

PV SoilSayer 2.1

Quick Start Guide

Introduction:

The *PV SoilSayer 2.1* is a web-based, soiling analysis and clean cycle optimization software platform that provides users with soiling loss calculations and optimal clean cycle forecasts, in order to improve the accuracy of PV energy production models, minimize operational costs and maximize PV system performance. The *PV SoilSayer 2.1* utilizes industry standard PV performance modeling software, combined with weather forecasts to calculate soiling losses, optimal cleaning schedules and net financial returns.

Documentation:

There are info points located throughout the website  to provide users with detailed information and guidance on *PV SoilSayer 2.1* features. For further information please visit the Enlighten Energy downloads page to access updated documentation including *PV SoilSayer 2.1 User Manual*, and related research papers.

Login:

In order to access the *PV SoilSayer 2.1* software you will need to login to the Enlighten Energy site. To login, navigate to <https://www.enlighten-energy.net/my-account/> and enter your email / username and password. If you do not have a username and password you will need to purchase a user license from the Store: <https://www.enlighten-energy.net/store/>.

Login

Username or email address *

Password *

Remember me

[Log in](#)

[Lost your password?](#)

Register

Email address *

A password will be sent to your email address.

[Register](#)

After logging-in, select the *PV SoilSayer 2.1* from the menu at the top right corner of the screen:

My account

Dashboard
Orders
Subscriptions
Downloads
Addresses
Payment methods
Account details
Logout

Hello **wikalamon** (not **wikalamon**? [Log out](#))

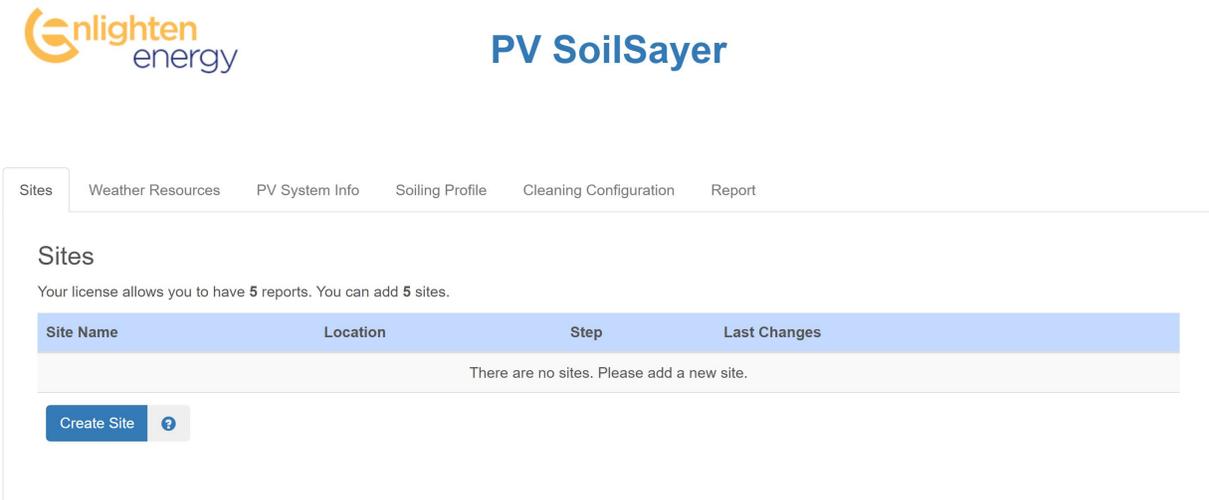
From your account dashboard you can view your recent orders, manage your shipping and billing addresses, and edit your password and account details.

Manage Sites:

After logging into the *PV SoilSayer 2.1* you will be ready to Create a Site. Note that there are 4 sections or steps required in order to configure a site and complete a *Report*. These steps are noted in the titles of each corresponding tab at the top of the *PV SoilSayer* and include: *Weather Resources*, *PV System Info*, *Soiling Profile*, and *Clean Cycle Configuration*.

The first tab, *Manage Sites*, is where you can create a new site, as well as view or edit existing sites. To view or edit an existing site, click on the Site Name.

To create a site, click on the **Create Site** button at the bottom of the page.



