

California Air Resources Board

Quantification Methodology for the Department of Community Services and Development Low-Income Weatherization Program Community Solar Pilot

California Climate Investments Greenhouse Gas Reduction Fund



Note:

The California Air Resources Board (CARB) is accepting public comments on the Revised Draft Community Solar Pilot Quantification Methodology and Revised Draft Community Solar Pilot Benefits Calculator Tool until July 26, 2018 via GGRFProgram@arb.ca.gov. The Revised Draft Community Solar Pilot Quantification Methodology and the Revised Draft Community Solar Pilot Benefits Calculator Tool are subject to change pending stakeholder comments and Final Community Solar Pilot Guidelines. The Final Community Solar Pilot Quantification Methodology and Final Benefits Calculator Tool will be available on the CARB quantification website at: <http://www.arb.ca.gov/ci-resources>.

**REVISED DRAFT
June 22, 2018**

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Section A. Introduction

California Climate Investments is a statewide initiative that puts billions of Cap-and-Trade dollars to work facilitating greenhouse gas (GHG) emission reductions; strengthening the economy; improving public health and the environment; and providing benefits to residents of disadvantaged communities, low-income communities, and low-income households, collectively referred to as “priority populations.” Where applicable and to the extent feasible, California Climate Investments must maximize economic, environmental, and public health co-benefits to the State.

The California Air Resources Board (CARB) is responsible for providing guidance on estimating the GHG emission reductions and co-benefits from projects receiving monies from the Greenhouse Gas Reduction Fund (GGRF). This guidance includes quantification methodologies, co-benefit assessment methodologies, and benefit calculator tools. CARB develops these methodologies and tools based on the project types eligible for funding by each administering agency, as reflected in the program expenditure records available at: <http://www.arb.ca.gov/cci-expenditurerecords>.

For the California Department of Community Services and Development (CSD) Community Solar Pilot, CARB staff developed this Community Solar Pilot Quantification Methodology and accompanying Community Solar Pilot Benefits Calculator Tool to provide guidance for estimating the GHG emission reductions and select co-benefits of each proposed project type (Section B), provide instructions for documenting and supporting the estimates (Section C), and outline the process for tracking and reporting GHG and other benefits once a project is funded (Section D).

This methodology uses calculations to estimate GHG emission reductions and select co-benefits associated with the reduction of fossil-fuel-generated electricity use due to increased on-site solar electricity generation associated with the implementation of Community Solar Pilot projects. Projects will report the total project GHG emission reductions and select co-benefits estimated using this methodology, as well as the total project GHG emission reductions per dollar of GGRF funds requested.

In an effort to enhance the analysis, provide greater transparency, and assist in project-level reporting, CARB has included an additional output tab for select co-benefits and key variables. Key variables are project characteristics that contribute to a project's GHG emission reductions and signal an additional benefit (e.g., renewable energy generated, trees planted).

Using largely the same inputs required to estimate GHG emission reductions, the Community Solar Pilot Benefits Calculator Tool estimates the following co-benefits and key variables from Community Solar Pilot projects: select criteria and toxic air pollutants (in pounds (lbs))—including nitrogen oxide (NO_x), reactive organic gases (ROG), and fine particulate matter less than 2.5 micrometers (PM_{2.5}); total annual energy cost savings (in \$); total lifetime energy cost savings (in \$); agricultural or natural land area

converted or disturbed by solar photovoltaic (PV) installation (in acres); total annual renewable electricity generation (in kWh); and total lifetime renewable electricity generation (in kWh). Additional co-benefits for which CARB assessment methodologies were not incorporated into the Community Solar Pilot Benefits Calculator Tool may also be applicable to the project. Applicants should consult the Community Solar Pilot Guidelines, solicitation materials, and agreements to ensure they are meeting Community Solar Pilot requirements.

Community Solar Pilot Project Types

The CSD Community Solar Pilot reduces GHG emissions by reducing the need for fossil-fuel-generated electricity as a result of increased on-site solar electricity generation. CSD developed a Program Design Document that outlines project types that meet the objectives of the Community Solar Pilot and for which there are methods to quantify GHG emission reductions.ⁱ Each project requesting GGRF funding must include the following project type:

- Grid-connected solar PV system.

Section B of this Quantification Methodology details the methods to use based on the project type proposed.

Methodology Development

CARB and CSD developed this Quantification Methodology consistent with the guiding implementation principles of California Climate Investments, including ensuring transparency and accountability.ⁱⁱ CARB and CSD developed this Quantification Methodology to be used to estimate the outcomes of proposed projects, inform project selection, and track results of funded projects. The implementing principles ensure that the methodology would:

- Apply at the project-level;
- Provide uniform methods to be applied statewide, and be accessible by all applicants;
- Use existing and proven tools and methods;
- Use project-level data, where available and appropriate; and
- Result in GHG emission reduction estimates that are conservative and supported by empirical literature.

CARB assessed peer-reviewed literature and tools and consulted with experts, as needed, to determine methods appropriate for the Community Solar Pilot project types. CARB also consulted with CSD to determine project-level inputs available. The methods were developed to provide estimates that are as accurate as possible with data readily available at the project level. CARB released the Draft Community Solar Pilot Quantification Methodology and Draft Community Solar Pilot Benefits Calculator Tool for public comment in May 2018.

In addition, the University of California, Berkeley, in collaboration with CARB, developed assessment methodologies for a variety of co-benefits such as providing cost savings, lessening the impacts and effects of climate change, and reducing the incidence of asthma/respiratory disease. As they become available, co-benefit assessment methodologies are posted at: www.arb.ca.gov/cci-cobenefits.

Tools

This Community Solar Pilot Quantification Methodology and accompanying Community Solar Pilot Benefits Calculator Tool rely on project-specific outputs from the following tools:

The National Renewable Energy Laboratory (NREL) PVWatts® Calculator is a web-based tool that estimates the electricity production of a grid-connected roof- or ground-mounted solar PV system based on simple inputs. PVWatts calculates estimated values for the proposed system's monthly and annual electricity production, and for the monetary value of the electricity. The tool is used statewide, publicly available, subject to regular updates to incorporate new information, is free of charge, and available to anyone with internet access. The tool can be accessed at: <http://pvwatts.nrel.gov/>.

