Commonwealth Energy Biogas/PV Mini-Grid Renewable Resources Program

Making Renewables Part of an Affordable and Diverse Electric System in California

Contract No. 500-00-036

PV Database, Siting Requirements & Mini-Grid Technical Potential Report

Project No. 1.1 Program Planning and Analysis

Task 1.1.5 Final Report

Prepared For:
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Table of Contents

List of Tables

1

Introduction

This report summarizes methods and findings of a study of the technical potential for building-integrated photovoltaics (BI-PV) in California. The study was conducted by Regional Economic Research, Inc. (RER) and the Renewable Energy Development Institute (REDI) for the California Energy Commission (Commission) under Contract No. 500-00-036 Task 1.1.5. This task is one element of the broader Commonwealth Energy Biogas/PV Renewable Mini-Grid Program (Program) being administered through the Commission's Public Interest Energy Research (PIER) group. The general, overall purpose of the broader Program is to increase the affordability of renewable energy in California.

1.1 Overview of Commonwealth Program Planning and Analysis Project

The primary objectives of the Commonwealth PIER Program Planning and Analysis Project are to:

- Define the initial study area,
- Inventory the study area's potential photovoltaic and biogas resources to assess the potential of such resources and to identify potential demonstration projects,
- Identify a mini-grid where the potential impact of the development of such resources can be assessed,
- Conduct power flow studies to identify and quantify the benefits of renewable energy projects on the local electric distribution system,
- Identify and prioritize individual demonstration projects, and
- Identify cost savings and benefits that would accrue by developing complementary resources.

A multidisciplinary team led by RER and supported by CH2MHill and REDI, is responsible for meeting these program planning objectives. CH2MHill is responsible for undertaking the various biogas resource inventory assessments. Power flow and other studies related to the mini-grid are being undertaken by Zaininger Engineering Company (ZECO). As mentioned above, the nonresidential BI-PV resource assessment documented in this report is being performed jointly by the Renewable Energy Development Institute (REDI) and RER.

1.2 BI-PV Resource Inventory

The geographic scope of this BI-PV technical potential assessment is limited to a specific area in the Chino Basin located east of Los Angeles. The boundaries of this "mini-grid" encompass area in the southwest portion of San Bernardino County and the northwest portion of Riverside County. Initial specification of a preliminary mini-grid boundary was completed under Task 1.1.1 of the Program.

The purpose of this task is to develop information that will ultimately support estimation of possible impacts of BI-PV development in the mini-grid area on the electric grid. Power flow modeling necessary to quantify these grid impacts will be completed under Task 1.1.9 of the Program, and will include several Biogas resources in addition to BI-PV. Estimation of Biogas technical potential was completed under Task 1.1.2, Task 1.1.3, and Task 1.1.4 of the Program. The power flow modeling will be based not on technical potential, but rather on market potential. Translation of estimates of technical potential described in this report into estimates of market potential will be completed under Task 1.1.7 of the Program.

Photovoltaics may be integrated into building systems in many different ways. Residential and nonresidential applications exist, and the possible range of affected building elements is large (e.g., roofs, walls, shade structures, awnings, skylights, windows). However, the scope of this technical potential assessment was limited to maintain focus on areas most germane to the Program. Only non-residential applications are considered, and particular emphasis is placed upon public facilities. Building elements included in the assessment include rooftops, awnings, parking lot shade structures, and other shade structures.

1.3 Report Organization

This report begins with a general overview of BI-PV technology and applications. The introductory overview is followed by a description of issues influencing siting of BI-PV systems. A description of data sources, analytic methodology, and current technical potential results is followed by 5-year and 10-year forecasts of future BI-PV technical potential. Appendix A contains the database of public sector facilities. Appendix B includes the data pertaining to private sector nonresidential establishments in the mini-grid; these data are summarized by building type and zip code. The databases are included as MS Excel files.

2

General Description of BI-PV Technology

Building Integrated Photovoltaics (BI-PV) refers to the practice of incorporating PV material into building shells. Products for a wide variety of building shell applications exist today or are being developed. Examples of BI-PV application types include: rooftops, awnings, skylights, opaque vertical architectural glass facades, and even vision glass. BI-PV refers to the type of application of photovoltaic material, not to the type of photovoltaic cell material used for the application. All types of cell materials can be used for BI-PV applications. The range of possible cell materials is large and continuing to grow. Many BI-PV products for horizontal rooftop applications have used conventional single- or poly-crystalline silicon photovoltaic cell material. Other products designed for sloped roofs have used amorphous thin-film silicon cell material. In the future, other types of thin-film cell materials such as cadmium telluride (CdTe) and copper indium diselenide (CIS) may see increased use.

The BI-PV approach to PV deployment stands in contrast to other possible approaches, including ground mounting PV in open spaces, or attaching PV to buildings in ways that minimize or eliminate interaction between the PV and other building elements. In certain circumstances the BI-PV approach offers numerous advantages over these other approaches. Several potential advantages of BI-PV include:

- Cost savings resulting from decreased need to purchase electricity,
- Cost savings resulting from replacement of conventional building materials,
- Cost savings resulting from replacement of conventional PV system structural elements with conventional building materials,
- Cost savings resulting from increased roof life and/or decreased HVAC loads,
- Improved aesthetics as compared to less-integrated deployment of PV on buildings, and
- Expansion of the market for distributed PV on buildings.

The penetration of BI-PV into building systems markets has been minimal to date. Numerous barriers to increased penetration rates exist, including: high cost, low familiarity among building systems professionals, absence of net-metering tariffs, and challenges presented by the interdisciplinary nature of BI-PV projects (i.e., architectural, electrical, structural). There are important reasons to pursue continued development of BI-PV, however.

Costs of BI-PV are expected to fall as production volumes increase, and the size of the potential market is very large. For instance, the global production of flat glass for buildings applications runs into the billions of square feet per year, and the area of existing flat rooftops is of a similar magnitude. Expanded deployment of BI-PV into these and other applications offers the promise of generating power at the point of use, thereby alleviating transmission and distribution losses and bottlenecks sometimes associated with traditional electricity supply models.

3

Photovoltaic Siting Requirements

3.1 Regional Solar Energy Resources

As with any type of solar energy generation facility, access to solar radiation is the primary requirement. The overall quality of the solar resource for an area may be expressed in terms of daily average "effective full-sun hours". The convention underlying this approach is that the energy intensity of the sun at mid-latitudes on the earth's surface corresponds to about 1,000 W/m^2 of incident solar radiation.

Full-sun hours values depend on the orientation of the surface upon which solar radiation is incident. For horizontal surfaces that are typical of many BI-PV applications, the Southern California solar resource is approximately 5 daily average full-sun hours. In contrast to some coastal and more northern areas of California the Commonwealth PIER mini-grid area has an excellent solar resource.

The urban and natural geography of the terrain surrounding the Commonwealth Renewables mini-grid region also provides plenty of solar access for BI-PV systems. The natural geography is largely flat terrain and is composed of low growing vegetation, allowing for good solar access throughout the majority of the built environment. The urban geography of the surrounding cities contains primarily low-rise buildings. Many cities within the target area have ordinances forbidding buildings over 75 feet in height. Solar access issues that might arise from building shadows are less likely to occur within the mini-grid area than other urban population zones that may have high-rise buildings and tall vegetation.

3.2 Building Type

Buildings come in all sorts of shapes, sizes, orientations, and have widely varying energy utilization intensities and energy consumption levels.

Since BI-PV generation capacity is dependant on the amount of area exposed to sunlight the assessment of building type dictates whether the facility can be a host for a BI-PV application or not. In order to facilitate the data analysis, public sector facilities were broken down into five categories of building types: colleges, schools, hospitals, offices, and miscellaneous. Each building type has physical limitations that could hinder the technical potential for BI-PV applications. Physical limitations include usable roof area, available

area for window awnings, amounts of area surrounding the facility, roof slope and orientation, and the size of the required parking lots. The siting requirements by building type are addressed in detail below in Section 3.

3.3 Regulatory

As part of the siting requirements, if a commercial facility plans to create its own photovoltaic electrical energy they must acquire the proper building permits and authorization from their utility provider.