Weather Resources:



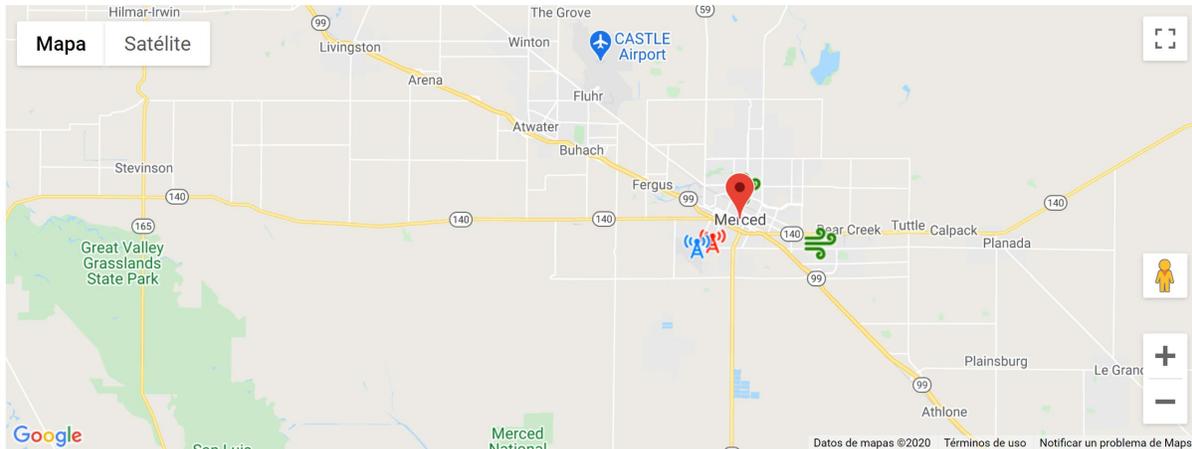
On the Weather Resources page you will need to enter a location for the plant. This can be a LAT / LONG, street address, or city. Note that once you run a report, you are not able to edit the location of the plant.

After entering the plant location, you will see a Google Map appear with your site location. The map also shows the location of available weather stations and PM10 sensors.

Plant Location [?](#)

Location of Plant :

 AccuWeather Stations
  Meteonorm Stations
  PM10 Sensors



Note: Accuweather (red) is a point source database, so it is important that there is an Accuweather station located nearby to the site for accurate results. The MeteoNorm TMY (blue), utilizes an interpolation algorithm to calculate typical weather from a number of different stations located in the region.

After locating the site, users will also see several options for selecting weather resources, which will be used to calculate energy production and soiling loss estimations.

Select a Weather Resource Database:

This default option allows users to *Select a Weather Resource Database*, from the dropdown menu.

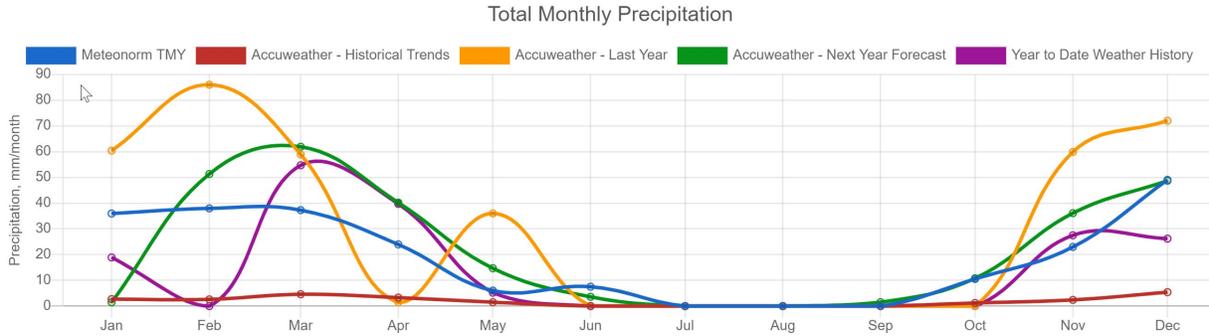
Weather Resources [?](#)

Select a Weather Resource Database [?](#)

Weather Resource Database:

Update Historical Weather Resources with Year to Date Weather [?](#)
 Update Historical Weather Resources with Long-term Weather Forecast [?](#)
 Update Reports Daily
 Update Reports Weekly

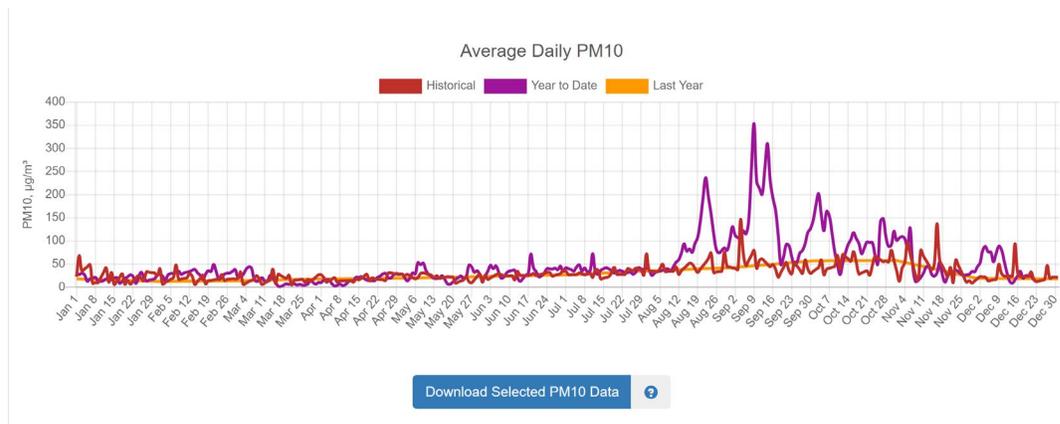
Several charts display the weather resources that are available for the selected site to give users insight into which weather database is most appropriate.