In addition to the tool above, this Quantification Methodology relies on CARB-developed emission factors. CARB has established a single repository for emission factors used in quantification methodologies, referred to as the California Climate Investments Quantification Methodology Emission Factor Database (Database).ⁱⁱⁱ The Database Documentation explains how emission factors used in CARB quantification methodologies are developed and updated.

Applicants must use this Quantification Methodology, in conjunction with the accompanying Community Solar Pilot Benefits Calculator Tool, to estimate the GHG emission reductions and select co-benefits of the proposed project. The Community Solar Pilot Benefits Calculator Tool can be downloaded from: <http://www.arb.ca.gov/cci-resources>.

Program Assistance

CSD staff will review the quantification portions of the Community Solar Pilot project applications to ensure that the methods described in this document were properly applied to estimate the GHG emission reductions and co-benefits for the proposed project. Applicants should use the following resources for additional questions and comments:

- Questions on this document should be sent to GGRFProgram@arb.ca.gov.
- For more information on CARB's efforts to support implementation of GGRF investments, see: <https://www.arb.ca.gov/auctionproceeds>.
- Questions pertaining to the Community Solar Pilot should be sent to CSD at: www.csd.ca.gov/ContactUs.aspx.

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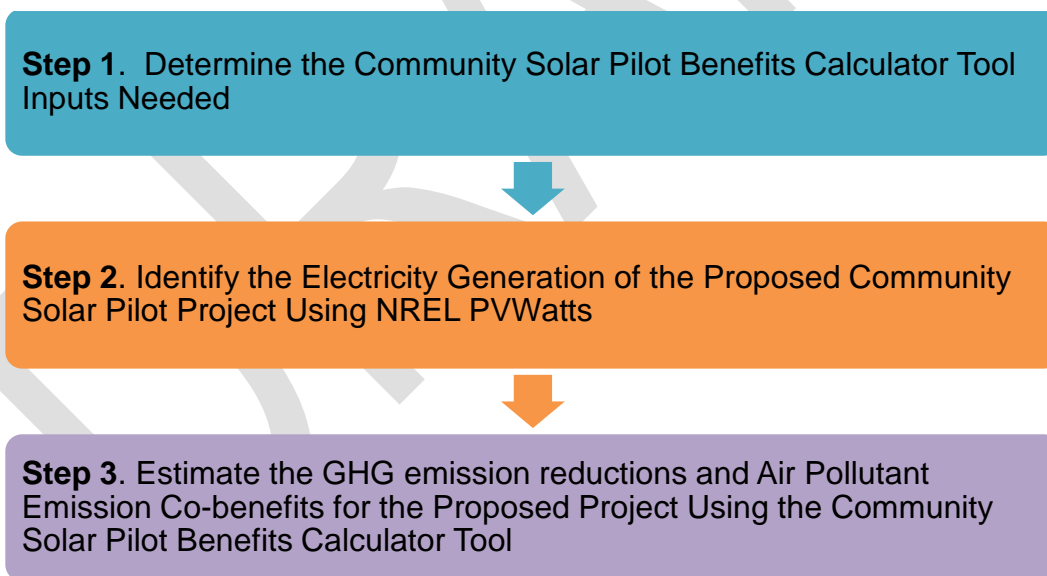
Section B. Quantification Methodology

Overview

Applicants will follow the steps outlined in Figure 1 to estimate the GHG emission reductions and air pollutant emission co-benefits from the proposed project. Detailed instructions for each step are provided on subsequent pages. An example project showing how to estimate the GHG emission reductions and air pollutant emission co-benefits from a grid-connected solar PV system is included in Appendix A.

Methods and equations used in the Community Solar Pilot Benefits Calculator Tool for estimating GHG emission reductions and air pollutant emission co-benefits are provided in Appendix B. Methods and equations used in the Community Solar Pilot Benefits Calculator Tool for estimating other co-benefits and key variables not included in this Quantification Methodology are available at: www.arb.ca.gov/cci-cobenefits. Emission factors used in calculations are contained in the Database available at: <http://www.arb.ca.gov/cci-resources>. Documentation on the sources and methods used to develop the emission factors are also provided.

Figure 1. Steps to Estimating GHG Emission Reductions and Air Pollutant Emission Co-benefits



Step 1: Determine the Community Solar Pilot Benefits Calculator Tool Inputs Needed

Table 1 identifies the required data inputs needed to estimate the GHG emission reductions and air pollutant emission co-benefits for the proposed project with the Community Solar Pilot Benefits Calculator Tool.

Table 1. Required Community Solar Pilot Benefits Calculator Tool Inputs for Eligible Projects

ALL PROJECTS
<p>General Information (Read Me worksheet)</p> <ul style="list-style-type: none"> • Project Name; • Contact Name; • Contact Phone Number; • Contact Email; • Date Calculator Completed; • Total Community Solar Pilot GGRF Funds Requested; • Other GGRF Leveraged Funds; and • Non-GGRF Leveraged Funds. <p>Total Project GHG Emission Reductions/GGRF Funds Requested (GHG Summary worksheet)</p> <ul style="list-style-type: none"> • Total amount of Community Solar Pilot GGRF funds requested from this solicitation to implement the project; • Total amount of additional GGRF funds to implement the project (include GGRF funds previously awarded to the project by another California Climate Investments program, GGRF funds currently being requested from another California Climate Investments program, and GGRF funds the project plans to request in the future from CSD's Community Solar Pilot or another California Climate Investments program). • Identify California Climate Investments program(s) from which the project has been awarded GGRF funds (include award date), is currently requesting GGRF funds, or plans to request GGRF funds. For a list of GGRF funded programs, go to: www.arb.ca.gov/cc-events.