Within the mini-grid area there are eight permitting agencies. Six of the permitting agencies are City Building and Planning Department, two are County Building and Planning Departments, and the remaining permitting agency is the State Architects Office. None of the permitting agencies have a streamlined permitting process for photovoltaic generation systems, although the State Architects Office is working toward streamlining their photovoltaic power system permitting process and the County of Riverside expressed interest in creating a streamlined permitting process for photovoltaic power systems.

In order to be issued a building permit a BI-PV application must follow the Uniform Building Code, National Electric Code, National Mechanical Code, and the materials be UL listed for fire retardant and be accepted by the International Conference of Building Officials. If the BI-PV application is a roof covering it must have a fire rating of at least Class B.

These requirements, and possibly more, must be met before being issued a permit. Within the mini-grid area the permitting processes are similar from jurisdiction to jurisdiction. Yet, there is a lack of consistency in the method of calculating the associated permitting fees. Most permitting agencies base the fees upon the total value of the project, while a few charge a flat fee. A brief summary of the requirements is listed in Table 3-1 below.

Table 3-1: Summary of Permitting Requirements

Jurisdiction	Flat Fee	Contract Valuation	Design Review	Engineering	Electrical Schematic	Other Procedure	Plot Plans
Chino	X		X	X	X		X
Corona		X	X	X	X		X
County of San Bernardino		X	X	X	X		X
County of Riverside		X	X	X	X		X
Norco		X	X	X	X		X
Ontario			X	X	X		X
Rancho Cucamonga	X	X	X	X	X	X	X
State Architects Office		X	X	X		X	X

When a photovoltaic array is located on the roof of a structure, the plans delivered to the permitting agency in most cases will be required to include roof load calculations from a licensed engineer.

In some circumstances when the photovoltaic array is located on the roof, it is essential that none of the power equipment is visible from the street. If the photovoltaic power equipment will be integrated into the building envelope it must be aesthetically attractive in order to be issued a permit. For this reason it is necessary for all photovoltaic projects to go through a plan check procedure. Since many of the permitting agencies within the mini-grid region are just beginning to become familiar with photovoltaic power systems, providing the permitting jurisdiction plenty of time and offering solar educational material is expected to expedite the permitting process.

4

Technical Potential Methodology (Non-Residential)

This assessment of BI-PV technical potential covers rooftop, awning, parking lot shade structure, and other shade structure applications. First, the number of nonresidential public facilities and private sector establishments are estimated. Next, building energy usage and availability of area for BI-PV are explored at the building-specific level and used to estimate BI-PV system sizes necessary to offset 100% of building energy consumption. These building-specific values are calculated for reference purposes to illustrate relationships between building energy usage characteristics and BI-PV system size requirements for individual buildings. Finally, the quantities of public facilities and private sector establishments are combined with estimates of average area available per building and with BI-PV system sizing factors to yield estimates of BI-PV technical potential for the mini-grid area.

4.1 The Number of Facilities

The first step in evaluating the photovoltaic technical potential was to determine the amount of public and commercial facilities within the target area of the study. This was done separately for public and private sector facilities.

Public Facilities

In order to accurately count the amount of facilities a common definition of a public facility needed to be clear. SIC codes and building types were used to define the public agency facilities vs. the commercial facilities. The final count analysis was narrowed down by zip code range.

Once the focus area zip code range and the definition of a public and commercial facility by SIC code and by building type were made distinct, a list of public agencies and facilities was created through a compilation of databases, including the *phone book, American Business Lists, Special District Committee, Thomas Guide 2003, and the Local Government Commission*. The amount of public facility arranged by building type is shown in Table 4-1 below. The facilities in the 'Miscellaneous' building type were grouped according to facility size because site-specific information was available for the very large facilities.

Table 4-1: Public Agency Facilities by Building Type

Building Type	# Facilities
School	71
College	4
Hospital	9
Office	108
Miscellaneous -- Very Large	6
-- Other	42
Total	**240**

The next step in the technical potential analysis was to determine the amount of buildings that exist at each public facility, since many of them have more than one building per facility. Data was used from the *1997 Commercial Saturation Survey: Final Report* submitted by Southern California Edison and the *1999 Commercial Energy Survey Report* by Pacific Gas & Electric to calculate the average amount of buildings per public facility.

To calculate the average amount of buildings per public facility the usable square footage per public facility was divided by the amount of public customers, which produces the average amount of usable square feet per public customer. The total amount of usable square feet per public customer was then divided by the average amount of square feet per building, which produced the average amount of buildings per public facility. The average amount of buildings per facility is shown in Table 4-3.

The average amount of buildings per facility is used within the base calculations to develop the total floor area and energy consumption per facility. The BI-PV technical potential is derived through the evaluation of the total floor area and the energy consumption per facility.

Table 4-2: Pubic Sector Buildings Per Facility

Building Type	# Buildings/ Facility
School	10.8
College	2.6
Hospital	3.5
Office	2.3
Miscellaneous -- Very Large[1]	51.3
-- Other	1.6

[1] Data available from the California Department of General Services was used to develop the estimate for the very large facilities in the miscellaneous building type.

4.2 Private Sector Establishments

Data from the US Census Bureau were used to identify private sector establishments within the mini-grid study area. These *County Business Patterns* data include information on both the number of establishments, and the total employment for particular business types by zip code area. The Commonwealth Renewables Mini-grid area covers all or part of 16 zip code areas. In cases where only a portion of a zip code area is inside the mini-grid, all of the establishments within the zip code area were assumed evenly distributed across the land area for purposes of allocation to the mini-grid area. The distribution of private sector establishments across building types is summarized in Table 4-3 for the mini-grid area.

Table 4-3: Private Sector Establishments by Building Type

Building Type	# Establishments
Education	21
Food Service	226
Health Care	203
Lodging	14
Manufacturing	1,748
Mercantile	478
Office	567
Other	120
Public Assembly	17
Religious Worship	32
Service	508
Warehouse and Storage	922
Total	**3,857**

4.3 Building Size and Energy Consumption

The next step established the average amount of kilowatt-hours (kWh) each building consumed per year. The average amount of kWh each utility customer consumed on an annual basis per square foot by building type was provided by the "California Energy Demand, 2000-2010", California Energy Commission, Publication # 200-00-002. Estimates of the total floor space for each public sector building type were calculated as the product of number of facilities and average floor space per customer. The energy demand forecast included Energy Use Intensities (EUI), which represent the amount of kWh each utility customer consumed on an annual basis per square foot by building type. The EUI values were combined with the floor space results to calculate estimates of total annual electric energy consumption.

After estimating the average amount of kWh each building consumed per year the required size of a photovoltaic generating system capable of offsetting 100% of the building's electric energy consumption was calculated. This system size was calculated for reference and comparison purposes; technical potential estimates were subsequently estimated based on area (e.g., roof, parking lot) availability. To determine the required photovoltaic system size, the total kWh consumed per year for each building was divided by the number of days in a year (365), and then divided by a number of daily average full-sun hours typical for the mini-grid area (5 full-sun hours). Average characteristics of public facilities are summarized in Table 4-4.

Table 4-4: Public Sector Facility Characteristics

Building Type	Floor Area (ft^2)	Energy Use Intensity (EUI) ($kWh/ft^2/Yr$)	Energy Consumption (kWh/Yr)	PV Required for 100% Offset (kW AC-PTC)
School	27,420	6	175,577	96
College	40,154	10	417,159	229
Hospital	38,652	38	1,484,387	813
Office	7,602	18	138,112	76
Miscellaneous				
Very large	668,566	11	7,518,160	4,120
Other	8,012	11	90,099	49

For the private sector, building size estimates were based on the number of employees. Information concerning floor space-per-employee available from the U.S. Department of Energy's Energy Information Administration (EIA) was combined with County Business Patterns employment data to calculate estimates of total floor space by building type. For the private sector, EUI data from the Energy Commission report were augmented with additional data from the EIA, as necessary. Average characteristics of private sector establishments are summarized in Table 4-5.

