Clean Coalition
Making Clean Local Energy Accessible Now

East Bay Community Energy

Solar Siting Survey

Draft Final Summary Report: Solar Photovoltaic (PV) Commercial-Scale Sites for 1,000 kW (AC) and Larger

Prepared for
East Bay Community Energy

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Table of Contents

Tables

Figures

About the Clean Coalition

The Clean Coalition is a nonprofit organization whose mission is to accelerate the transition to renewable energy and a modern grid through technical, policy, and project development expertise.

The Clean Coalition drives policy innovation to remove barriers to procurement and interconnection of distributed energy resources (DER) — such as local renewables, advanced inverters, demand response, and energy storage — and we establish market mechanisms that realize the full potential of integrating these solutions. The Clean Coalition also collaborates with utilities and municipalities to create near-term deployment opportunities that prove the technical and financial viability of local renewables and other DER.

Visit us online at www.clean-coalition.org.

I. Introduction

The Clean Coalition conducted the East Bay Community Energy (EBCE) Solar Siting Survey to determine the technical siting potential for commercial-scale solar photovoltaic (PV) installations throughout the County. While this particular survey focuses on Alameda County, the methodology used builds upon the Clean Coalition's work conducting similar Solar Siting Surveys for other entities and can be applied to any defined geographic area. In addition to assessing the technical solar potential, the Clean Coalition also evaluated the Integration Capacity Analysis (ICA) of the nearest feeder line for each of the identified solar sites. By combining the ICA data with analysis of prospective solar sites, the Solar Siting Survey highlights the optimal locations to connect local solar to the electric grid, where the siting opportunity is excellent and interconnection is likely to be quick and cost-effective.

The Solar Siting Survey identifies lower cost and higher value renewable resource opportunities reflecting characteristics of all available sites in relation to existing loads and electric grid infrastructure. The goal of this survey was to identify feasible, commercial-scale sites for installing 1,000 kW (AC) or larger solar PV within the built environment. By highlighting high-quality PV siting opportunities, this survey is designed to guide the development of cost-effective local solar generation within Alameda County. The scope covered all urban areas of the county with the exception of the City of Alameda which has its own municipal utility.

II. Technical Siting Potential

The PV generation potential is an assessment of electrical power that could be generated from a given location based upon a set of reasonable assumptions. The goal is to be within about 20% of the technical solar potential of what a more detailed feasibility assessment would uncover. There was no consideration of structural integrity or other considerations that can only be discovered by performing a deeper and much more detailed study for each individual site. The goal is to identify prospective solar sites that are worth further investigation.

The results of the Solar Siting Survey can be used to create targeted marketing campaigns that allow utilities and communities to focus on those properties with high solar potential.

a. Methodology

Professional solar PV project developers validated the methodology and assisted in its creation. The survey is performed manually through a multi-step process:

- Scan an aerial survey source, such as Google Earth Pro, for prospective solar sites.
- Measure the usable surface area (roof, parking lot, parking structure) and eliminate obvious portions that are not viable. Trees were ignored since some property owners may elect to top or remove them in order to install PV.

- Assess the probable PV density as explained below.
- Extrapolate the surface area and density assessment to obtain the projected generation capability in Watts (W) AC.

With current and pending solar PV panel efficiencies, high-medium-low density scenarios were examined and direct current (DC) power levels of 8-7-6 W/square feet (sq ft), respectively, were agreed on. For alternating current (AC) output, these numbers were backed off to 7-6-5 W/sq ft, respectively. These numbers are probably more conservative than needed, especially for the medium and low density scenarios, but it was felt they provided an additional downward margin to allow for increasing roof clutter typically found in older buildings with lower density, but still usable, potential. The goal is to be within 20% of the values that a detailed design would produce.

Tools available online (like Google Sunroof) are typically oriented toward residential solar installations. These tools use Light Detection and Ranging (LIDAR) data from aerial surveys conducted by the U.S. government with a resolution of about one square meter for each data point. They are reasonably accurate for uncluttered residential rooftops where the LIDAR data is combined with government records showing structure boundaries. However, these online tools totally omit parking lots and parking structures, and they overestimate the potential on cluttered flat rooftops because they cannot "see" the clutter of heating, ventilation and air condition (HVAC) components and piping with 1-meter resolution. Since parking lots and parking structures represent 30% of the potential found in this survey, it is important to include these sites in an assessment of technical solar potential.

For parking lots, only the rows where two cars can park head-in to each other (two deep) are considered, which is typically toward the center of the parking lot. For the most part, single layer rows on the outer boundaries of parking lots were not assessed because the economic proposition for installing solar on the edge of a parking lot is less attractive. The support structure costs are the same, but these single layer rows offer only half the solar PV siting opportunity of the two-deep rows.

Parking garages are rated at high density because fire truck access space is not required between rows on the roof as it is with parking lots

b. Minimum Project Size

A minimum project size is established to provide a reasonable stopping point to the survey process. In this survey, 1,000 kW (AC) was chosen as the minimum project size. Some sites that are lower, but still close to that size, are included, especially when part of an aggregated set of buildings or part of a larger entity.

This minimum size was chosen because, unlike other counties in the greater Bay Area, Alameda County has an abundance of sites capable of hosting projects of at least 1,000 kW (AC). Moreover, projects at the megawatt scale are more cost and capital efficient than smaller projects and, therefore, have greater potential to attract project developers and investors.

Appendix B provides an estimate of technical siting potential for minimum project size of 500kW (AC) and 100kW (AC), respectively.

c. Types of Structures

In dense urban environments, rooftops provide a ready source of siting options. The large, flat rooftops found on commercial and industrial buildings are ideal for siting large solar arrays because pitch, azimuth, and layout designs can be optimized. Angled roofs are also included in this survey. South-facing angled roofs generally offer smaller surface areas, but can be useful in the aggregations discussed below. Low-angled roofs facing south-west and south-east may also be feasible (especially during peak energy demand in summer months).

Large parking lots and parking structures offer a significant untapped resource within urban and suburban environments. Parking lots have a slightly lower density opportunity due to the openings between rows that must be maintained for fire truck access. Parking structures do not have this requirement and can have very dense canopies of PV arrays covering the top level of the structure. Adding solar to a parking lot or structure provides the added benefit of shade and rain protection for users and may help buildings achieve LEED certification by abating the heat island effect, providing storm water catchment, and integrating EV charging station infrastructure with DER.

Ground-mount sites are identified if they are within the built environment or on disturbed land or have brownfield designation. The notable example in this survey is the land around and within the Livermore Municipal Airport. Density specifications for ground-mount systems do not differentiate between fixed-tilt or tracker mounting systems.

d. Structure Aggregations

In the Solar Siting Survey, siting opportunities are not restricted to individual rooftops. There are logical groupings of structures that may fall under a single ownership or management entity, including shopping centers, business and industrial parks, school campuses and apartment complexes. Although individual structures in these groups may not reach the minimum project size, their combined totals can far exceed 1,000 kW. Also, from a marketing standpoint, there are fewer owners or site managers to contact. In many cases, a judgment is made on aggregations based on parking lot configuration and other obvious indications of common ownership. All attempts have been made to provide accuracy and to err on the conservative side. It's likely that parcel and owner data, which have not been utilized in this survey, would identify additional aggregation sites.

e. Icons Used in Map Files for Structures and Information

Solar sites are indicated on the map using the following icons:

Table 1: Site Icons

Site Type	Icon	Description
Flat Roof		Typically commercial and industrial rooftops Usually have HVAC, piping clutter, and skylights Shallow pitches are included
Pitched Roof		Typical angled pitched roof found primarily at schools and some apartments
Parking Lot **Parking Structure**		Parking lots are usually just the central double row head-in areas for cars Parking structures usually cover the entire canopy
Water		Capped terminal or recharge reservoirs
Brown Field		A property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.