COMMUNITY SOLAR PV**Quantification Inputs¹** (Inputs worksheet)

NREL PVWatts Calculator inputs:

- Location;
- Direct current (DC) system size (kW);
- Module type;
- Array type;
- System losses (%);
- Tilt (deg);
- Azimuth (deg);
- “Loss Calculator,” – to refine the systems losses (%) input - includes the following (as a percent, %):
 - Soiling;
 - Shading;
 - Snow;
 - Mismatch;
 - Wiring;
 - Connections;
 - Light induced degradation;
 - Nameplate rating;
 - Age;
 - Availability;
- “Advanced Parameters”,² which includes the following:
 - DC to alternating current (AC) size ratio;
 - Inverter efficiency (%); and
 - Ground coverage ratio.

Other Community Solar Pilot Benefits Calculator Tool inputs:

- Useful life (years); and
- Annual solar PV production (kWh/year) (*output from NREL PVWatts Calculator*).

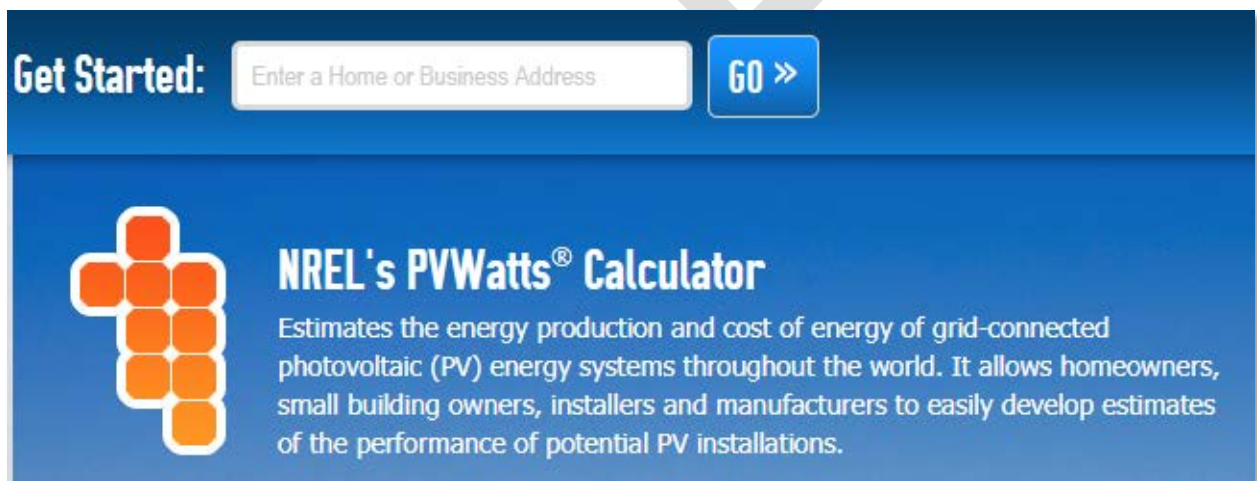
¹ Details on the quantification inputs can be found in the NREL PVWatts Calculator. “Retail Electricity Rate” fields are optional and do not need to be entered by the applicant.

² If the advanced parameters are known, the applicant may modify the inputs and provide supporting documentation (as detailed in Section C); if unknown, the applicant should leave the default parameters provided by the NREL PVWatts Calculator.

Step 2: Identify the Electricity Generation of the Proposed Community Solar Pilot Project Using the NREL PVWatts Calculator

Applicants must use the NREL PVWatts Calculator to estimate solar PV electricity production from Community Solar Pilot projects. Applicants must enter information about the location of the proposed Community Solar project and the basic design parameters specific to the system. The NREL PVWatts Calculator calculates an estimated value for the system's monthly and annual electricity production.

The applicant's first step is to access the online NREL PVWatts Calculator to estimate the electricity production of the proposed Community Solar PV system. The NREL PVWatts Calculator is accessed at: <http://pvwatts.nrel.gov/>. To get started, the applicant must enter the ZIP code of the proposed Community Solar Pilot project in the NREL PVWatts Calculator.



Next, the “Solar Resource Data” page allows the applicant to select the weather data files applicable to the location of the proposed project. The NREL PVWatts Calculator uses typical year weather data files from the NREL National Solar Radiation Database (NSRDB) to represent the long-term solar resource at the location. By default, the NREL PVWatts Calculator chooses the NSRDB typical meteorological year version 2 (TMY2) 1961-1990 weather file, but provides the option to select the 1991-2010 update TMY3 data file. For CSD Community Solar Pilot project proposals, it is required that applicants select the typical meteorological year version 3 (TMY3) weather data file option. To select the TMY3 option, simply double-click on the “3” icon closest to the proposed project location identified on the map. Either a blue “hat” displayed on the number “2” icon or number “3” icon on the map indicates the selected TMY option. The screenshot on the following page identifies the blue “hat” for the selected TMY3 option.

Next, the “System Info” page allows the applicant to enter the specific system information of the proposed project. Required system information includes system size, module type, array type, system losses, tilt, azimuth, and advanced system parameters (including DC to AC size ratio, inverter efficiency, and ground coverage ratio). The NREL PVWatts Calculator inputs are identified on Table 1 of this Quantification Methodology.

Enter the information applicable to the proposed system. For system losses, the NREL PVWatts Calculator uses a default value of 1.5% for light-induced degradation, however, the Community Solar Pilot Benefits Calculator Tool uses a default value of 0.5%.^{iv} To remain consistent with the Community Solar Pilot Benefits Calculator Tool, it is required to modify the light-induced degradation value from 1.5% to 0.5% unless documentation for the proposed project supports a different value. To modify the “System Losses,” select the “Loss Calculator” as shown below.

SYSTEM INFO

Modify the inputs below to run the simulation.

DC System Size (kW):	1000	i
Module Type:	Standard	i
Array Type:	Fixed (open rack)	i
System Losses (%):	13.20	i Loss Calculator
Tilt (deg):	20	i
Azimuth (deg):	180	i

The screenshot shows a web form titled "SYSTEM INFO" with a subtitle "Modify the inputs below to run the simulation." The form contains six input fields, each with a label, a value, and an information icon (i). The fields are: "DC System Size (kW)" with value 1000; "Module Type" with value Standard; "Array Type" with value Fixed (open rack); "System Losses (%)" with value 13.20; "Tilt (deg)" with value 20; and "Azimuth (deg)" with value 180. The "Loss Calculator" button next to the "System Losses (%)" field is circled in red.