4.4 Size of Photovoltaic Generating System

The PV system size needed to offset 100% of average building electric energy consumption was estimated above. Because solar radiation is an inherently diffuse energy resource the total physical PV array sizes (i.e., square feet) corresponding to these kW results is of interest. To estimate these sizes for both crystalline and amorphous silicon photovoltaic materials 'square feet per kW' factors were applied to the kW results from above. For crystalline PV a value of 150 ft^2/kW was used; 300 ft^2/kW was assumed for amorphous PV systems. The basis of these values is described in detail in a later section of this report titled Mini-Grid Photovoltaic Technical Potential.

Average characteristics of private sector establishments are summarized in Table 4-5.

Table 4-5: Private Sector Establishment Characteristics

Building Type	Floor Area (ft^2)	Energy Use Intensity (EUI) ($kWh/ft^2/Yr$)	Energy Consumption (kWh/Yr)	PV Required for 100% Offset (kW AC-PTC)
Education	11,014	18	198,252	109
Food Service	9,853	41	403,980	221
Health Care	9,030	38	343,148	188
Lodging	58,997	13	766,966	420
Manufacturing	33,173	69	2,288,914	1,254
Mercantile	20,992	11	230,916	127
Office	7,225	18	130,053	71
Other	23,619	11	259,813	142
Public Assembly	45,940	13	597,224	327
Religious Worship	32,103	3	96,309	53
Service	22,477	12	269,719	148
Warehouse and Storage	33,324	8	266,593	146

The PV areas necessary to offset annual electric loads in public facilities are summarized in Table 4-6.

Table 4-6: PV Area Needed to Displace Annual Load– Public Facilities

Building Type	Estimated Crystalline PV Area (ft^2)	Estimated Amorphous PV Area (ft^2)
School	14,431	28,862
College	34,287	68,574
Hospital	122,004	244,009
Office	11,352	22,703
Miscellaneous		
Very large	617,931	1,235,862
Other	7,405	14,811

4.5 Available Building Area for BI-PV

Once the amount of public agency and private sector buildings was established, accompanied by the average floor area for each building type and annual electrical consumption for each building type per square foot, the available area for installing a photovoltaic energy system needed to be addressed. A "floor area to roof area ratio" by building type was available

through the "CBP-CBECS Roof Analysis Report". The closer the ratio is to equaling 1, the fewer floors are typically contained in the building type. For instance, in the "CBP-CBECS

Table 4-7: PV Area Needed to Displace Annual Load– Private Sector Establishments

Building Type	Estimated Crystalline PV Area (ft^2)	Estimated Amorphous PV Area (ft^2)
Education	16,296	32,592
Food Service	33,206	66,412
Health Care	28,206	56,412
Lodging	63,043	126,085
Manufacturing	188,143	376,286
Mercantile	18,981	37,961
Office	10,690	21,380
Other	21,356	42,712
Public Assembly	49,090	98,181
Religious Worship	7,916	15,833
Service	22,170	44,340
Warehouse and Storage	21,913	43,827

Roof Analysis Report" it is stated that hospitals have a "floor area to roof area ratio" equal to 0.30, meaning that, on average, hospitals have close to one third of the amount of roof space as they do floor space, or the average hospital is three stories tall. The amount of roof space available for housing a photovoltaic array was further estimated by using information from the NREL report: "Assessing Roof top Solar-Electric Distributed Energy Resources for the California Local Government Commission", which states that overall 40% of the total roof area is capable of housing a photovoltaic array. It is assumed that the remaining 60% of roof area is either already populated with roof-mounted equipment or that it experiences shading, which will severely dampen the energy output of a photovoltaic array.

4.6 Additional Area for BI-PV

To estimate the total Building-Integrated Photovoltaic (BI-PV) potential within the targeted area for public facilities, parking lot shade structures and awnings on the south side of the facilities were considered as available area for photovoltaic arrays. Also included as additional area are potential BI-PV shade structures, entry canopies, and direct-current (DC) PV applications.

Parking Lots

The total amount of parking spaces that could be used as additional area for photovoltaic arrays was calculated by using the city of Montclair's Municipal Code 11.66.010 Parking requirements. In some circumstances, such as schools and hospitals, the amount of required parking spaces was determined by the amount of staff, or the amount of beds at a public agency facility. In these cases, an estimate based upon an average of other parking space requirements, such as commercial, office, and manufacturing, was used to calculate the available photovoltaic parking lot area. The minimum parking lot area for the city of Montclair is 9 ft wide by 20 ft long, or 180 ft^2. Areas in parking lots other than the actual parking spaces were not taken into consideration for this calculation.

Awnings

The available awning area was calculated by assuming the facilities were constructed as square buildings, then calculating the square root of the building total roof area to determine the length of one side of the structure. The resulting length was multiplied by 4 ft to estimate the total area of a photovoltaic awning for one story of a building. In order to address the full photovoltaic awning potential a ratio of building roof area to awning area was created by dividing one by the building area to roof area ratio. The "roof area to awning area ratio" takes into consideration multiple floors for each building type, assuming that all of the windows on the south side of each building have a potential for housing a photovoltaic awning. Once the roof area to awning area ratio was calculated, it was multiplied by the "total roof area", which resulted in the total square feet of a photovoltaic awning 4 ft in length a running the entire span of one side of each facility.

Outdoor Structures

Another area that could house BI-PV structures is "open space". Open space is the available area surrounding each facility that could possibly house a photovoltaic roof integrated shade structure. Schools, colleges, prisons, wastewater treatment plants, etc… have large amounts of open area for a BI-PV shade structure, while only a few offices and commercial entities have enough open area. It was assumed that the building types that have large amounts of area could house one 1000 ft^2 BI-PV shade structure, while only 1/3 of the offices and other commercial entities had enough sunny area available for a 1000 ft^2 BI-PV shade structure. If the 1000 ft^2 PV system utilized crystalline photovoltaic technology the estimated size of the system would equal 6.7 kW (AC-PTC), while amorphous silicon photovoltaic technology would equal 3.3 kW (AC-PTC) for the same area.

Roof Slope and Orientation

The type of roof a potential BI-PV facility has is also a solar siting concern. Satellite images viewed through www.terraserver.com showed that 93% of 30 randomly selected public

agency buildings had flat roof slopes, qualifying them as good BI-PV roofing candidates. Since the land within the Commonwealth PIER mini-grid area does not receive large quantities of rain or snow, buildings are often built with flat roofs. A flat roof allows for the photovoltaic roof arrays to be mounted in an orientation that produces maximum kWh production or maximum value generation. Due to the popularity of flat roofs in the area, for purposes of this analysis all private sector, non-residential buildings were assumed to have flat roofs.

Availability of area for public facility BI-PV applications is summarized on a per-building basis in Table 4-8. The roof area results presented in this table represent 40% of the total roof area.

Table 4-8: BI-PV Area Available by Building Type per Facility – Public Sector Facilities

Building Type	Roof (ft^2)	Awning (ft^2)	Parking Lot (ft^2)	Shade Structure (ft^2)	Total (ft^2)
School	6,471	2,834	16,452	1,000	26,757
College	9,476	1,683	20,651	1,000	32,810
Hospital	4,638	2,686	19,878	1,000	28,202
Office	1,186	847	5,473	333	7,839
Miscellaneous					
Very large	213,941	26,191	240,684	1,000	481,816
Other	2,564	506	2,884	1,000	6,955

Availability of area for private sector BI-PV applications is summarized on a per-building basis in Table 4-9. Again, the roof area results presented in the table represent 40% of the total roof area.

4.7 Mini-Grid Building-Integrated Photovoltaic Technical Potential

To develop the photovoltaic technical potential for the target area within the greater Chino Basin, each potential photovoltaic system area was addressed separately then as a whole. Furthermore, two types of photovoltaic technologies were addressed in estimating the technical potential; crystalline photovoltaic cells and amorphous photovoltaic cells. In general, crystalline cells are 10-12% efficient at converting sunlight into Alternating Current (AC) electricity; amorphous cells are 4-6% efficient.