Logical clusters of related sites are grouped with the following icons:

Table 2: Aggregation Icons

Aggregation Type	Icon	Description
Apartment		Apartment buildings and parking
Train Stations		BART parking lots
Business		Industrial and business complexes or campuses
Education		School campuses
Hospital		Hospital grounds, typically mostly parking
Shopping		Commercial shopping centers
Storage		Consumer storage facilities

Airport		Parking lots and vacant land
Venue **Yellow in Google-Earth** White in Google-Maps		Arenas, amusement parks, tracks, and other entertainment venues

Some sites are noted for other reasons. Existing sites have two icons, one that denotes interesting local installations in the survey area, and another to identify a goal of what high-density solar installations can look like. A few sites, typically already in the planning stages for PV projects, have been noted as well.

Table 3: Other Informational Icons

Site Type	Icon	Description
Existing		Informational notation regarding existing PV on neighboring buildings No numeric data is provided
Existing, Target **Red in Google Earth** White **in Google Maps**		High-density PV examples on neighboring buildings that should be used as reference targets for PV density
More info to come		Site location noted for now without analysis More information may come as project progresses

f. Nearest Feeder and PV Capacity Analysis

The nearest feeder is found from Pacific Gas & Electric's (PG&E) ICA map. The various ICA category values are also obtained from this map and includes the hosting capacity estimates. If the structure PV exceeds the ICA value of the closest (shortest direct distance) feeder, the next closest feeder is used until a viable value is found.

In the cases where multiple feeder lines serve aggregation sites, the single best feeder was selected — based on PV capacity and shortest distance to a common point of interconnection.

See Section III. Integration Capacity Analysis for more details.

g. Distribution of Files

The Solar Siting Survey results are distributed in two forms, which are found at the URLs in Appendix A:

- .kml (Keyhole Markup Language) files, which can be displayed on Google Earth or imported into Google Maps.

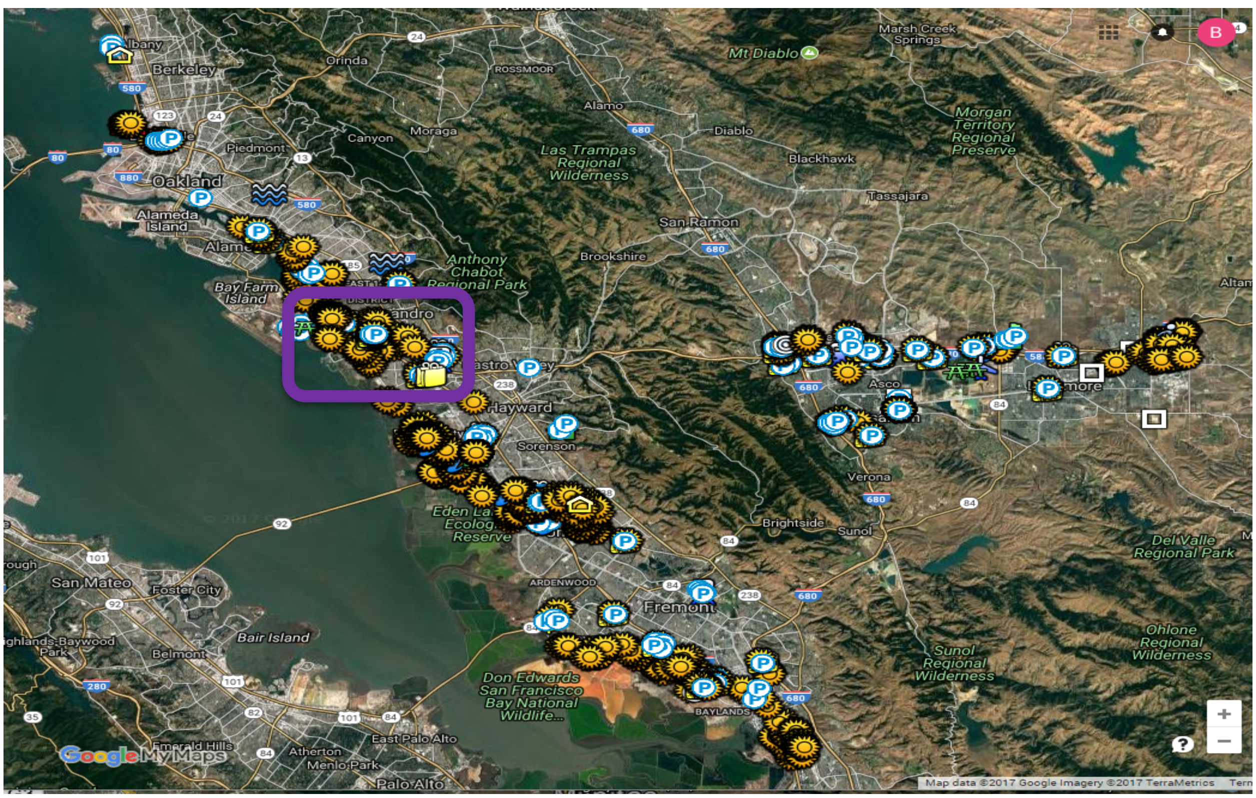
- .xslx (Excel) spreadsheet with a table containing all the data used to generate the .kml file, as well as summary breakdowns of the findings. The .kml files are generated from the data found in this file.

h. Summary of Solar Siting Survey

The Solar Siting Survey identified over 650 MW (AC) of technical PV siting potential on over 250 discrete sites. A site is defined as a unique address (or group of related addresses) with the potential to host at least 1,000 kW (AC) on rooftops, parking lots, parking structures, and logical aggregations thereof. Note that the technical solar siting potential will be reduced by constraints that were not considered like structures that cannot support extra weight without significant upgrade and grid bottlenecks that would result in excessive solar curtailment (or require time-shifting dispatchability via energy storage)