In the case that an available weather resource is selected from the *Select a Weather Resource Database*, the PM10 data is automatically selected which matches the chosen weather resource (ie. if AccuWeather Last Year weather data is selected, the Last Year PM10 data will be used).

Physical PM10 sensor locations are indicated on the Google Map, however, additional PM10 calculations derived from satellite data are provided for locations that are farther than 70km from a physical sensor. In the case that *Soiling Calculator* option is chosen on the *Soiling Profile* page, these sensors will be utilized to estimate soiling losses.

Users can download the PM10 data that is selected to be used in the Soiling Calculations. This data will only be used in the case that the user selects to estimate the soiling losses using the *Soiling Calculator* option on the *Soiling Profile* page.



In the case that users *Select a Weather Resource Database*, the associated PM10 data is selected automatically based-on distance from the site (see *PV Soiling Sayer 2.1 User Manual* for more information). Users can also select an appropriate PM10 dataset to be used with weather data uploads on the *Upload Weather Resource Data* menu option.

Update Historical Weather Resources:

You can choose to update the MeteoNorm 7.2 – TMY / TMY3, AccuWeather 10yr P50 TMY or AccuWeather Last Year weather data, with Year To Date measured weather data from AccuWeather. The Year to Date data also includes updates for the PM10 sensors.

Selecting the year to date data checkbox will overwrite the historical dataset with measured data from the nearest Accuweather weather station, from Jan 1st up to the present day.

You can also choose to update the MeteoNorm 7.2 – TMY / TMY3, AccuWeather 10yr P50 TMY or AccuWeather Last Year weather data, with a long-term weather forecast. In the current version of the *PV SoilSayer 2.1* this is only available as a 90 day forecast from the nearest Accuweather station. Note that the 90 day weather forecast does not include PM10 data, however, a 10 day PM10 forecast may be available depending on the region selected.

Choosing to update the historical data with a long-term weather forecast will overwrite the historical dataset with forecast data based-on the nearest Accuweather weather station, starting from the present day out to 90 days from the present day.

Update Reports:

Users can also choose to update the report on a daily or weekly basis by selecting Update Reports Daily or Weekly. When one of these options is selected the registered user will receive automated emails when reports have been updated and are ready to view.

Upload Weather Resource Data:

Alternatively, users can choose to enter their own weather data by selecting the *Upload Weather Resources Data* menu and selecting either hourly weather data (including hourly precipitation data) or hourly weather data with daily precipitation data. There is a link to download a template file for weather uploads in the menu for each option. All weather data fields (ie. GHI, DNI, DHI, RH, Temp...etc) must include a full calendar year of data. Any missing data fields will be filled using the MeteoNorm 7.2 TMY data.



The screenshot shows a web interface titled "Weather Resources" with a help icon. It contains several interactive elements:

- A button labeled "Select a Weather Resource Database" with a plus icon and a help icon.
- A button labeled "Upload Weather Resource Data" with a plus icon and a help icon.
- Two sub-buttons under the upload section: "Upload Hourly Weather Data" and "Upload Hourly Weather Data with Daily Precipitation", both with plus icons.
- A label "Please select a PM10 Dataset:" followed by a dropdown menu currently showing "Historical".
- A checkbox labeled "Update Historical Weather Resources with Year to Date Weather".

Users can choose to select an appropriate PM10 dataset to be used with uploaded weather data. Users also have the option to download the selected PM10 data for reference.

PV System Info:

After hitting the Proceed button at the bottom of the Weather Resources page users are taken to the PV System Info page. In this section, detailed information about the system design is required in order to calculate the energy production and soiling losses of the PV System. The default values for most inputs will be sufficient to provide a reasonable energy production calculation. For detailed descriptions of the inputs in this section please refer to the *PV SoilSayer 2.1 User Manual*.

PV System Design ?

DC System Size:	<input type="text" value="10000"/>	kWp	Max Tracker Angle:	<input type="text" value="55"/>	deg
AC System Size:	<input type="text" value="8000"/>	kWp	Tracker Stow Angle:	<input type="text" value="15"/>	deg
Module Type:	<input type="text" value="Glass/Backsheet"/>	▼	Elevation Angle:	<input type="text" value="0"/>	deg
Cell Type:	<input type="text" value="Mono c-Si"/>	▼	Azimuth Angle:	<input type="text" value="180"/>	deg
Array Type:	<input type="text" value="1-Axis True Tracking"/>	▼			

Albedo: ?	Jan :	Feb :	Mar :	Apr :	May :	Jun :	Jul :	Aug :	Sep :	Oct :	Nov :	Dec :
	<input type="text" value="0.2"/>											

PV System Losses ?