Efficiency characteristics of photovoltaic *cells* were described above. To estimate technical potential it is necessary to estimate PV *system* capacity corresponding to the available installation area. The translation of total square feet of usable roof area into PV system

Table 4-9: BI-PV Area Available by Building Type per Establishment – Private Sector Establishments

Building Type	Roof (ft^2)	Awning (ft^2)	Parking Lot (ft^2)	Shade Structure (ft^2)	Total (ft^2)
Education	2,599	451	7,930	333	11,314
Food Service	2,877	400	17,736	333	21,346
Health Care	1,084	486	4,644	333	6,547
Lodging	8,024	1,358	28,319	333	38,033
Manufacturing	9,952	644	9,186	333	20,115
Mercantile	6,466	519	15,115	333	22,433
Office	1,127	412	5,202	333	7,075
Other	7,747	455	17,006	333	25,542
Public Assembly	9,923	988	82,693	333	93,937
Religious Worship	7,448	829	57,785	333	66,396
Service	7,193	495	16,183	333	24,204
Warehouse and Storage	11,330	602	5,998	333	18,264

technical potential entailed several steps. First, the total DC-STC[2] capacity that could be placed on available roof area was estimated. Second, the corresponding Buydown Program system capacity was estimated so that findings of the USDOE/Energy Commission's recent PV/Wind system monitoring project could be applied to this mini-grid technical potential estimate. Finally, actual one sun equivalent output (i.e., 1,000 W/m^2) under reference ambient temperature conditions was estimated. The various system component estimates required in each of these steps are further delineated below.

First, the total DC-STC capacity that could be placed on the usable roof area was estimated. Review of manufacturers product data suggests that crystalline silicon modules typically produce approximately 10 W/ft^2 of module area. For amorphous modules, the data suggest that electricity production is approximately 5 W/ft^2 of module area. Total capacity was calculated as the product of the total usable area and this per-unit-area module capacity value.

Second, the corresponding Buydown Program system capacity was estimated so that findings of the monitoring project could be applied. As a first-order approximation, an adjustment factor equal to 90% can be used both for DC to AC conversion efficiency, and also STC to

[2] STC refers to the Standard Test Conditions that PV module manufacturers typically base the nominal size rating of their modules on (i.e., 1,000 W/m^2 solar radiation, 25 ^{0}C cell temperature, and 1.5 air mass). When PV modules are installed and operating in the field, cell temperatures coincident with 1,000 W/m2 of solar radiation may be substantially higher than 25^{0}C, which can cause actual power output to fall below the nominal size rating.

PTC[3] conversion. Consequently, the estimate of equivalent rebated system capacity is equal to the product of DC-STC capacity and 0.81.

Third, AC power output under PTC conditions was estimated. The CEC-rebated capacity does not include other such system-integrated factors as wiring and module mismatch losses, and so actual PTC power output will be less than the rebated values estimated above. Findings reported in the RER June 2001 PV/Wind System Monitoring Report suggested an average adjustment factor of approximately 73% for small systems using older inverter technology. This system adjustment value was increased by 15% for this study because newer inverters and larger PV systems are expected to perform better than the residential systems covered by the Monitoring Report. An adjustment multiplier of 0.84 was applied to the estimate of CEC rebated system size to account for such factors as wiring and module mismatch losses.

If the total DC-STC rating of 10 W/ft^2 for crystalline modules and 5 W/ft^2 for amorphous modules is subject to the above-mentioned multipliers of 0.81 and 0.84, then the estimated AC-PTC output per square foot is 6.8 W and 3.4 W respectively per technology type. Therefore, in order to derive the square feet required for 1 kW AC-PTC of solar modules per technology type, 1,000 W was divided by the 6.8 W/ft^2 and the 3.4 W/ft^2 of AC output per technology type, which calculated to 147 ft^2 for crystalline modules and 294 ft^2 for amorphous modules.

The method described above was used to calculate ratios of PV system capacity to available PV system coverage area. To calculate the crystalline technical potential the amount of area available for each building type was divided by 150 ft^2. To calculate the amorphous technical potential the amount of area available for each building type was divided by 300 ft^2. This methodology resulted in producing the average size of a photovoltaic power generation system that each building type could possibly house, if all of the available area was utilized for photovoltaic arrays. For further analysis, the average size of a BI-PV application was divided into its area related constituents (i.e., roof, awning, covered parking, open space structures).

[3] PTC refers to PVUSA Test Conditions developed by the Photovoltaics for Utility Scale Applications (PVUSA) national public-private partnership to provide a system size-rating basis more reflective of conditions actually observed in the field. PVUSA Test Conditions (PTC) weather comprises 1,000 W/m^2 plane-of-array irradiance, 20^0C ambient temperature, and wind speed equal to 1 m/s.

5

Technical Potential Results

5.1 Technical Potential in Public Facilities

Results of the technical potential calculations for public facilities are summarized in Table 5-1 and Table 5-2. The building type with the most technical potential is Miscellaneous, for which crystalline potential is 21,220 kW and amorphous potential is 10,610 kW. The application type with the most technical potential is Covered Parking. Within the Miscellaneous segment, Covered Parking is responsible for half of total technical potential.

Table 5-1: Crystalline Technical Potential for the Total Public Facilities (kW)

Building Type	Roof Mounted	Awning Mounted	Covered Parking	Open Space	Total kW
School	3,063	1,341	7,787	473	12,665
College	253	45	551	27	875
Hospital	278	161	1,193	60	1,692
Office	854	610	3,941	240	5,644
Miscellaneous					
Very large	8,558	1,048	9,627	40	19,273
Other	718	142	808	280	1,947

Table 5-2: Amorphous Technical Potential for the Total Public Facilities (kW)

Building Type	Roof Mounted	Awning Mounted	Covered Parking	Open Space	Total kW
School	1,532	671	3,894	237	6,333
College	126	22	275	13	437
Hospital	139	81	596	30	846
Office	427	305	1,970	120	2,822
Miscellaneous					
Very large	4,279	524	4,814	20	9,636
Other	359	71	404	140	974

5.2 Technical Potential in the Private Sector (Non-Residential)

Results of the technical potential calculations for nonresidential private sector establishments for crystalline and amorphous PV are summarized in Table 5-3 and Table 5-4. The building

type with the most technical potential is Warehouse and Storage, for which crystalline potential is 112,248 kW. The four building types with crystalline technical potential results exceeding 70,000 kW includes: Warehouse and Storage, Manufacturing, Service, and Mercantile. Amorphous photovoltaic technical potential results summarized in Table 5-4 are one-half as large as the results for crystalline-based PV systems. The area application type with the greatest technical potential is most often Covered Parking. For Offices, Covered Parking is most often the application type responsible for the largest share of total technical potential. For only two building types (i.e., Manufacturing, Warehouse & Storage) does some other area/application type account for more technical potential than Parking.

Table 5-3: Crystalline Technical Potential for Private Sector (kW)

Building Type	Roof Mounted	Awning Mounted	Covered Parking	Open Space	Total kW
Education	371	64	1,131	48	1,614
Food Service	4,342	603	26,763	503	32,211
Health Care	1,468	658	6,290	451	8,867
Lodging	773	131	2,728	32	3,664
Manufacturing	49,646	3,212	45,827	1,663	100,349
Mercantile	20,582	1,653	48,115	1,061	71,411
Office	4,263	1,559	19,674	1,261	26,757
Other	6,216	365	13,644	267	20,493
Public Assembly	1,095	109	9,124	37	10,364
Religious Worship	1,569	175	12,173	70	13,987
Service	24,361	1,676	54,812	1,129	81,978
Wrhse & Storage	69,635	3,698	36,866	2,049	112,248

Table 5-4: Amorphous Technical Potential for Private Sector (kW)

Building Type	Roof Mounted	Awning Mounted	Covered Parking	Open Space	Total kW
Education	185	32	566	24	807
Food Service	2,171	302	13,382	252	16,105
Health Care	734	329	3,145	226	4,433
Lodging	386	65	1,364	16	1,832
Manufacturing	24,823	1,606	22,914	831	50,174
Mercantile	10,291	827	24,057	531	35,706
Office	2,131	779	9,837	630	13,378
Other	3,108	183	6,822	134	10,246
Public Assembly	547	55	4,562	18	5,182
Religious Worship	785	87	6,087	35	6,994
Service	12,181	838	27,406	565	40,989
Wrhse and Storage	34,818	1,849	18,433	1,024	56,124

Technical potential for both the public and private sectors is summarized in Table 5-5. For crystalline photovoltaic technology, the total technical potential is approximately 526 MW. Public facilities contribute 8% of this total. The total for amorphous photovoltaic material is one-half of that estimated for crystalline material. The allocation of the 263 MW of total amorphous technical potential is identical as it is for crystalline potential.