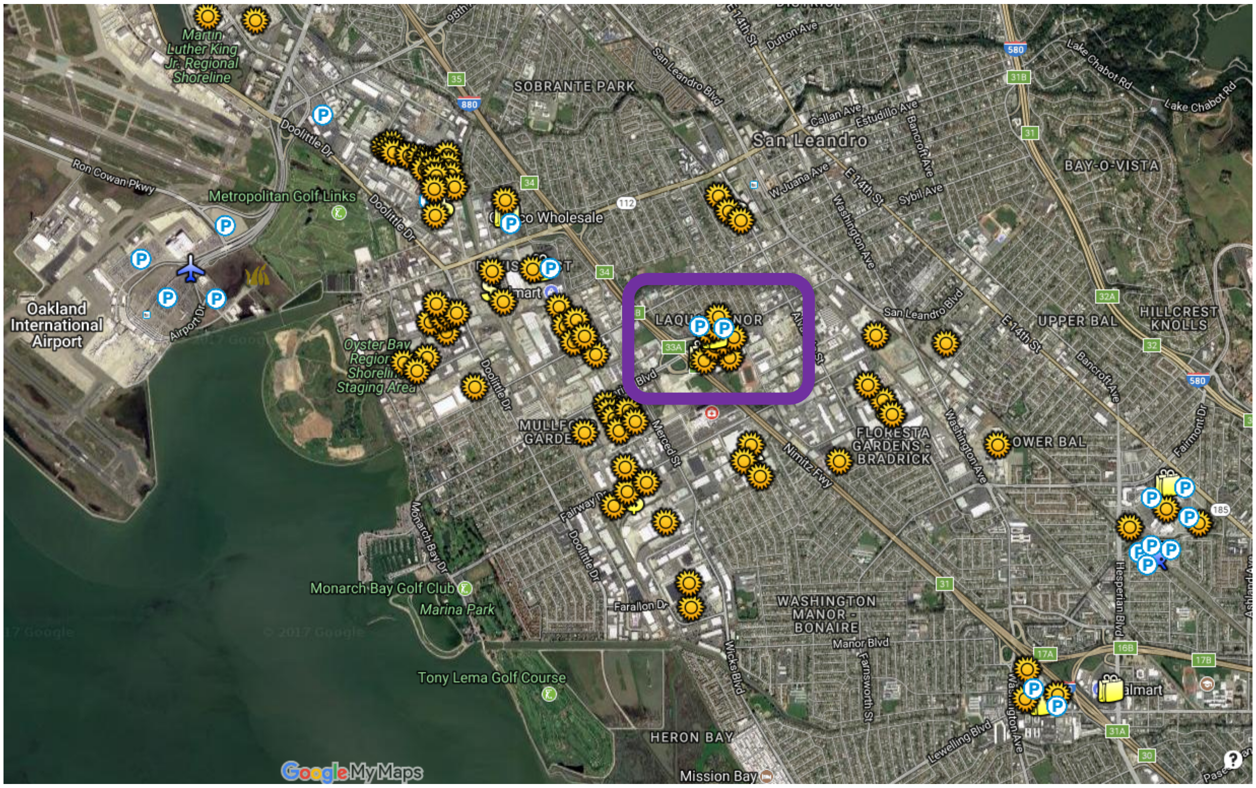
Figure 1 below provides an overview of Alameda County and Solar Siting Survey locations.

Figure 1: Overview of Solar Siting Potential in Alameda County



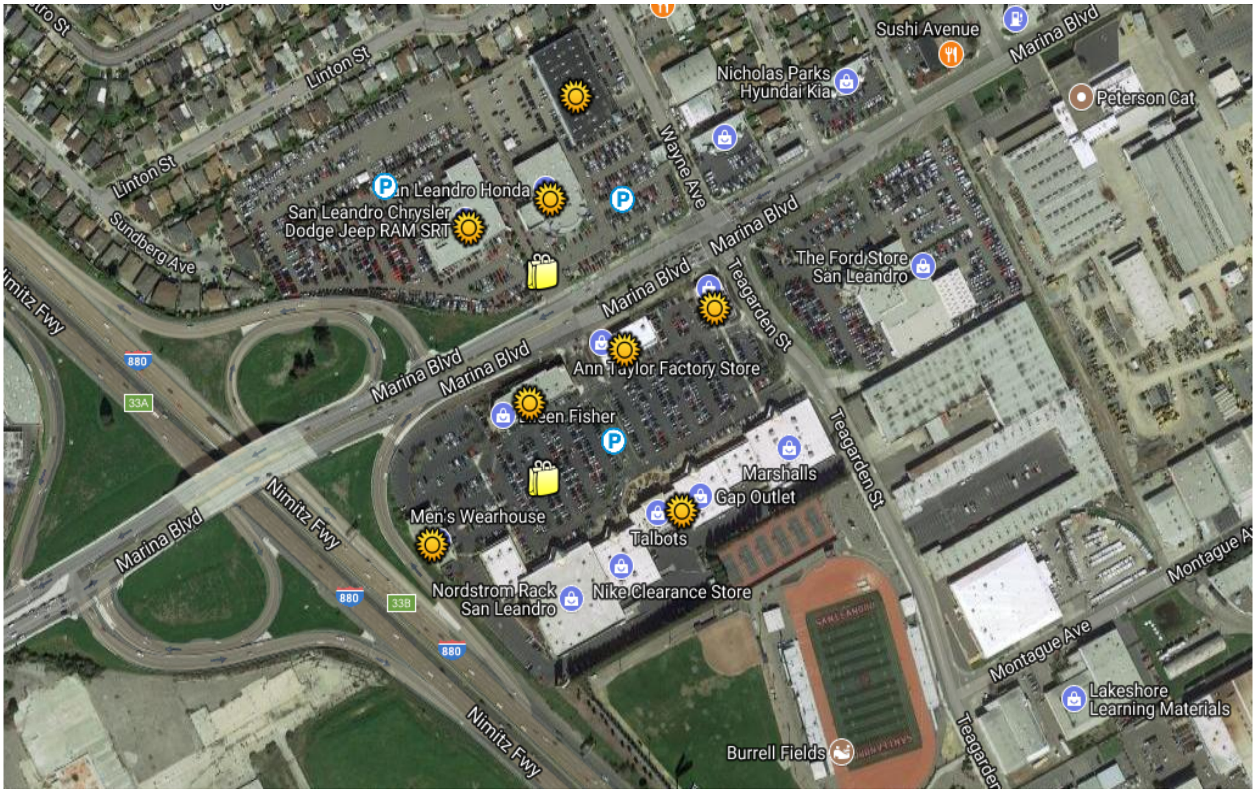
The purple zone above indicates the next area of zoom into San Leandro, which also picks up the eastern edge of the Oakland International Airport.

Figure 2: Drill down into San Leandro



The purple area above defines the next level of zoom into Marina Square Shopping Center in San Leandro.

Figure 3: Marina Square Shopping Center in San Leandro



A summary of sites, grouped by siting potential and city, is shown in the tables below. The spreadsheet with the complete summary can be found in Appendix B. An excerpt of the summary tables by ZIP Code is shown below in Table 4, Table 5, and Table 6.

Table 4: Summary by ZIP Code and PV Structure Size (kW)

	Count	Count	kW_Total	PV W_AC >=	1,000 kW	> and >=	500 kW	Less than	500 kW
	Sites	Structures		Structures		Structures		Structures	
Totals:	252	679	662,224 kW	210	464,151 kW	179	128,294 kW	290	69,779 kW
Berkeley, CA 94710	1	3	5,699	2	4,874	1	825	-	-
Emeryville, CA 94608	2	18	7,637	-	-	6	3,975	12	3,662
Oakland, CA 94601	5	9	7,650	4	4,666	3	2,107	2	877
Oakland, CA 94602	1	1	5,712	1	5,712	-	-	-	-
Oakland, CA 94603	2	2	2,618	2	2,618	-	-	-	-
Oakland, CA 94605	2	4	2,921	1	1,526	1	600	2	795
Oakland, CA 94606	1	1	1,476	1	1,476	-	-	-	-
Oakland, CA 94607	1	1	1,240	1	1,240	-	-	-	-
Oakland, CA 94621	11	24	53,368	15	47,536	7	5,388	2	444
San Leandro, CA 94579	2	6	3,734	2	2,310	1	684	3	740
San Leandro, CA 94578	4	12	10,882	6	8,152	3	1,850	3	880
San Leandro, CA 94577	27	77	55,645	23	38,165	13	9,343	41	8,137
Castro Valley, CA 94546	1	1	2,690	1	2,690	-	-	-	-
San Lorenzo, CA 94580	2	3	2,610	1	1,308	2	1,302	-	-
Hayward, CA 94544	14	31	32,067	12	19,186	13	10,616	6	2,265
Hayward, CA 94545	30	125	72,478	20	34,112	35	25,020	70	13,346
Hayward, CA 94541	1	1	2,702	1	2,702	-	-	-	-
Hayward, CA 94542	1	2	5,800	2	5,800	-	-	-	-
Union City, CA 94587	27	85	54,437	20	27,720	21	15,339	44	11,378
Newark, CA 94560	18	41	50,766	21	38,953	15	9,907	5	1,906
Fremont, CA 94536	1	4	2,265	1	1,150	-	-	3	1,115
Fremont, CA 94538	38	61	83,755	34	69,165	14	10,146	13	4,444
Fremont, CA 94539	5	15	8,931	1	1,008	8	5,781	6	2,142
Dublin, CA 94568	12	38	30,408	12	17,848	12	8,373	14	4,187
Pleasanton, CA 94566	7	38	12,606	3	6,825	3	2,025	32	3,756
Pleasanton, CA 94588	7	15	22,512	7	18,774	5	3,363	3	375
Livermore, CA 94550	14	21	23,107	8	15,679	8	5,784	5	1,644
Livermore, CA 94551	15	40	96,507	8	82,956	8	5,866	24	7,685

