take in improving pool efficiency.

Solar thermal power can also be used to heat domestic hot water. This could be used in camping areas where a significant number of showers are used. This is most effective during summer months when the skies are clearer, which should correlate with when the shower load is the highest.

Solar thermal heating for domestic hot water is more difficult than solar pool heating. While solar pool collectors are typically unglazed plastic, solar domestic hot water collectors are typically copper collectors with aluminum fins in a frame with low e glazing. These collectors are subject to freezing at night during colder weather. They must be built with a freeze protection design (glycol, automatic draining, or other) or they must be manually drained seasonally. Solar domestic hot water heating typically requires a pressurized insulated tank to store at least one day's thermal output. This may require a new structure as it is unlikely to fit into an existing mechanical room. The economics will favor solar thermal at sites with high loads on propane fired domestic hot water heaters.

Note that the restrooms typically do not have enough roof area to collect significant amounts of solar thermal energy. These systems would require that some structure be added, probably elevating the solar collectors to an overhead location, similar to a PV module shade structure.

6.2 FUTURE OPTIONS TO REDUCE THE GHG IMPACT OF NATURAL GAS AND PROPANE

The local installation of PV systems gives the District an opportunity to generate a good portion of their electricity needs, eliminating much of the GHG generation. Offsetting the GHG associated with the District's use of natural gas and propane is somewhat more difficult. After the efficiency projects are implemented what can the District do to reduce the GHG emissions associated with these fuels?

The first option is solar thermal heating. This is most cost-effective for heating swimming pools because of the relatively low temperature of the pool. The District is already using solar heat at the one pool. It is not an easy option for the other pools because of the lack of space for a system.

The use of solar heating for higher temperature loads like domestic hot water is typically not as cost-effective, requiring storage tanks and freeze protection. It is still less cost-effective to offset space heating loads because of their higher temperature and because less solar energy is available in the winter when it is needed.

Some larger institutions are now purchasing biogas from different sources to minimize the impact of their natural gas use. Waste water treatment plants, for example, can generate methane and clean it well enough to be injected into the utility distribution system. They pay a surcharge for this gas, even though they do not burn the specific gas from the plant. This is not an option for the propane use, however, as this is typically not generated through any renewable process.

6.2.1 Zero Net Greenhouse Gas Emissions

After installation of electrical energy efficiency projects and the balance of the electrical load being provided by PV systems, the District's remaining greenhouse gas emissions are contributed by the remaining natural gas and propane loads.

The case for the District to pursue Zero Net Greenhouse Gas Emissions is achieved most easily by serving the remaining natural gas loads and propane loads with the use of electrical appliances, such as electric heat pumps and electric water heaters. The increased electrical load can be made GHG emission free by being served by an additional PV solar system. This is a costly endeavor, and the economics of pursuing this plan are listed in Table 6-2.

Table 6-2: Economics of Net Zero GHG Emissions

Summary of Net Zero GHG Plan	
Electrical retrofit costs	$ 1,015,712
Solar PV cost	$ 1,911,389
Total	$ 2,927,101
Annual Avoided Costs	$ 121,695
Simple Payback (years)	24

PROJECT ANALYSIS

The projects in this report have been analyzed in a workbook which is quite large and cannot easily be printed for inclusion in a hard copy in this report. A live copy of the workbook will be provided to the District so that the calculations and documentation supporting the numbers in this report can be directly referenced and reviewed.

In addition to the workbook, a Microsoft Access database was developed as part of this effort. This database includes structure identification numbers, the associated energy meters that serve the structure, as well as the projects that are recommended for each structure. A live copy of this database will be provided to the District as well.