Table 5-5: Summary Results – Public and Private Sector Technical Potential

Nonresidential Sector	Number of Facilities/ Establishments	Crystalline (kW)	Amorphous (kW)
Public Facilities	240	42,096	21,048
Private Establishments	3,857	483,943	241,972
Total	**4,097**	**526,039**	**263,020**

The allocation of crystalline BI-PV technical potential results to specific zip code areas is summarized in Table 5-6. Zip code 91710 has the most public facility BI-PV technical potential, while zip code area 91761 has the most nonresidential private sector technical potential. Approximately three-quarters of the private sector potential is concentrated in two zip code areas, whereas about one-half of the public facility potential is found in two zip code areas.

Technical potential results are depicted graphically in Figure 1, which identifies the percentage of total technical potential existing in specific 5-digit zip code areas. Five zip code areas account for 88% of the total technical potential. The remaining technical potential exists in small portions of other zip code areas that intersect the mini-grid boundary. Substations are identified in this map with triangular symbols.

The allocation of crystalline BI-PV technical potential results to specific zip code areas is summarized in Table 5-6.

Table 5-6: Crystalline BI-PV Technical Potential by Sector and Zip Code (kW)

Zip	Public	Private	Total
91709	434	1,658	2,091
91710	16,169	133,246	149,414
91730	4,809	9,212	14,021
91739	93	1,458	1,551
91743	0	753	753
91752	46	29,101	29,147
91761	5,596	237,506	243,102
91762	3,293	3,535	6,827
91764	4,250	12,186	16,436
91766	0	4,048	4,048
92335	0	6,180	6,180
92337	0	2,202	2,202
92860	6,573	12,773	19,346
92879	46	6,635	6,682
92880	449	22,001	22,450
92882	339	1,451	1,790
Total	**42,096**	**483,943**	**526,040**

6

Future Technical Potential in the Mini-Grid

The future growth of the technical potential for BI-PV applications within the Commonwealth Renewables Mini-grid area was forecasted for a 5-year (2007) and 10 year (2012) period. In order to determine the future technical potential for BI-PV applications with the mini-grid area, data derived from "2002-2012 Electricity Outlook Report CEC 2002_06_10_700_01_004F" table II-I-2 was used as the basis of future electric growth projections of public agency and commercial facilities. The data, which are summarized in Table 6-1, specifically address California's total future energy consumption at three different growth rates: low, likely, and high. *The growth forecasts are based on the "likely growth" rates.* Even though this data speaks specifically to future energy consumption scenarios, the key operating assumption is that the existing buildings will not be consuming more energy, rather there will be more buildings consuming equal (or potentially slightly smaller) amounts of energy as existing (2002) buildings. Therefore, the percent of change of California's future energy consumption levels represents the amount of new buildings throughout all of the sectors for the years of 2007 and 2012.

Table 6-1: California Forecasted Energy Consumption

Year	Energy Consumption Forecasts		
	Low Growth (GWh)	Most Likely Growth (GWh)	High Growth (GWh)
2002	252,070	255,829	270,236
2003	260,860	266,011	277,601
2004	269,800	276,414	285,012
2005	278,230	286,359	291,778
2006	286,018	293,625	298,466
2007	294,328	299,263	304,904
2008	300,098	305,132	311,604
2009	305,528	310,655	317,978
2010	311,320	316,546	324,757
2011	316,407	321,718	330,065
2012	321,399	326,796	335,277

Data Source: California Energy Commission 2002-2012 Electricity Outlook Report February 2002 pg. 21

The future technical potential for both crystalline and amorphous photovoltaic technologies for BI-PV applications within the mini-grid was estimated by multiplying the accumulated yearly percent of change of energy consumption for 2007 (115.4%) and 2012 (124.1%) by the existing 2002 BI-PV technical potential.

6.1 Technical Potential Forecasts

Results yielded by application of the Commission's energy consumption growth factors described above are summarized in Table 6-2 and Table 6-3. In the mini-grid market potential assessment to be completed at a future date, these technical potential results will be combined with market penetration estimates and other market data and assumptions to estimate market potential given the existence of technical (e.g., available implementation area), economic (e.g., capital cost of photovoltaic systems, systems owner investment hurdle rates), and market (e.g., willingness to use new technology) barriers to BI-PV deployment.

Table 6-2: Public Facility Technical Potential – 5- & 10-Year Forecasts

Year	Number of Facilities	Crystalline (kW)	Amorphous (kW)
2002	240	42,096	21,048
2007	277	48,579	24,290
2012	298	52,242	26,121

Table 6-3: Private Sector Nonresidential Technical Potential – 5- & 10-Year Forecasts

Year	Number of Establishments	Crystalline (kW)	Amorphous (kW)
2002	3,857	483,943	241,972
2007	4,451	558,470	279,235
2012	4,787	600,573	300,287

Appendix A

Database of Public Sector Facilities

An MS Excel database of public sector facilities is included with this report. The file is named Appendix-A_Public-Sector.xls. Field names included in the database are listed below:

- Organization / Site Name
- City
- Zip
- Building Type

[Note: Specific street addresses for the sites in the database were included in the deliverable for Project 3.3.1a.]

Appendix A
Database of Public Sector Facilities

Organization / Site Name	City	Zip	Building Type
City of Chino - Public Works Dept.	Chino	91708-	Office
City of Chino, City Manager	Chino	91708-	Office
City of Chino, Parks & Rec	Chino	91708-	Office
City of Chino, Street Dept	Chino	91708-	Office
City of Chino, Community Development Dept	Chino	91708-	Office
Butterfield Elementary School	Chino Hills	91709-	School
Chino Hills Fish Hatchery	Chino Hills	91709-	Office
Chino Public Facilities and Operations	Chino	91709-	Office
City of Chino Hills, Admin	Chino Hills	91709-	Office
Los Angeles Fire Station 141, Chino Hills	Chino Hills	91709-	Misc
City of Chino Hills, Community Development	Chino Hills	91709-	Office
US Postal Service, Chino	Chino	91710-	Misc
Chino Airport	Chino	91710-	Misc
Chino City Refuse	Chino	91710-	Misc
Chino Fairgrounds	Chino	91710-	Misc
Prado Tiro Shooting Range	Chino	91710-	Misc
Chino Valley Medical Ctr	Chino	91710-	Hospital
Chino Senior Center	Chino	91710-	Hospital
Alice E. Cortez Elementary School	Chino	91710-	School
Ana Borba Fundamental School	Chino	91710-	School
Buena Vista High School	Chino	91710-	School
Cattle Elementary School	Chino	91710-	School
Chino High School	Chino	91710-	School
Dickson Elementary School	Chino	91710-	School
Don Antonio Lugo High School	Chino	91710-	School
El Rancho Elementary School	Chino	91710-	School
Gird Elementary School	Chino	91710-	School
Lyle S. Briggs Fundamental School	Chino	91710-	School
Magnolia Junior High School	Chino	91710-	School
Marshall Elementary School	Chino	91710-	School
Ramona Junior High School	Chino	91710-	School
Walnut Avenue Elementary School	Chino	91710-	School
Newman Elementary School	Chino	91710-	School
Chino Branch Library	Chino	91710-	Misc
Planes of Fame Museum	Chino	91710-	Misc
Yorba Slaughter Adobe	Chino	91710-	Misc
Chino Valley Chamber of Commerce	Chino	91710-	Office
7th Street Community Theater	Chino	91710-	Office
Chino Youth & Family Human Services	Chino	91710-	Office
City of Chino Planning Commission	Chino	91710-	Office
City of Chino, Admin	Chino	91710-	Office
City of Chino, Housing Programs	Chino	91710-	Office
City of Chino, Marketing	Chino	91710-	Office
City of Chino, Planning	Chino	91710-	Office
El Prado Golf Course	Chino	91710-	Office
Envirothene	Chino	91710-	Office
Oranco Bowmen Archery Range	Chino	91710-	Office
Prado Recreation, Dog Training Facility	Chino	91710-	Office
Prado Regional Park	Chino	91710-	Office
Prado Stables & Equestrian Center	Chino	91710-	Office
Chino Recreation Dept	Chino	91710-	Office