Table 5: Summary by Zip Code and Structure Type

	Count	Count	kW_Total	Roof_Flat	kW_Total	Pkg_Lot	kW_Total	Pkg_Garage	kW_Total	Brown_Fld	kW_Total	Roof_Angled	kW_Total	Water	kW_Total
	Sites	Structures													
Totals:	252	679	662,224 kW	536	386,344 kW	130	197,244 kW	3	2,096 kW	4	64,470 kW	4	4,832 kW	2	7,238 kW
Berkeley, CA 94710	1	3	5,699	-	-	2	3,395	-	-	-	-	1	2,304	-	-
Emeryville, CA 94608	2	18	7,637	13	4,822	5	2,815	-	-	-	-	-	-	-	-
Oakland, CA 94601	5	9	7,650	6	5,625	3	2,025	-	-	-	-	-	-	-	-
Oakland, CA 94602	1	1	5,712	-	-	-	-	-	-	-	-	-	-	1	5,712
Oakland, CA 94603	2	2	2,618	1	1,218	1	1,400	-	-	-	-	-	-	-	-
Oakland, CA 94605	2	4	2,921	2	795	1	600	-	-	-	-	-	-	1	1,526
Oakland, CA 94606	1	1	1,476	1	1,476	-	-	-	-	-	-	-	-	-	-
Oakland, CA 94607	1	1	1,240	-	-	1	1,240	-	-	-	-	-	-	-	-
Oakland, CA 94621	11	24	53,368	15	16,598	8	27,670	-	-	1	9,100	-	-	-	-
San Leandro, CA 94579	2	6	3,734	3	1,254	3	2,480	-	-	-	-	-	-	-	-
San Leandro, CA 94578	4	12	10,882	5	5,142	7	5,740	-	-	-	-	-	-	-	-
San Leandro, CA 94577	27	77	55,645	71	49,000	6	6,645	-	-	-	-	-	-	-	-
Castro Valley, CA 94546	1	1	2,690	-	-	1	2,690	-	-	-	-	-	-	-	-
San Lorenzo, CA 94580	2	3	2,610	3	2,610	-	-	-	-	-	-	-	-	-	-
Hayward, CA 94544	14	31	32,067	22	23,204	8	7,675	-	-	-	-	1	1,188	-	-
Hayward, CA 94545	30	125	72,478	119	60,718	6	11,760	-	-	-	-	-	-	-	-
Hayward, CA 94541	1	1	2,702	1	2,702	-	-	-	-	-	-	-	-	-	-
Hayward, CA 94542	1	2	5,800	-	-	2	5,800	-	-	-	-	-	-	-	-
Union City, CA 94587	27	85	54,437	76	45,787	9	8,650	-	-	-	-	-	-	-	-
Newark, CA 94560	18	41	50,766	31	33,456	9	16,810	1	500	-	-	-	-	-	-
Fremont, CA 94536	1	4	2,265	-	-	4	2,265	-	-	-	-	-	-	-	-
Fremont, CA 94538	38	61	83,755	51	68,030	10	15,725	-	-	-	-	-	-	-	-
Fremont, CA 94539	5	15	8,931	14	8,111	1	820	-	-	-	-	-	-	-	-
Dublin, CA 94568	12	38	30,408	23	11,823	14	17,675	1	910	-	-	-	-	-	-
Pleasanton, CA 94566	7	38	12,606	26	2,413	11	9,804	-	-	-	-	1	390	-	-
Pleasanton, CA 94588	7	15	22,512	8	8,026	6	13,800	1	686	-	-	-	-	-	-
Livermore, CA 94550	14	21	23,107	19	19,857	2	3,250	-	-	-	-	-	-	-	-
Livermore, CA 94551	15	40	96,507	26	13,677	10	26,510	-	-	3	55,370	1	950	-	-

Table 6: Summary by ZIP Code and <u>Site</u> <u>Count</u>

	Count	kW_Total	PV W_AC >=	5,000 kW	> and >=	2,000 kW	Less than	2,000 kW
	Sites		Sites		Sites		Sites	
Totals:	252	662,224 kW	20	244,609 kW	71	190,041 kW	161	227,574 kW
Berkeley, CA 94710	1	5,699	1	5,699	-	-	-	-
Emeryville, CA 94608	2	7,637	1	5,387	1	2,250	-	-
Oakland, CA 94601	5	7,650	-	-	1	2,619	4	5,031
Oakland, CA 94602	1	5,712	1	5,712	-	-	-	-
Oakland, CA 94603	2	2,618	-	-	-	-	2	2,618
Oakland, CA 94605	2	2,921	-	-	-	-	2	2,921
Oakland, CA 94606	1	1,476	-	-	-	-	1	1,476
Oakland, CA 94607	1	1,240	-	-	-	-	1	1,240
Oakland, CA 94621	11	53,368	2	37,490	3	6,748	6	9,130
San Leandro, CA 94579	2	3,734	-	-	1	2,424	1	1,310
San Leandro, CA 94578	4	10,882	1	6,390	1	2,040	2	2,452
San Leandro, CA 94577	27	55,645	-	-	13	34,415	14	21,230
Castro Valley, CA 94546	1	2,690	-	-	1	2,690	-	-
San Lorenzo, CA 94580	2	2,610	-	-	-	-	2	2,610
Hayward, CA 94544	14	32,067	1	7,675	4	10,898	9	13,494
Hayward, CA 94545	30	72,478	2	20,046	9	24,221	19	28,211
Hayward, CA 94541	1	2,702	-	-	1	2,702	-	-
Hayward, CA 94542	1	5,800	1	5,800	-	-	-	-
Union City, CA 94587	27	54,437	1	9,249	7	18,320	19	26,868
Newark, CA 94560	18	50,766	2	17,145	6	20,293	10	13,328
Fremont, CA 94536	1	2,265	-	-	1	2,265	-	-
Fremont, CA 94538	38	83,755	1	21,125	9	22,861	28	39,769
Fremont, CA 94539	5	8,931	-	-	1	2,088	4	6,843
Dublin, CA 94568	12	30,408	2	12,504	3	8,133	7	9,771
Pleasanton, CA 94566	7	12,606	-	-	2	5,465	5	7,141
Pleasanton, CA 94588	7	22,512	1	11,541	3	6,819	3	4,152
Livermore, CA 94550	14	23,891	-	-	3	9,280	11	14,611
Livermore, CA 94551	15	95,723	3	78,846	1	3,510	11	13,367