Next, the “Calculate System Losses Breakdown” page allows the applicant to modify any of the potential losses that typically occur for a solar PV system. For specific losses of the proposed Community Solar Pilot PV system, please refer to the manufacturer specifications, otherwise, use the defaults listed. For light-induced degradation, modify the default value from 1.5% to 0.5%. For additional information about any of the parameters listed, select the **i** icon. Remember to click “Save” when finished.

Calculate System Losses Breakdown

Modify the parameters below to change the overall System Losses percentage for your system.

Soiling (%)	2
Shading (%)	3
Snow (%)	0
Mismatch (%)	2
Wiring (%)	2
Connections (%)	0.5
Light-Induced Degradation (%)	0.5
Nameplate Rating (%)	1
Age (%)	0
Availability (%)	3

Estimated System Losses:
13.20%

Buttons: HELP, RESET, CANCEL, **SAVE**

Once all project specific information is entered, the applicant clicks the “Results” arrow on the upper right of the screen to generate the estimated monthly and annual electricity production of the proposed solar PV system. An example “Results” page is displayed on the following page.

On the “Results” page, the applicant must download the “monthly” results as shown above. Applicants must submit the “monthly” results excel spreadsheet as part of the CSD Community Solar Pilot application. The applicant must enter the system information from the NREL PVWatts Calculator into the Community Solar Pilot Benefits Calculator Tool.

Step 3: Estimate GHG Emission Reductions and Air Pollutant Emission Co-benefits for the Proposed Project Using the Community Solar Pilot Benefits Calculator Tool

Applicants must use the Community Solar Pilot Benefits Calculator Tool to complete this step. The Community Solar Pilot Benefits Calculator Tool can be downloaded from: www.arb.ca.gov/cqi-resources.

Users should begin with the **Read Me** tab, which contains instructions and prompts users to enter project information.

The **calculation** tabs identify inputs required by the user, generally requiring project-specific data or assumptions. Input and output fields are color coded:

- **Yellow** fields indicate a direct user input is required.³
- **Gray** fields indicate output or calculation fields that are automatically populated based on user entries and the calculation methods.

Details of calculation methods are provided in Appendix B.

The **GHG Summary** tab displays the estimated:

- Total GHG emission reductions (MTCO_{2e});
- Total GHG emission reductions per total funds requested (MTCO_{2e}/);
- Total GHG emission reductions per total GGRF funds requested (MTCO_{2e}/); and
- Total GHG emission reductions per Community Solar Pilot GGRF funds requested (MTCO_{2e}/).⁴

The **Co-benefits Summary** tab displays the estimated:

- Total NO_x emission reductions (lbs);
- Total ROG emission reductions (lbs);
- Total PM_{2.5} emission reductions (lbs);
- Total annual energy cost savings (\$);
- Total lifetime energy cost savings (\$);
- Agricultural or natural land area converted or disturbed by solar PV installation (acres)

³ If a default is modified, the applicant must submit additional supporting documentation (see Section C. Documentation).

⁴ This is the portion of GHG emission reductions attributable to funding from Community Solar Pilot; GHG emission reductions are prorated according to the level of program funding contributed from Community Solar Pilot and other California Climate Investments programs, as applicable. The results in the Co-benefits Summary tab are prorated using the same approach, as applicable.

- Total annual renewable electricity generation (kWh); and
- Total lifetime renewable electricity generation (kWh).

Read Me Tab

Once the Community Solar Pilot Benefits Calculator Tool is accessed, the applicant must complete the project identifier information on the “Read Me” tab.

Project Name:	
Applicant ID:	<i>To be completed by CSD</i>
Contact Name:	
Contact Phone Number:	
Contact Email:	
Date Calculator Completed:	
Total Community Solar Pilot GGRF Funds Requested (\$):	
Other GGRF Leveraged Funds (\$):	
Non-GGRF Leveraged Funds (\$):	
Total Funds (\$):	\$ -

Community Solar Inputs Tab

Applicants enter data into the **yellow cells** within the “Inputs” tab. The required data in the “Inputs” tab reflect the same data entered into the NREL PVWatts Calculator, along with other program-specific information such as project ID and the expected number of dwellings served by the proposed project. Each row corresponds to a project (i.e., one community solar PV system installation).

Project No.	Project ID	Location (ZIP Code)	GGRF Funds Requested (\$)	No. of Dwellings Expected to be Served by Project	DC System Size (kW)	Module Type	Array Type	System Losses (%)	Tilt (degrees)	Azimuth (degrees)	Advanced Parameters				Annual Solar PV Production (kWh/year)	Agricultural or Natural Land Area Converted or Disturbed by Solar PV Installation (acres)
											DC to AC Size Ratio	Inverter Efficiency (%)	Ground Coverage Ratio	Light-Induced Degradation (%)		
1																
2																
3																
4																
5																
TOTALS																

Project reporting metrics and a summary of the overall project GHG emission reductions, air pollutant emission co-benefits, and key variables are provided on the “GHG Summary” and “Co-benefits Summary” tabs.

Section C. Documentation

In addition to Community Solar Pilot application requirements, applicants for GGRF funding are required to document results from the use of this Quantification Methodology, including supporting materials to verify the accuracy of project-specific inputs.

Applicants are required to provide electronic documentation that is complete and sufficient to allow the calculations to be reviewed and replicated. Paper copies of supporting materials must be available upon request by agency staff.

The following checklist is provided as a guide to applicants; additional data and/or information may be necessary to support project-specific input assumptions.