Appendix A
Database of Public Sector Facilities

Organization / Site Name	City	Zip	Building Type
Chino Community Building	Chino	91710-	Office
San Bernardino County Div, Chino	Chino	91710-	Office
Chino Public Works Services Center	Chino	91710-	Office
Southern California Agency, Riverside	Chino	91710-	Office
Chino Police Department	Chino	91710-	Office
Chino Public Defender's Office	Chino	91710-	Office
CA Institute for Women	San Bernardino Co.	91710-	Misc
California Dept Of Corrections, Chino	Chino	91710-	Misc
California Institute for Men	Chino	91710-	Misc
Stark Youth Correctional Facility	Chino	91710-	Misc
Chino Hills Fire Dept	Chino	91710-	Misc
Chino Valley Independent Fire District	Chino Hills	91710-	Misc
Forestry Dept, Prado Conservation Camp	Chino	91710-	Misc
Chino Valley Ind Fire Dst	Chino	91710-	Misc
Chino Finance Department	Chino	91710-	Office
Chino Public Health Dept	Chino	91710-	Office
West Valley Mosquito & Vector Control District	Chino	91710-	Office
Prado Conservation Camp	Chino	91710-	Office
Community Services Administration, Chino	Chino	91710-	Office
Inland Empire Utilities Agency (IEUA)	Rancho Cucamonga	91729-	Misc
Rancho Cucamonga County Water Dist - Gen Mgr	Rancho Cucamonga	91729-	Misc
Rancho Cucamonga County Water District	Rancho Cucamonga	91729-	Misc
City of Rancho Cucamonga	Rancho Cucamonga	91729-	Office
City of Rancho Cucamonga, Admin	Rancho Cucamonga	91729-	Office
Rancho Cucamonga Fire District	Rancho Cucamonga	91729-	Office
Rancho Cucamonga C H P	Rancho Cucamonga	91729-	Office
California Dept Of Corrections, Rancho Cucamonga	Rancho Cucamonga	91729-	Misc
US Postal Service, Rancho Cucamonga	Rancho Cucamonga	91730-	Misc
Big League Dreams Sports Park	Rancho Cucamonga	91730-	Misc
Rancho San Antonio Medical Center	Rancho Cucamonga	91730-	Hospital
Rancho Cucamonga School District	Rancho Cucamonga	91730-	School
West End Educational Services Ctr, Cucamonga	Rancho Cucamonga	91730-	School
Alta Loma High School	Rancho Cucamonga	91730-	School
Bear Gulch Elementary School	Rancho Cucamonga	91730-	School
Coyote Canyon Elementary School	Rancho Cucamonga	91730-	School
Dona Merced Elementary School	Rancho Cucamonga	91730-	School
Los Amigos Elementary School	Rancho Cucamonga	91730-	School
Rancho Cucamonga Elementary School	Rancho Cucamonga	91730-	School
Rancho Cucamonga Junior High School	Rancho Cucamonga	91730-	School
Rancho Cucamonga Middle School	Rancho Cucamonga	91730-	School
Ruth Musser Junior High School	Rancho Cucamonga	91730-	School
Terra Vista Elementary School	Rancho Cucamonga	91730-	School
Valle Vista Elementary School	Rancho Cucamonga	91730-	School
Rancho Cucamonga Junior College	Rancho Cucamonga	91730-	College
Rancho Cucamonga Library	Rancho Cucamonga	91730-	Misc
Casa de Rancho Cucamonga	Rancho Cucamonga	91730-	Misc
Law Library, Cucamonga	Rancho Cucamonga	91730-	Misc
Route 66 Visitor Center & Museum	Rancho Cucamonga	91730-	Misc
City of Rancho Cucamonga, Community Dev	Rancho Cucamonga	91730-	Office
City of Rancho Cucamonga, Council	Rancho Cucamonga	91730-	Office
City of Rancho Cucamonga, Mayor's Office	Rancho Cucamonga	91730-	Office

Appendix A
Database of Public Sector Facilities

Organization / Site Name	City	Zip	Building Type
City of Rancho Cucamonga, Planning	Rancho Cucamonga	91730-	Office
Rancho Cucamonga Animal Shelter	Rancho Cucamonga	91730-	Office
Rancho Cucamonga Selection And Standards	Rancho Cucamonga	91730-	Office
Rancho Cucamonga, Lions Park East	Rancho Cucamonga	91730-	Office
Rancho Cucamonga, Lions Park West	Rancho Cucamonga	91730-	Office
Rancho Cucamonga, Senior Center	Rancho Cucamonga	91730-	Office
Rancho Cucamonga, Street & Park Maintenance Yard	Rancho Cucamonga	91730-	Office
Rancho Cucamonga Maintence Dept	Rancho Cucamonga	91730-	Office
Courthouse, San Bernardino	Rancho Cucamonga	91730-	Office
Juvenile Court-Delinquency, Cucamonga	Rancho Cucamonga	91730-	Office
Juvenile Traffic Court Cucamonga	Rancho Cucamonga	91730-	Office
Rancho Cucamonga Child Protective Services	Rancho Cucamonga	91730-	Office
Rancho Cucamonga Sheriff's Station	Rancho Cucamonga	91730-	Office
Rancho Cucamonga Police Dept, San Bernardino	Rancho Cucamonga	91730-	Office
Rancho Cucamonga Court	Rancho Cucamonga	91730-	Office
San Bernardino District Attorney's Office	Rancho Cucamonga	91730-	Office
Rancho Cucamonga Jobs & Employment Services	Rancho Cucamonga	91730-	Office
Dept of Children's Services, Cucamonga	Rancho Cucamonga	91730-	Office
Rancho Cucamonga Department Aging & Adult Svcs	Rancho Cucamonga	91730-	Office
Transitional Assistance Dept, Cucamonga	Rancho Cucamonga	91730-	Office
Rancho Cucamonga, Mosquito & Vector Control	Rancho Cucamonga	91730-	Office
Pitassi Architects, Inc.	Rancho Cucamonga	91730-	Office
Department of Motor Vehicles, Cucamonga	Rancho Cucamonga	91730-	Office
Road & Flood Maintenance Yard, Cucamonga	Rancho Cucamonga	91730-	Office
West Valley Juvenile Hall	Rancho Cucamonga	91739-	Misc
West Valley County Jail	Rancho Cucamonga	91739-	Misc
Mira Loma Space Ctr	Mira Loma	91752-	Misc
Ontario International Airport	Ontario	91761-	Misc
FAA Airways Facilities Sector Field Office	Ontario	91761-	Misc
Ontario Community Hospital	Ontario	91761-	Hospital
Mountain View School District	Ontario	91761-	School
Bon View Elementary School	Ontario	91761-	School
Creek View Elementary School	Ontario	91761-	School
De Anza Junior High School	Ontario	91761-	School
De Anza Middle School	Ontario	91761-	School
Levi H Dickey Elementary School	Ontario	91761-	School
Loma Vista Elementary School	Ontario	91761-	School
Mountain View Elementary School, Ontario	Ontario	91761-	School
Ranch View Elementary School	Ontario	91761-	School
Sultana Elementary School	Ontario	91761-	School
Woodcrest Junior High School	Ontario	91761-	School
South Ontario Branch Library	Ontario	91761-	Misc
Employment Development Dept, Ontario	Ontario	91761-	Office
Ontario Recreation Dept, Bon View Community Ctr	Ontario	91761-	Office
Ontario Municipal Service Center	Ontario	91761-	Office
Ontario, Westwind Community Ctr	Ontario	91761-	Office
City Of Corona, Public Works	Corona	91761-	Office
Ontario Police Air Support Unit	Ontario	91761-	Office
Ontario Police Department	Ontario	91761-	Office
California Institute For Women, Corona	Corona	91761-	Misc
US Forestry Dept, Animal & Plant Inspect, Ontario	Ontario	91761-	Misc