III. Integration Capacity Analysis (ICA)

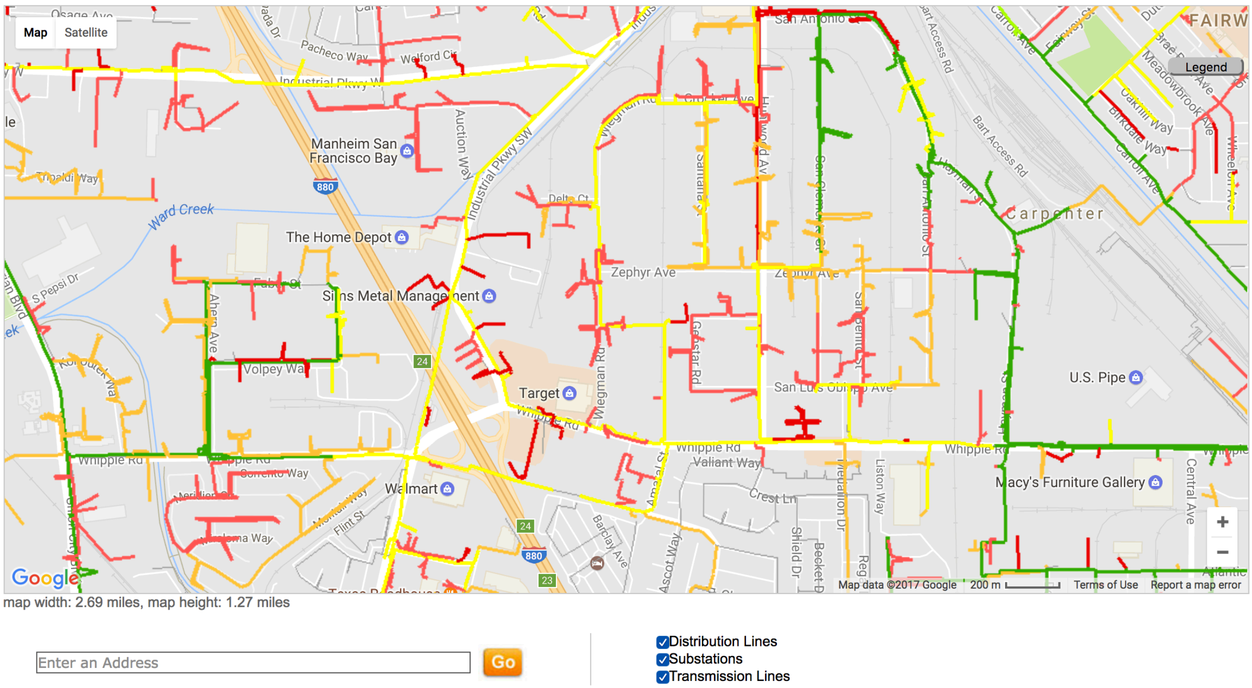
The ICA segment of the Solar Siting Survey provides inputs from PG&E's ICA database at the feeder sections that appear to be closest for interconnection at the proposed site. The ICA calculations are only done for the 3-phase segments of the distribution grid (see Figure 4).

PG&E's ICA mapping tool is found at:

> https://www.pge.com/b2b/energysupply/wholesaleelectricsuppliersolicitation/PVRFO/PVRAMMap/

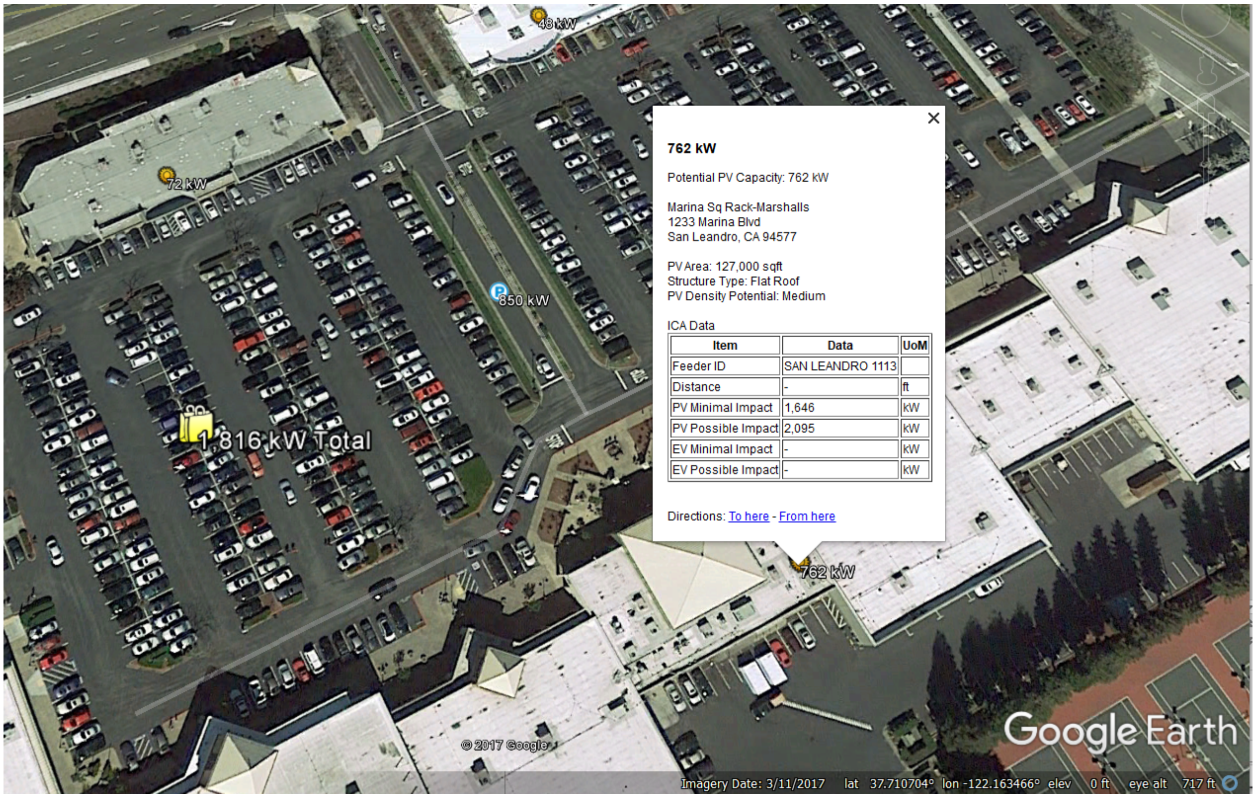
The PG&E Help file link can be found on that page. In the Help file, it notes: "These values are intended to help users by indicating DER capacities that are expected to require Detailed Interconnection Studies. It is encouraged that customers apply using DER capacities that are less than the reported Integration Capacity value to have better chances of passing the interconnection Fast Track." Thus, information found in the ICA map for a specific node on a feeder is an indicator (not a guarantee) of a proposed project's likelihood of getting into the Fast Track approval queue with a lower probability of major grid upgrades being needed. The more margin that exists between the proposed project's size and the available capacity, the higher the likelihood of the project entering Fast Track.