	Documentation Description	Completed
1.	Contact information for the person who can answer project specific questions from staff reviewers on the quantification calculations	
2.	Project description, including excerpts or specific references to the location in the main Community Solar Pilot application of the project information necessary to complete the applicable portions of the Quantification Methodology	
3.	Populated Community Solar Pilot Benefits Calculator Tool file (in.xlsm) with worksheets applicable to the project populated (ensure that all fields in the GHG Summary and Co-benefits Summary tabs are populated)	
4.	Any other information as necessary and appropriate to substantiate Community Solar Pilot Benefits Calculator Tool inputs (e.g., “Monthly” Results Excel Spreadsheet produced by the NREL PVWatts Calculator) or modified default values	

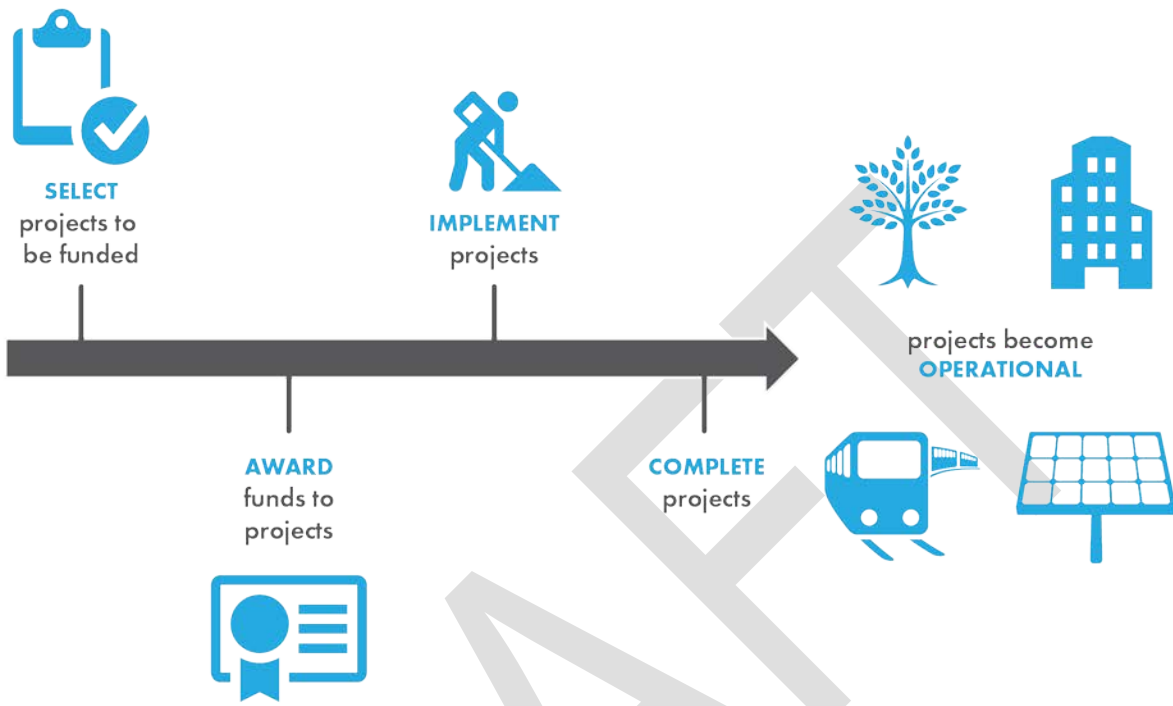
Section D. Reporting after Funding Award

Accountability and transparency are essential elements for all California Climate Investments. All administering agencies are required to track project implementation and report on the benefits of those investments. CARB develops tracking and reporting guidance for California Climate Investments. The reporting process and requirements are found in CARB's Funding Guidelines for Agencies that Administer California Climate Investments (Funding Guidelines).⁵

The Community Solar Pilot uses a one-step approach to quantification and reporting. In the one-step approach, GHG emission reductions and select co-benefits are estimated once for reporting purposes based on project-specific inputs.

CSD will submit periodic reports to CARB. The specific data that need to be reported depend on the project type and the stage of project implementation at the time of reporting. Initially, administering agencies must report basic project information and expected benefits. As projects are implemented, administering agencies provide additional information on project status, benefits, and results. When projects are completed, administering agencies submit project closeout reports. A subset of projects, selected by CSD, will report on project outcomes upon reaching a specified milestone and being considered "operational." Reporting templates which contain detailed reporting requirements that are specific to each project type and cover all stages of reporting are available at: www.arb.ca.gov/cci-resources.

⁵ CARB released Draft Revised Funding Guidelines in April 2018. These Draft Revised Funding Guidelines are subject to change based on public input and Board direction. While the draft provides an indication of what is currently required, administering agencies must incorporate all provisions reflected in the Draft Revised Funding Guidelines and subsequent Board approved Funding Guidelines.



CSD is required to collect and compile project data from funding recipients, including the GHG emission reductions estimated using this Quantification Methodology, co-benefits, and information on benefits to priority populations.⁶ Reported information will be used to demonstrate how the Administration is achieving or exceeding the statutory objectives for California Climate Investments. Select co-benefit and key variable estimates are highlighted in the Co-benefits Summary tab of the Community Solar Pilot Benefits Calculator Tool. Funding recipients have the obligation to provide, or provide access to, data and information on project outcomes to CSD. Applicants should familiarize themselves with the requirements within the Community Solar Pilot Guidelines, solicitation materials, and grant agreement, as well as the CARB Funding Guidelines.

⁶ Priority populations include residents of: (1) census tracts identified as disadvantaged by the California Environmental Protection Agency per Senate Bill (SB) 535; (2) census tracts identified as low-income per Assembly Bill (AB) 1550; or (3) a low-income household per AB 1550. Detailed information is provided in CARB's Funding Guidelines.

ⁱ California Department of Community Services and Development. www.csd.ca.gov/liwp

ⁱⁱ California Air Resources Board. www.arb.ca.gov/cci-fundingguidelines

ⁱⁱⁱ California Air Resources Board. <http://www.arb.ca.gov/cci-resources>

^{iv} The estimated rate of system degradation (0.5% per year) was obtained from the National Renewable Energy Laboratory Technical Report (2012). "Photovoltaic Degradation Rates – An Analytical Review." Available at: <https://www.nrel.gov/docs/fy12osti/51664.pdf>. Accessed on May 11, 2018.

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Appendix A. Example Project

Introduction

The following is a hypothetical project⁷ to demonstrate how the Community Solar Pilot Quantification Methodology would be applied. This hypothetical project does not provide examples of the supporting documentation that is required of actual project applicants.