Appendix A
Database of Public Sector Facilities

Organization / Site Name	City	Zip	Building Type
U.S. Forestry Dept, South Zone Fire Cache, Ontario	Ontario	91761-	Misc
Corona Fire Department	Corona	91761-	Misc
U.S. Bankruptcy Court, Riverside	Ontario	91761-	Office
Social Security Administration, Ontario	Ontario	91761-	Office
Inland Empire West Resource Conservation District	Ontario	91761-	Office
Air National Guard	Ontario	91761-	Office
Home Gardens County Water Dst	Corona	91762-	Misc
Kaiser Permanente Ontario Medical Offices	Ontario	91762-	Hospital
Community Med Group Of Corona	Corona	91762-	Hospital
Ontario Montclair School District	Ontario	91762-	School
Chaffey High School	Ontario	91762-	School
El Camino Elementary School	Ontario	91762-	School
Elderberry Elementary School	Ontario	91762-	School
Euclid Elementary School	Ontario	91762-	School
Grace Yokley Middle School	Ontario	91762-	School
Hawthorne Elementary School	Ontario	91762-	School
Mission Elementary School	Ontario	91762-	School
Oaks Middle School	Ontario	91762-	School
Ontario High School	Ontario	91762-	School
Richard E Haynes Elementary School	Ontario	91762-	School
Vina Danks Middle School	Ontario	91762-	School
Chaffey Community College Dst, Ontario	Ontario	91762-	College
Ontario Museum of History and Art	Ontario	91762-	Misc
District Office, c/o Pat King	Ontario	91762-	Office
Ontario Recreation Dept, Colony Park Community Ctr	Ontario	91762-	Office
Ontario Recreation Dept, Armstrong Ctr	Ontario	91762-	Office
Ontario Recreation Dept, De Anza Community Ctr	Ontario	91762-	Office
Assessor	Ontario	91762-	Office
Land Use Services Dept, Ontario	Ontario	91762-	Office
Veterans Affairs	Ontario	91762-	Office
Ontario Fire Department Inc	Ontario	91762-	Misc
Ontario Department Aging & Adult Svcs	Ontario	91762-	Office
Ontario Convention Center	Ontario	91764-	Misc
Kindred Hospital	Ontario	91764-	Hospital
Vencor Hospital, Ontario	Ontario	91764-	Hospital
Arroyo Elementary School	Ontario	91764-	School
Berlyn Elementary School	Ontario	91764-	School
Central Elementary School	Ontario	91764-	School
Corona Elementary School	Ontario	91764-	School
Del Norte Elementary School	Ontario	91764-	School
Edison Elementary School	Ontario	91764-	School
Mariposa Elementary School	Ontario	91764-	School
Ontario Center Elementary School	Ontario	91764-	School
Ray Wiltsey Middle School	Ontario	91764-	School
Valley View High School	Ontario	91764-	School
Vineyard Elementary School	Ontario	91764-	School
Ontario Library	Ontario	91764-	Misc
City of Ontario, Admin	Ontario	91764-	Office
City of Ontario, Creekside Golf-Pitch N' Putt	Ontario	91764-	Office
City of Ontario, Development	Ontario	91764-	Office
City of Ontario, Engineering	Ontario	91764-	Office

Appendix A
Database of Public Sector Facilities

Organization / Site Name	City	Zip	Building Type
City of Ontario, Finance	Ontario	91764-	Office
City of Ontario, Housing	Ontario	91764-	Office
City of Ontario, Planning	Ontario	91764-	Office
City of Ontario, Public Works	Ontario	91764-	Office
L.D. King, Inc.	Ontario	91764-	Office
Ontario Teen Ctr	Ontario	91764-	Office
Ontario Multi-Purpose Building	Ontario	91764-	Office
Rancho Cucamonga-Guasti Regional Park	Ontario	91764-	Office
Office of Hazardous Materials Enforcement, Western	Ontario	91764-	Office
Export Assistance Center, Ontario	Ontario	91764-	Office
U.S. Army, Org Maintenance Shop, Ontario	Ontario	91764-	Office
Corona Norco Unified School District	Norco	92860-	School
Highland Elementary School	Norco	92860-	School
Norco High School	Norco	92860-	School
Norco School	Norco	92860-	School
Riverview Elementary School	Norco	92860-	School
Sierra Vista Elementary School	Norco	92860-	School
Riv Comm College Norco	Norco	92860-	College
Riverside Community College Norco	Norco	92860-	College
Norco Branch Library	Norco	92860-	Misc
City Of Norco, Parks & Rec	Norco	92860-	Office
City Of Norco, Public Works	Norco	92860-	Office
Norco Community Center	Norco	92860-	Office
City of Norco, Admin	Norco	92860-	Office
Norco Rehabilitation Ctr	Norco	92860-	Misc
Department of Motor Vehicles, Norco	Norco	92860-	Office
Naval Surface Warfare Ctr Corona Div	Norco	92860-	Office
Home Gardens Sanitary District	Corona	92879-	Misc
Corona Municipal Airport	Corona	92880-	Misc
Elsinore Valley Municpl Water District, Corona	Corona	92880-	Misc
Auburndale School	Corona	92880-	School
Washington Elementary School	Corona	92880-	School
Corona Regional Medical Center	Corona	92882-	Hospital
Corona Library	Corona	92882-	Misc
City of Corona, City Manager	Corona	92882-	Office
Courthouse, Corona	Corona	92882-	Office

Appendix B

Database of Private Sector Establishments

A MS Excel database of private sector establishments is included with this report. The file is named Appendix-B_Private-Sector.xls. Field names included in the database are listed below:

- Zip Code Area
- Building Activity Type
- No. of Establishments
- No. of Employees
- Total Bldg. Area (Square Feet)
- Total Roof Area (Square Feet)

In the case of private sector establishments the analysis was performed at the zip code-building type level. The database summarizes mini-grid private sector establishment characteristics for zip code and building type combinations. Results in the worksheet have been rounded off to the nearest whole number. In some cases this results in the number of facilities being equal to 0 while the number of employees, building square footage, and total roof square footage are non-zero. This is a consequence of application of zip code area proration factors. That is, for the private sector analysis, for several zip code areas we do not know whether particular facilities lie within the mini-grid or outside the mini-grid area. The probabilistic approach employed in the analysis yields satisfactory accuracy at the zip code and mini-grid levels (but not necessarily the individual facility level).

Appendix B
Database of Private Sector Establishments

Zip Code Area	Building Activity Type	No. of Establishments	No. of Employees	Total Bldg. Area (Square Feet)	Total Roof Area (Square Feet)
91709	Education	0	10	9,900	5,841
91709	Food Service	2	30	15,125	11,041
91709	Health Care	2	14	6,989	2,097
91709	MECS	0	1	575	432
91709	Mercantile	4	84	94,725	72,938
91709	Office	6	25	12,725	4,963
91709	Other	0	1	1,038	851
91709	Public Assembly	0	4	9,625	5,198
91709	Religious Worship	0	2	5,925	3,437
91709	Service	4	33	37,163	29,730
91709	Warehouse and Storage	3	11	15,870	13,490
91710	Education	10	72	72,000	42,480
91710	Food Service	80	1,842	921,200	672,476
91710	Health Care	102	1,640	821,440	246,432
91710	Lodging	3	53	107,237	36,461
91710	MECS	222	8,865	6,829,238	5,121,929
91710	Mercantile	174	3,088	3,474,000	2,674,980
91710	Office	182	2,027	1,013,600	395,304
91710	Other	34	319	245,157	201,029
91710	Public Assembly	9	94	234,000	126,360
91710	Religious Worship	18	236	706,800	409,944
91710	Service	160	2,165	2,405,537	1,924,430
91710	Warehouse and Storage	239	4,489	6,360,630	5,406,535
91730	Education	1	13	13,450	7,936
91730	Food Service	5	120	59,788	43,645
91730	Health Care	7	131	65,406	19,622
91730	Lodging	0	0	254	86
91730	MECS	12	516	367,370	275,527
91730	Mercantile	10	171	192,797	148,454
91730	Office	22	292	146,050	56,960
91730	Other	2	23	17,725	14,535
91730	Public Assembly	1	13	32,000	17,280
91730	Religious Worship	1	3	8,625	5,003
91730	Service	10	287	318,774	255,019
91730	Warehouse and Storage	11	223	316,522	269,044
91739	Education	0	3	3,450	2,036
91739	Food Service	1	11	5,475	3,997
91739	Health Care	1	6	2,781	834
91739	MECS	2	90	95,732	71,799
91739	Mercantile	2	50	56,194	43,269
91739	Office	2	10	5,075	1,979
91739	Other	0	1	385	315
91739	Religious Worship	1	5	14,700	8,526
91739	Service	1	24	26,886	21,509
91739	Warehouse and Storage	2	24	33,725	28,666
91743	Education	1	15	14,500	8,555
91743	Food Service	1	15	7,250	5,293
91743	MECS	4	36	23,408	17,556
91743	Office	3	8	3,750	1,463
91743	Other	2	5	3,845	3,153