Figure 4: ICA Map Example



In the pop-up window for each potential site, the following information appears:

Figure 5: PV Site ICA Information Example in Marina Square Shopping Center



- The Feeder ID is the closest feeder identified for easy interconnection.
- Distance is estimated as a straight line from the nearest feeder line to a significant portion of the building or parking lot/structure. Zero distance means that the feeder crosses or appears to terminate on the property near the point of intended use.
- PV Minimal and Possible Impacts are calculations that, as noted above, allow the utility to assess whether the interconnection can be placed into the Fast Track queue.
- EV Minimal and Possible Impacts are similar to the PV impacts, but are numbers selected for workplace EV charging installations.

Table 7 below summarizes the major ICA findings by feeder. The complete table can also be found in the Appendix A spreadsheet URL.

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Table 7: ICA Findings by Feeder

ICA		SSS Findings		ICA			
Substation - Feeder	Feeder Nominal Voltage [kV]	Num of PV Structures	PV Total Generation on Structures [kW]	PV Feeder Minimal Impact [kW]	PV Feeder Possible Impact [kW]	EV Workplace Minimal Impact [kW]	EV Workplace Possible Impact [kW]
CASTRO VALLEY 1101	12	3	5,800	-	-	2,263	-
CASTRO VALLEY 1102	12	1	2,690	2,263	3,577	2,263	3,815
CAYETANO 2111	21	12	3,568	2,058	-	5,144	-
DIXON LANDING 2106	21	9	4,840	3,772	5,111	3,772	6,612
DIXON LANDING 2107	21	4	6,865	3,875	5,718	3,875	6,368
DIXON LANDING 2109	21	3	1,603	2,229	-	2,008	-
DIXON LANDING 2111	21	15	5,764	5,041	6,128	5,041	7,332
DUMBARTON SUB 1104	12	1	882	2,263	3,571	2,263	2,379
DUMBARTON SUB 1106	12	9	6,594	1,646	-	1,051	967
DUMBARTON SUB 1107	12	3	1,625	1,646	-	929	-
DUMBARTON SUB 1108	12	21	9,249	2,325	-	2,325	-
DUMBARTON SUB 1109	12	8	3,498	1,646	-	1,358	-
DUMBARTON SUB 1112	12	4	6,720	3,087	3,906	3,087	4,577
DUMBARTON SUB 2111	21	7	7,795	3,429	-	3,354	-
EDES 1101	12	6	3,526	1,646	-	1,567	-
EDES 1110	12	25	7,069	2,263	3,452	2,263	3,642
EDES 1111	12	8	6,090	1,708	-	1,708	-
EDES 1112	12	1	1,218	2,058	-	1,498	-
EDES 1113	12	2	3,450	1,337	-	2,263	-

FREMONT 1112	12	5	2,265	2,325	3,988	2,325	2,464
GRANT 1102	12	18	9,974	2,263	3,495	2,263	3,815
GRANT 1103	12	24	13,442	2,263	3,922	2,263	2,681
GRANT 1104	12	5	2,040	1,384	3,503	1,384	3,503
GRANT 1107	12	1	2,304	2,263	-	2,263	-
GRANT 1108	12	1	2,702	2,263	-	2,263	-
JARVIS 1103	12	8	7,219	2,263	4,557	2,263	4,889
JARVIS 1104	12	7	5,448	2,341	-	2,588	-
JARVIS 1105	12	3	1,680	1,646	-	969	-
JARVIS 1106	12	2	2,898	2,263	3,917	2,263	3,675
JARVIS 1109	12	31	17,479	2,263	3,917	2,263	3,675
LAS POSITAS 2103	21	8	4,530	3,129	-	3,601	6,386
LAS POSITAS 2104	21	4	2,460	2,744	-	1,640	-
LAS POSITAS 2105	21	33	34,055	4,012	5,396	4,012	7,325
LAS POSITAS 2110	21	13	7,047	4,698	6,947	4,581	-
LIVERMORE 1104	12	3	11,060	908	-	1,102	1,664
MT. EDEN 1101	12	16	9,072	1,646	-	1,099	-
MT. EDEN 1104	12	12	9,450	2,263	-	2,263	-
MT. EDEN 1105	12	39	17,356	2,613	3,228	2,613	6,049
MT. EDEN 1106	12	7	3,739	2,058	-	1,975	-
MT. EDEN 1107	12	23	13,790	2,263	-	2,263	-
MT. EDEN 1110	12	17	4,741	2,325	4,329	1,840	-
MT. EDEN 1111	12	19	9,589	2,263	4,053	2,263	2,621

MT. EDEN 1113	12	17	11,970	2,263	2,685	2,263	4,053
MT. EDEN 1114	12	4	1,794	839	-	2,325	6,956
NEWARK 1101	12	12	15,660	2,325	3,643	2,325	4,523
NEWARK 1102	12	3	1,770	1,337	-	712	-
NEWARK 1104	12	1	1,330	2,302	-	2,325	5,897
NEWARK 1105	12	12	12,925	3,025	4,770	3,025	4,770
NEWARK 1107	12	2	4,062	1,646	-	1,411	-
NEWARK 1108	12	3	4,098	2,058	-	1,464	-
NEWARK 2102	21	2	4,140	5,041	8,711	5,041	10,227
NEWARK 2103	21	13	8,874	3,429	-	3,634	-
NEWARK 2104	21	6	9,440	3,875	6,811	3,875	4,331
NEWARK 2105	21	4	3,194	3,772	9,140	2,989	-
NEWARK 2107	21	8	4,762	3,772	3,854	3,772	3,854
NEWARK 2108	21	13	8,388	4,355	7,276	4,355	5,888
NEWARK 2109	21	12	6,070	3,875	7,058	3,875	6,491
NEWARK 2110	21	4	1,520	14,848	-	8,063	-
NEWARK-NUMMI Xmsn service	0	4	21,125	-	-	-	-
NORTH DUBLIN 2101	21	19	10,803	5,144	5,903	5,144	7,153
NORTH DUBLIN 2103	21	7	2,712	3,601	7,249	3,601	7,318
OAKLAND 1109	12	1	1,240	412	-	-	-
SAN LEANDRO 1101	12	15	7,261	2,058	2,105	2,058	6,795
SAN LEANDRO 1103	12	4	1,528	823	-	646	-
SAN LEANDRO 1104	12	13	9,596	1,337	-	1,178	-

SAN LEANDRO 1105	12	7	6,390	2,139	-	2,263	-
SAN LEANDRO 1106	12	13	10,005	2,263	3,762	2,325	2,454
SAN LEANDRO 1107	12	1	1,310	1,646	-	493	-
SAN LEANDRO 1108	12	11	8,267	2,263	2,441	2,263	4,262
SAN LEANDRO 1109	12	4	1,395	2,263	3,086	2,263	3,802
SAN LEANDRO 1110	12	2	2,915	2,336	-	3,025	4,889
SAN LEANDRO 1111	12	2	2,452	2,613	4,485	1,681	-
SAN LEANDRO 1113	12	8	4,434	1,646	-	-	-
SAN RAMON 2103	21	3	2,014	2,744	-	1,590	-
SAN RAMON 2106	21	14	17,427	3,739	-	4,875	-
SAN RAMON 2111	21	9	6,030	3,429	-	3,601	-
SAN RAMON 2114	21	2	4,805	4,698	9,129	4,698	9,129
SAN RAMON 2117	21	7	5,151	2,744	-	2,288	-
SAN RAMON 2118	21	3	1,290	1,715	-	1,002	-
SUBSTATION D 1132	12	13	5,387	3,025	4,234	3,025	3,591
SUBSTATION G 1109	12	4	5,699	1,623	2,185	-	-
SUBSTATION J 1103	12	5	3,778	2,104	-	-	-
SUBSTATION J 1108	12	3	1,254	1,337	-	-	-
SUBSTATION J 1110	12	10	15,357	2,263	4,236	2,263	4,280
SUBSTATION J 1112	12	8	5,250	2,263	4,269	2,263	-
SUBSTATION J 1115	12	2	2,622	2,263	-	2,263	-
SUBSTATION J 1117	12	1	1,512	2,058	-	1,575	-
SUBSTATION J 1118	12	1	1,526	1,337	-	1,337	-