Overview of the proposed project

A Sacramento cooperative proposes to install a 1,000 kilowatt (kW)—or 1 megawatt (MW)—community solar PV system in an open field to provide renewable electricity to approximately 100 single-family dwellings within a disadvantaged community in Sacramento. The Community Solar Pilot project proposes to use \$1 million in CSD LIWP funds and proposes to leverage \$500,000 from other sources for a total proposed project cost of \$1.5 million.

⁷ The hypothetical project has not undergone verification of any Community Solar Pilot requirements; all assumptions about location type and project features are for quantification methodology demonstration purposes only.

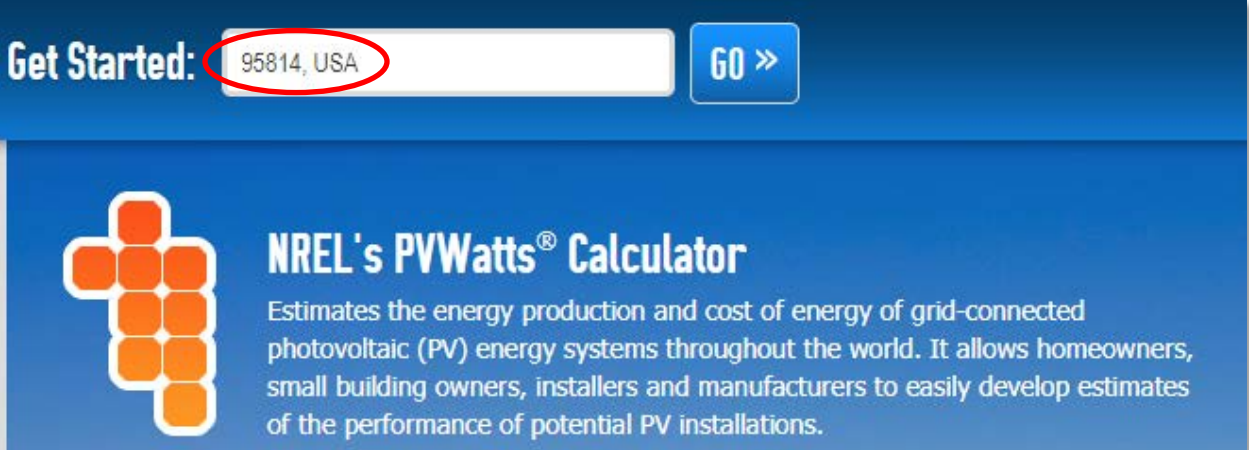
Methods to apply

Step 1: Determine the Community Solar Pilot Benefits Calculator Tool Inputs Needed


General Information	
Total Community Solar Pilot GGRF Funds Requested	\$1,000,000
Non-GGRF Leveraged Funds	\$500,000
Quantification Inputs	
Location	95814 (Sacramento)
Number of dwellings expected to be served by project	100
DC system size	1,000 kW
Module type	Standard
Array type	Fixed (open rack)
System losses	13.20%
Tilt	20°
Azimuth	180°
DC to AC size ratio	1.2
Inverter efficiency	96%
Ground coverage ratio	0.4
Light-Induced degradation	0.5%
Useful Life	30 years
Agricultural or natural land area converted or disturbed by solar PV installation (acres)	4.0

Step 2: Identify the Electricity Generation using the NREL PVWatts Calculator

First, the applicant must access the online NREL PVWatts Calculator to estimate the electricity production of the proposed Community Solar PV system. The NREL PVWatts Calculator is accessed at: <http://pvwatts.nrel.gov/>. To get started, the applicant must enter the ZIP code of the proposed Community Solar PV system in the NREL PVWatts Calculator. In this example, the Sacramento ZIP code 95814 is entered.



Get Started:

 **NREL's PVWatts® Calculator**

Estimates the energy production and cost of energy of grid-connected photovoltaic (PV) energy systems throughout the world. It allows homeowners, small building owners, installers and manufacturers to easily develop estimates of the performance of potential PV installations.

Next, the “Solar Resource Data” page allows the applicant to select the weather data files applicable to the location of the proposed project. For Community Solar Pilot project proposals, it is required that applicants select the TMY3 weather data file option. To select the TMY3 option, simply double-click on the “3” icon closest to the proposed project location identified on the map. The selection of TMY3 for this example is displayed in the screenshot below.

SOLAR RESOURCE DATA

The latitude and longitude of the solar resource data site is shown below, along with the distance between your location and the center of the site grid cell. Use this data unless you have a reason to change it.