Appendix B
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Zip Code Area	Building Activity Type	No. of Establishments	No. of Employees	Total Bldg. Area (Square Feet)	Total Roof Area (Square Feet)
91743	Service	4	39	42,774	34,219
91743	Warehouse and Storage	2	10	13,462	11,442
91752	Food Service	8	137	68,250	49,823
91752	Health Care	4	42	21,230	6,369
91752	MECS	29	1,884	1,329,940	997,455
91752	Mercantile	14	134	150,188	115,644
91752	Office	22	223	111,563	43,509
91752	Other	8	658	505,810	414,764
91752	Religious Worship	1	2	5,625	3,263
91752	Service	23	169	187,898	150,318
91752	Warehouse and Storage	57	3,117	4,416,789	3,754,271
91761	Education	3	52	51,500	30,385
91761	Food Service	74	1,292	646,000	471,580
91761	Health Care	31	1,143	572,643	171,793
91761	Lodging	7	259	526,029	178,850
91761	MECS	340	16,336	13,348,289	10,011,217
91761	Mercantile	156	3,739	4,206,375	3,238,909
91761	Office	181	3,936	1,967,750	767,423
91761	Other	58	2,567	1,973,639	1,618,384
91761	Public Assembly	2	109	272,500	147,150
91761	Religious Worship	7	54	162,000	93,960
91761	Service	172	5,755	6,393,250	5,114,600
91761	Warehouse and Storage	470	11,891	16,849,547	14,322,115
91762	Education	0	13	12,500	7,375
91762	Food Service	3	52	25,988	18,971
91762	Health Care	4	44	22,244	6,673
91762	Lodging	0	2	3,148	1,070
91762	MECS	4	113	75,673	56,754
91762	Mercantile	7	79	89,297	68,759
91762	Office	6	56	28,225	11,008
91762	Other	0	3	2,442	2,002
91762	Public Assembly	0	6	16,063	8,674
91762	Religious Worship	1	7	22,275	12,920
91762	Service	8	132	146,652	117,322
91762	Warehouse and Storage	4	36	51,083	43,420
91764	Education	1	20	20,000	11,800
91764	Food Service	6	258	128,750	93,988
91764	Health Care	3	67	33,417	10,025
91764	Lodging	2	90	181,775	61,803
91764	MECS	2	51	29,696	22,272
91764	Mercantile	20	364	409,500	315,315
91764	Office	19	405	202,450	78,956
91764	Other	1	37	28,376	23,268
91764	Public Assembly	0	18	44,250	23,895
91764	Religious Worship	1	7	19,650	11,397
91764	Service	7	443	491,618	393,294
91764	Warehouse and Storage	3	83	117,186	99,608
91766	Education	0	21	20,550	12,125
91766	Food Service	3	28	14,225	10,384
91766	Health Care	2	31	15,556	4,667

Appendix B
Database of Private Sector Establishments

Zip Code Area	Building Activity Type	No. of Establishments	No. of Employees	Total Bldg. Area (Square Feet)	Total Roof Area (Square Feet)
91766	Lodging	0	2	3,199	1,088
91766	MECS	5	243	163,011	122,259
91766	Mercantile	5	113	127,350	98,060
91766	Office	6	115	57,413	22,391
91766	Other	1	4	3,422	2,806
91766	Public Assembly	0	0	938	506
91766	Religious Worship	0	2	6,450	3,741
91766	Service	5	72	80,381	64,305
91766	Warehouse and Storage	6	190	268,769	228,454
92335	Education	0	5	5,050	2,980
92335	Food Service	5	94	47,013	34,319
92335	Health Care	4	160	80,398	24,119
92335	Lodging	0	2	3,656	1,243
92335	MECS	6	272	239,595	179,696
92335	Mercantile	11	170	191,503	147,457
92335	Office	6	52	26,163	10,203
92335	Other	1	32	24,877	20,399
92335	Public Assembly	0	4	8,938	4,826
92335	Religious Worship	1	5	13,575	7,874
92335	Service	9	90	99,518	79,614
92335	Warehouse and Storage	9	263	372,281	316,439
92337	Food Service	1	5	2,713	1,980
92337	Health Care	0	3	1,716	515
92337	MECS	4	188	161,612	121,209
92337	Mercantile	2	32	35,972	27,698
92337	Office	1	32	16,163	6,303
92337	Other	0	11	8,709	7,141
92337	Public Assembly	0	0	313	169
92337	Religious Worship	0	0	1,425	827
92337	Service	3	32	35,774	28,619
92337	Warehouse and Storage	5	155	219,670	186,720
92860	Education	2	4	4,000	2,360
92860	Food Service	14	214	107,200	78,256
92860	Health Care	16	84	42,284	12,685
92860	Lodging	1	12	23,560	8,010
92860	MECS	14	370	257,166	192,874
92860	Mercantile	34	500	562,500	433,125
92860	Office	42	228	114,000	44,460
92860	Other	6	20	15,072	12,359
92860	Public Assembly	2	14	34,000	18,360
92860	Service	39	448	497,728	398,182
92860	Warehouse and Storage	16	116	164,372	139,716
92879	Education	1	4	4,250	2,508
92879	Food Service	8	131	65,563	47,861
92879	Health Care	17	174	86,986	26,096
92879	MECS	17	520	350,074	262,555
92879	Mercantile	13	100	112,922	86,950
92879	Office	21	155	77,625	30,274
92879	Other	2	5	3,845	3,153
92879	Public Assembly	0	2	4,375	2,363

Appendix B
Database of Private Sector Establishments

Zip Code Area	Building Activity Type	No. of Establishments	No. of Employees	Total Bldg. Area (Square Feet)	Total Roof Area (Square Feet)
92879	Religious Worship	1	7	21,750	12,615
92879	Service	16	135	150,124	120,099
92879	Warehouse and Storage	16	160	226,189	192,260
92880	Education	1	2	2,000	1,180
92880	Food Service	14	200	100,000	73,000
92880	Health Care	8	99	49,499	14,850
92880	MECS	87	1,888	1,516,019	1,137,014
92880	Mercantile	25	250	281,250	216,563
92880	Office	44	600	300,000	117,000
92880	Other	3	8	6,152	5,045
92880	Public Assembly	2	41	103,000	55,620
92880	Religious Worship	1	6	16,800	9,744
92880	Service	46	413	458,621	366,897
92880	Warehouse and Storage	78	899	1,273,600	1,082,560
92882	Education	0	3	2,550	1,505
92882	Food Service	2	31	15,725	11,479
92882	Health Care	4	24	11,899	3,570
92882	Lodging	0	2	3,656	1,243
92882	MECS	2	53	35,713	26,785
92882	Mercantile	3	35	39,291	30,254
92882	Office	5	33	16,275	6,347
92882	Other	1	3	2,096	1,718
92882	Public Assembly	0	0	313	169
92882	Religious Worship	0	3	8,850	5,133
92882	Service	4	42	46,523	37,219
92882	Warehouse and Storage	2	15	21,822	18,549