SUBSTATION L 1103	12	7	2,250	2,263	-	-	-
SUBSTATION X 1109	12	1	5,712	2,263	2,814	350	-
Unknown Feeder	0	6	25,745	-	-	-	-
VASCO 1102	12	4	4,108	1,978	-	2,058	3,146
VINEYARD 2104	21	3	8,476	2,229	-	2,229	-
VINEYARD 2106	21	25	4,804	2,006	-	1,406	-
VINEYARD 2107	21	3	1,054	2,058	-	1,847	-
VINEYARD 2108	21	13	3,409	2,744	-	1,853	-
VINEYARD 2109	21	3	3,340	3,601	5,064	3,601	9,374
VINEYARD 2110	21	4	46,998	4,012	5,839	4,012	6,721

Note that there are many feeders on which the proposed PV generation exceeds the minimal or possible impact capacities. This is normal, and exemplifies why those who apply for interconnection first on a feeder can have potentially lower interconnection costs if their projects are under the impact levels that the utility has pre-calculated. This is a first mover advantage.

IV. Spreadsheet and Google Earth .kml File Content

a. Summary Sheets

The PV Summary sheet is derived from the data sheet described below. The survey has uncovered more the 650 MW of siting potential in the survey area. Totals are given for solar PV siting potential, broken down by City/Zip Code combinations and by structure type as well as by site count. See Table 4, Table 5, and Table 6 above for excerpts from the summary. Also, a breakdown of aggregations is provided by City/Zip Code and aggregation type.

The legend symbols used in the map are defined on the PV Summary sheet as well as in Table 1 and Table 2 above. The cities and ZIP codes with the top 5 highest potentials are also listed in the summary

The ICA Summary sheet is also derived from elements in the data sheet. It contains the table in Figure 5 as described in Section III. Integration Capacity Analysis.

b. Data

The spreadsheet columns are clearly labeled. All information appearing in the .kml map is derived from the data sheet. For roofs that do not fit easily into a rectangular definition or may have cutouts or shade exclusions, notes can be found in the *Area_ft2* formula entries with comments that explain which portions of the rooftops were assessed ("+") or excluded ("-").

c. Map Content

The output of the survey process is a .kml file that is viewable in Google Earth. The legend for the symbols used on the map is found on the spreadsheet summary page and Section II.e. The technical solar PV capacity for each structure and for relevant aggregations is shown next to the icon. When the icon is clicked, a pop-up screen appears with the relevant information for that site, as found in the data sheet. Aggregation icons are scaled to be slightly larger than their components constituents.

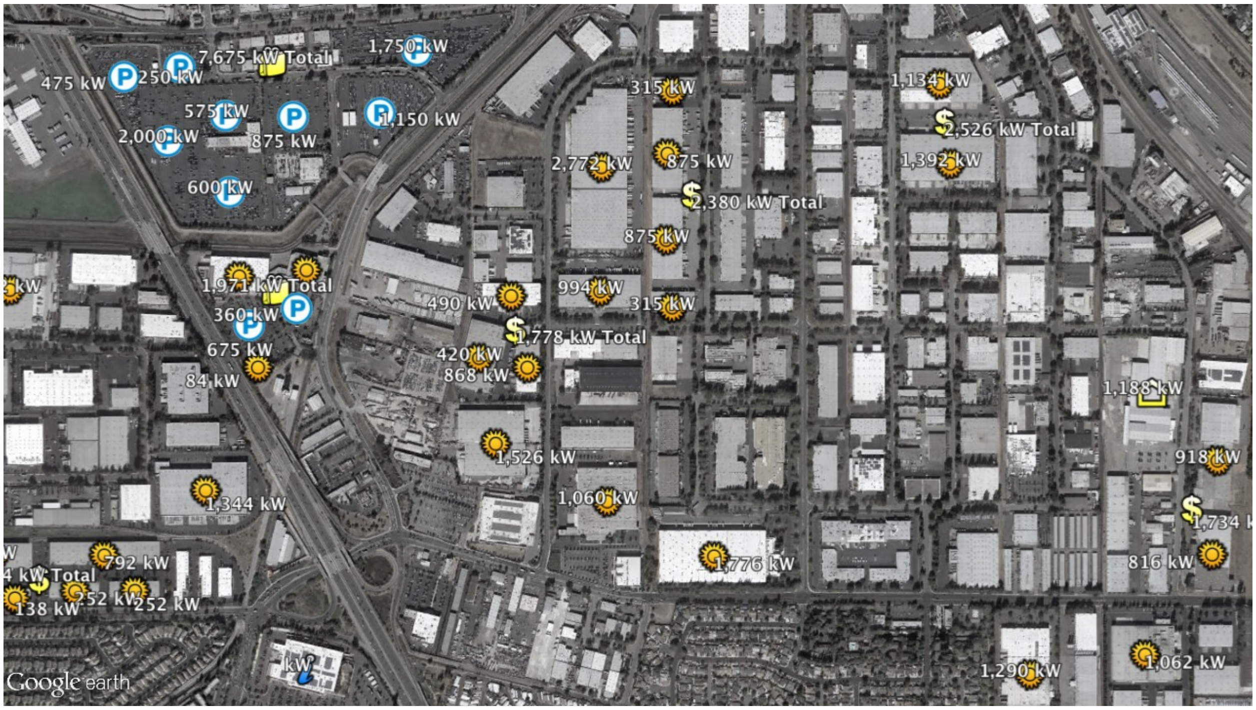
The controls in Google Earth allow for viewing of the city and county outlines. Use the "Borders and Labels" option under the Layers menus.

The .kml file can also be imported into Google Maps for viewing, but it loses several features when viewed with this tool, such as:

- The estimated site capacity no longer appears next to the map icon, but does appear in the folder on the left.
- The Aggregation symbol is not larger than its constituents.
- Certain icons that are colored in Google Earth (e.g. the red target for ideal example rooftops with high density PV) are not colored in Google Maps.
- The folders on the left do not collapse.

In spite of these shortcomings, the Google Maps version is still accurate and useful because many potential viewers may not have the Google Earth application.

Figure 6: Close-up View of Commercial and Industrial Aggregations



d. Structure Types

The major structure types examined are flat roofs, angled roofs, parking lots, and parking structures. In Alameda County, flat roofs and parking lots comprise [89%] of the technical hosting sites identified. They are easily identified by their symbols as defined in Table 1.

e. Aggregations

Aggregations are easily identified by their symbols. A new one that has been added to this survey due to the lower project size is Public Storage Facilities. The symbols used are defined in Table 2. As shown in Table 8 aggregation sites total over 480 MW, or more than 70% of the PV capacity in this survey. Table 9 also shows a breakdown of aggregations by ZIP code.