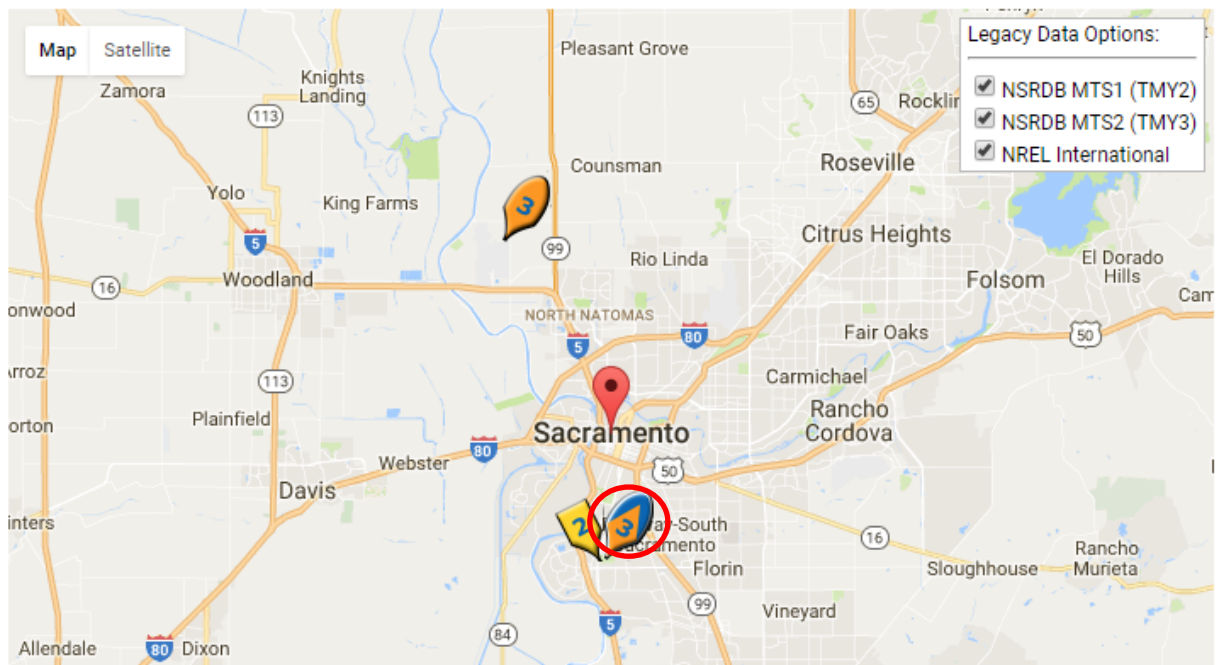
Solar resource data site

(TMY3) SACRAMENTO EXECUTIVE ARPT, CA

5.6 mi

Resource Data Map

The blue rectangle on the map indicates the NREL NSRDB grid cell for your location. If your location is outside the NSRDB area, the map shows a pin for the nearest available NREL international data site instead of a rectangle. If you want to use data for a different NSRDB grid cell, double-click the map to move the rectangle. *Dragging the rectangle will not move it.* Use the Legacy Data Options check boxes to show pins for legacy data sites. Click a legacy data pin to use legacy data instead of the recommended NSRDB data. See [Help](#) for details.



Next, the “System Info” page allows the applicant to enter the specific system information of the proposed project. System information required includes system size, module type, array type, system losses, tilt, azimuth, and advanced system parameters such as DC to AC size ratio, inverter efficiency, and ground coverage ratio. Enter the information applicable to the proposed system. For system losses, NREL PVWatts Calculator uses a default value of 1.5% for light-induced degradation, however, the CSD Community Solar Pilot Benefits Calculator Tool uses a default value of 0.5%. To remain consistent with the CSD Community Solar Pilot Benefits Calculator Tool, it is required to modify the light-induced degradation value from 1.5% to 0.5% unless documentation for the proposed project supports a different value. To modify the “System Losses,” select the “Loss Calculator” as shown below.

SYSTEM INFO

Modify the inputs below to run the simulation.

DC System Size (kW):	<input type="text" value="1000"/>	i
Module Type:	<input type="text" value="Standard"/>	i
Array Type:	<input type="text" value="Fixed (open rack)"/>	i
System Losses (%):	<input type="text" value="13.20"/>	i Loss Calculator
Tilt (deg):	<input type="text" value="20"/>	i
Azimuth (deg):	<input type="text" value="180"/>	i

The "Loss Calculator" link is circled in red in the original image.

Next, the “Calculate System Losses Breakdown” page allows the applicant to modify any of the potential losses that typically occur for a solar PV system. For specific losses of the proposed Community Solar PV system, please refer to the manufacturer specifications, otherwise, use the defaults listed. For light-induced degradation, modify the default value from 1.5% to 0.5%. For additional information about any of the parameters listed, select the **i** icon. Remember to click “Save” when finished.

Calculate System Losses Breakdown ✕

Modify the parameters below to change the overall System Losses percentage for your system.

Soiling (%):	<input type="text" value="2"/>	<div style="border: 1px solid #ccc; padding: 10px; text-align: center;"> Estimated System Losses: 13.20% </div>
Shading (%):	<input type="text" value="3"/>	
Snow (%):	<input type="text" value="0"/>	
Mismatch (%):	<input type="text" value="2"/>	
Wiring (%):	<input type="text" value="2"/>	
Connections (%):	<input type="text" value="0.5"/>	
Light-Induced Degradation (%):	<input type="text" value="0.5"/>	
Nameplate Rating (%):	<input type="text" value="1"/>	
Age (%):	<input type="text" value="0"/>	
Availability (%):	<input type="text" value="3"/>	

HELP RESET CANCEL **SAVE**

For this example, the remaining default parameters are retained for the proposed project. Once all project specific information is entered, the applicant clicks the “Results” arrow to generate the estimated annual and monthly electricity production of the proposed system. For this example, the proposed 1,000 kW (i.e., 1 MW) community solar PV system in Sacramento is estimated to generate 1,547,409 kilowatt-hours (kWh) per year of electricity. The estimates for the example proposed project are displayed on the next page.


On the “Results” page, applicants must download the “monthly” results as shown above. Applicants must submit the “monthly” results excel spreadsheet as part of the CSD Community Solar Pilot application. The applicant must enter the system information from the NREL PVWatts Calculator into the CSD Community Solar Pilot Benefits Calculator Tool.


RESULTS

1,547,409 kWh/Year*

 [Print Results](#)

System output may range from 1,511,509 to 1,578,976 kWh per year near this location. Click [HERE](#) for more information.

 Download Results: **Monthly** [Hourly](#) [Find A Local Installer](#)

 * Caution: The PVWatts[®] energy estimate is based on an hourly performance simulation using a typical-year weather file that represents a multi-year historical period for Sacramento, CA for a Fixed (open rack) photovoltaic system. The kWh range is based on analysis of a nearby data site described [here](#).

The estimate for the value of this energy is the product of the AC energy and the average retail electricity rate. This value is useful for basic comparisons but does not account for financial considerations in a cash flow-based analysis. All of these results are based on assumptions described in [Help](#) that may not accurately represent technical or economic characteristics of the project you are modeling.

Step 3: Estimate GHG Emission Reductions and Air Pollutant Emission Co-benefits for the Proposed Project Using the Community Solar Pilot Benefits Calculator Tool

Read Me Tab

Once the Community Solar Pilot Benefits Calculator Tool is accessed, the applicant must complete the project identifier information on the “Read Me” tab.

Project Name:	Sacramento County Community Solar	
Applicant ID:	<i>To be completed by CSD</i>	
Contact Name:	John Smith	
Contact Phone Number:	(916) 555-1234	
Contact Email:	john.smith@sacounty.com	
Date Calculator Completed:	5/18/2018	
Total Community Solar Pilot GGRF Funds Requested (\$):	\$	1,000,000
Other GGRF Leveraged Funds (\$):	\$	-
Non-GGRF Leveraged Funds (\$):	\$	500,000
Total Funds (\$):	\$	1,500,000

Community Solar Inputs Tab

Applicants enter data into the **yellow cells** within the “Inputs” tab. The required data in the “Inputs” tab reflect the same data entered into the NREL PVWatts Calculator, along with other program-specific information. Each row corresponds to a project (i.e., one community solar PV installation). For this example, one community solar PV system is proposed for installation, therefore only one row will be used to enter relevant project data.

Project No.	Project ID	Location (ZIP Code)	GGRF Funds Requested (\$)	No. of Dwellings Expected to be Served by Project	DC System Size (kW)	Module Type	Array Type	System Losses (%)	Tilt (degrees)	Azimuth (degrees)	Advanced Parameters				Annual Solar PV Production (kWh/year)	Agricultural or Natural Land Area Converted or Disturbed by Solar PV Installation (acres)	
											DC to AC Size Ratio	Inverter Efficiency (%)	Ground Coverage Ratio	Light-Induced Degradation (%)			
1	1234	95814	\$ 1,000,000	100	1,000	Standard	Fixed (open rack)	13.20	20	180	1.2	96	0.4	0.5%	30	1,547,409	4.0
2																	
3																	
4																	
5																	
TOTALS			\$ 1,000,000	100												1,547,409	4.0

Quantification Methodology for the CSD Community Solar Pilot

Project reporting metrics and a summary of the overall project GHG emission reductions, air pollutant emission co-benefits, and key variables are provided on the “GHG Summary” and “Co-benefits Summary” tabs.

Project Information	
Project Name	Sacramento County Community Solar
Total Community Solar Pilot GGRF Funds Requested (\$)	\$ 1,000,000
Other GGRF Leveraged Funds (\$)	\$ -
Non-GGRF Leveraged Funds (\$)	\$ 500,000
Total Funds (\$)	\$ 1,500,000

GHG Summary	
Total GHG Emission Reductions (MTCO ₂ e)	12,190.43
Total GHG Emission Reductions per Total Funds Requested (MTCO ₂ e/\$)	0.00813
Total GHG Emission Reductions per Total GGRF Funds Requested (MTCO ₂ e/\$)	0.01219
Total GHG Emission Reductions per Community Solar Pilot GGRF Funds Requested (MTCO ₂ e/\$)	0.01219

Co-benefits and Key Variables Summary	
	Total Funds
NOx emission reductions (lbs)	5,621
ROG emission reductions (lbs)	895
PM2.5 emission reductions (lbs)	1,408
Annual Energy Cost Savings (\$)	300,043
Lifetime Energy Cost Savings (\$)	8,303,679
Agricultural or Natural Land Area Converted or Disturbed by Solar PV Installation (acres)	4
Annual Renewable Electricity Generation (kWh)	1,547,409
Lifetime Renewable Electricity Generation (kWh)	42,824,544
	Total GGRF Funds
NOx emission reductions (lbs)	3,748
ROG emission reductions (lbs)	597
PM2.5 emission reductions (lbs)	939
Annual Energy Cost Savings (\$)	200,028
Lifetime Energy Cost Savings (\$)	5,535,786
Agricultural or Natural Land Area Converted or Disturbed by Solar PV Installation (acres)	3
Annual Renewable Electricity Generation (kWh)	1,031,606
Lifetime Renewable Electricity Generation (kWh)	28,549,696
	Community Solar Pilot GGRF Funds
NOx emission reductions (lbs)	3,748
ROG emission reductions (lbs)	597
PM2.5 emission reductions (lbs)	939
Annual Energy Cost Savings (\$)	200,028
Lifetime Energy Cost Savings (\$)	5,535,786
Agricultural or Natural Land Area Converted or Disturbed by Solar PV Installation (acres)	3
Annual Renewable Electricity Generation (kWh)	1,031,606
Lifetime Renewable Electricity Generation (kWh)	28,549,696

Submit Documentation

To complete the quantification process, the applicant must submit an electronic copy of the calculator (in .xlsm) and all of the required documentation as noted in Section C of this Quantification Methodology.

Appendix B. Equations Supporting Emission Estimates in the Community Solar Pilot Benefits Calculator Tool

Methods used in the Community Solar Pilot Benefits Calculator Tool for estimating the GHG emission reductions and air pollutant emission co-benefits by activity type are provided in this appendix. The Database Documentation explain how emission factors used in CARB quantification methodologies are developed and updated.

A. Emission Estimates from Community Solar PV

The emission reductions from the project are estimated based on reduced fossil-fuel-based electricity generation as a result of increased solar PV electricity generation using Equation 1.

Equation 1: Emission Reductions from Community Solar PV

$$Emission\ Reductions_{Community\ Solar} = \sum_{n=1}^{30} [1 - (n)(R_{degradation})](PV_{production})(EF_{electricity})$$

<i>Where,</i>		
<i>Emission Reductions</i>	=	total emissions reduced from community solar PV system
<i>Community Solar</i>		
<i>n</i>	=	any given year
<i>30</i>	=	estimated useful life of community solar PV systems ⁸
<i>R degradation</i>	=	rate of system degradation (0.5)
<i>PV production</i>	=	estimated annual kWh generated based on the NREL PVWatts Calculator
<i>EF electricity</i>	=	emission factor for California grid electricity
		<u>Units</u> MT CO ₂ e/ or lbs
		years
		%/year
		kWh/year
		MT CO ₂ e/ kWh; or lbs/kWh

⁸ The 30-year useful life was obtained from the "Life Cycle Greenhouse Gas Emissions from Solar Photovoltaics," NREL fact sheet. Available at: <https://www.nrel.gov/docs/fy13osti/56487.pdf>. Accessed on May 11, 2018.