Table 8: Summary of Aggregation Sites by Type

Summary by **Aggregation Type**: PV at All Sites

Aggregation Type	Count	kW_Total	PV W_AC >= 5,000 kW (Count)	PV W_AC >= 5,000 kW (kW)	> and >= 2,000 kW (Count)	> and >= 2,000 kW (kW)	Less than 2,000 kW (Count)	Less than 2,000 kW (kW)
Airport	2	81,115	2	81,115	-	-	-	-
Apartments	1	2,250	-	-	1	2,250	-	-
Biz	93	205,811	3	35,531	31	84,107	59	86,173
Edu	3	11,986	1	5,800	1	4,996	1	1,190
Shopping	37	138,357	10	84,007	12	31,135	15	23,215
Storage	5	23,666	1	15,000	2	5,840	2	2,826
Venue	3	19,374	2	17,444	-	-	1	1,930
Water	2	7,238	1	5,712	-	-	1	1,526
Totals:	**146**	**489,797 kW**	**20**	**244,609 kW**	**47**	**128,328 kW**	**79**	**116,860 kW**

Table 9: Summary of aggregation facilities by City/ZIP

	Airport		Apartments		Biz		Edu		Shopping		Storage		Venue	
Berkeley, CA 94710	Num_Sites	kW_Total	Num_Sites	kW_Total	Num_Sites	kW_Total	Num_Sites	kW_Total	Num_Sites	kW_Total	Num_Sites	kW_Total	Num_Sites	kW_Total
Berkeley, CA 94710	-	-	-	-	-	-	-	-	-	-	-	-	1	5,699
Emeryville, CA 94608	-	-	1	2,250	-	-	-	-	1	5,387	-	-	-	-
Oakland, CA 94601	-	-	-	-	1	1,155	-	-	2	3,873	-	-	-	-
Oakland, CA 94602	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oakland, CA 94603	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oakland, CA 94605	-	-	-	-	-	-	-	-	1	1,395	-	-	-	-
Oakland, CA 94606	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oakland, CA 94607	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oakland, CA 94621	1	25,745	-	-	4	6,316	-	-	-	-	-	-	1	11,745
San Leandro, CA 94579	-	-	-	-	-	-	-	-	2	3,734	-	-	-	-
San Leandro, CA 94578	-	-	-	-	-	-	-	-	1	6,390	-	-	-	-
San Leandro, CA 94577	-	-	-	-	12	26,366	-	-	4	10,352	-	-	-	-
Castro Valley, CA 94546	-	-	-	-	-	-	-	-	-	-	-	-	-	-
San Lorenzo, CA 94580	-	-	-	-	1	1,302	-	-	-	-	-	-	-	-
Hayward, CA 94544	-	-	-	-	5	11,638	-	-	1	7,675	-	-	-	-
Hayward, CA 94545	-	-	-	-	19	42,154	1	4,996	1	12,360	-	-	-	-
Hayward, CA 94541	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hayward, CA 94542	-	-	-	-	-	-	1	5,800	-	-	-	-	-	-
Union City, CA 94587	-	-	-	-	10	22,743	-	-	3	12,900	-	-	-	-
Newark, CA 94560	-	-	-	-	9	25,249	-	-	2	12,050	-	-	-	-
Fremont, CA 94536	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fremont, CA 94538	-	-	-	-	7	32,439	-	-	5	10,414	-	-	-	-
Fremont, CA 94539	-	-	-	-	4	7,265	-	-	1	1,666	-	-	-	-
Dublin, CA 94568	-	-	-	-	4	7,694	-	-	5	19,254	-	-	-	-
Pleasanton, CA 94566	-	-	-	-	2	2,532	-	-	1	1,054	2	4,966	1	1,930
Pleasanton, CA 94588	-	-	-	-	-	-	-	-	4	16,607	-	-	-	-
Livermore, CA 94550	-	-	-	-	6	7,981	-	-	1	1,260	1	2,500	-	-
Livermore, CA 94551	1	55,370	-	-	9	10,977	1	1,190	2	11,986	2	16,200	-	-
Totals:	**2**	**81,115**	**1**	**2,250**	**93**	**205,811**	**3**	**11,986**	**37**	**138,357**	**5**	**23,666**	**3**	**19,374**

V. Conclusion

There is tremendous opportunity to expand local solar PV generation in Alameda County. To facilitate development of local renewable energy, the Clean Coalition conducted the Solar Siting Survey, which identified over 660 MW of technical solar PV siting potential across 250 sites, with each site being able to host a solar PV system of at least 1,000 kW. Notably, more than 30% of this siting potential is on parking lots and parking structures, which are often overlooked siting opportunities for clean local energy. In total, this survey identified enough local solar PV capacity to power 165,000 homes.

While this survey identified solar siting opportunities of at least 1 MW (AC) in size, there is also siting potential for smaller PV projects in Alameda County. With a minimum project size of 500 kW, the Clean Coalition expects a technical solar siting potential of 1.2 gigawatts (GW); a minimum project size of 100 kW would likely have uncovered over 2 GW of solar siting potential. More details for this method can be found in Appendix B: Estimate for Technical Siting Potential for Projects < 1000kW (AC).

Developing the local solar projects identified in this survey can help create a stronger, more resilient grid in Alameda County. By pairing distributed solar with other distributed energy resources, such as energy storage, demand response, and electric vehicle charging infrastructure, the County can establish Community Microgrids and Solar Emergency Microgrids. These innovative configurations can be designed to provide indefinite, renewables-based, backup power to critical facilities in the event of regional power outages. With the addition of energy storage combined with solar, many of the large solar sites identified in this survey are prime candidates for these applications.

VI. Appendices

Appendix A: EBCE Solar Siting Survey Files

The following files are available with the Solar Siting Survey information:

- Data spreadsheet including PV and ICA Summary sheets: https://drive.google.com/drive/u/0/folders/0B0ebi4di8sxfMDZGRU9iVU5CYXc

- .kml file importable into Google Earth that contains city outlines and Solar Siting Survey sites: https://drive.google.com/drive/u/0/folders/0B0ebi4di8sxfMDZGRU9iVU5CYXc

- A Google-Maps viewable version of the .kml file that is accurate but has fewer viewing features than when viewed in Google-Earth: https://www.google.com/maps/d/u/0/viewer?ll=37.6708454140984%2C-122.00631600000003&hl=en&z=10&mid=1fRb4m-t4U8afQIJ2XbFnmo8xOR8

Appendix B: Estimate for Technical Siting Potential for Projects < 1,000 kW (AC)

The Solar Siting Survey considers sites with the potential to host PV systems of 1,000 kW (AC) and larger. However, technical siting potential throughout the County is far greater if smaller PV system sizes are considered.

To reach a reasonable estimate of this potential, the methodology described in Section II.a. of this report was repeated for a minimum project size of 500 kW (AC) in the cities of San Leandro, Fremont, and Livermore, representing North County, South County, and East County, respectively. The results across these sample populations are fairly consistent, showing a 78% increase in siting potential, and additional capacity. By extrapolating across the survey data with inferences for projects as small as 100 kW (AC), an estimate of 176% of technical siting potential is found compared to 1 MW projects.

Table 10: Estimates of Total PV Siting Potential as Project Minimum Size Decreases

Minimum Project Size	Low Conservative Estimate of Solar Siting Potential, including the baseline 1 MW projects
1 MW AC	> 650 MW AC (baseline)
500 kW AC	> 1.2 GW AC total
100 kW AC	> 2 GW AC total