Mismatch:	<input type="text" value="1"/>	%	Light-Induced Degradation:	<input type="text" value="1.5"/>	%
Wiring:	<input type="text" value="2"/>	%	Nameplate Rating:	<input type="text" value="1"/>	%
Connections:	<input type="text" value="0.5"/>	%	System Degradation:	<input type="text" value="0"/>	%
			Availability:	<input type="text" value="1.5"/>	%

Shading %: ?	Jan :	Feb :	Mar :	Apr :	May :	Jun :	Jul :	Aug :	Sep :	Oct :	Nov :	Dec :
	<input type="text" value="0"/>											

Snow %: ?	Jan :	Feb :	Mar :	Apr :	May :	Jun :	Jul :	Aug :	Sep :	Oct :	Nov :	Dec :
	<input type="text" value="0"/>											

Inverter Efficiency:	<input type="text" value="98"/>	%	Ground Coverage Ratio:	<input type="text" value="0.4"/>
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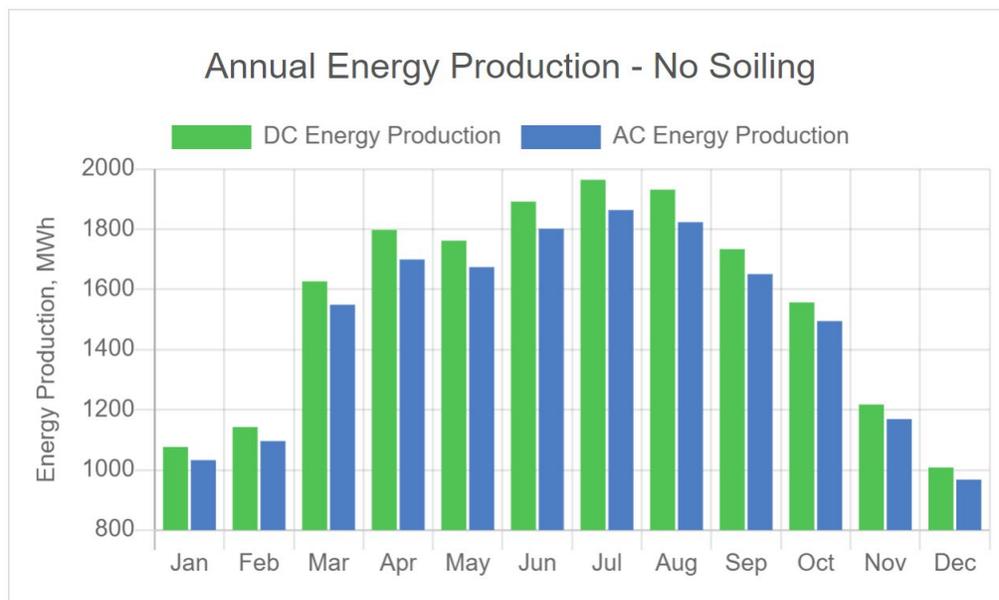
Note: AC System Size cannot be edited after running the report. All other inputs can be edited.

In the *PV System Design* section, users can define the baseline performance model for the system. The PV System performance model is based-on PVLib libraries and should represent as closely as possible, the PV system design and technology. Users can define an entire PV System or a block or array of a PV system in order to calculate different soiling regions within a larger PV System, however, note that each block or section will require a separate site subscription in order to change the values of the AC System size.

The DC / AC ratios are calculated from the nominal *DC System Size and AC System Size* and these values are used to determine the energy production as well as the DC and AC soiling loss ratios. Also note that the *Array Type, Max Tracker Angle, Tracker Stow Angle, Elevation Angle Azimuth Angles, and Albedo* (albedo is for calculations of reflected light on Mono Facial panels only) will have an impact on the energy production as well as the soiling loss calculations due to impact of soiling as a function of sun angle (see Info Points located throughout the site and the *PV SoilSayer 2.1 User Manual* for more info).

In the *PV System Losses* defines losses in relation to the nominal DC power of the system. Default values are provided for general guidance and can be adjusted to match actual or estimated system losses as needed. The *PV System Losses* are not intended to replace more detailed energy production analysis models, but rather provide a relative estimate of energy loss / gain for No Clean vs Clean energy production analysis.

Users can select to *Calculate Annual Energy* using the button located at the bottom of the page.



Tip: Use the *Calculate Annual Energy Production* button to see the resulting calculation of energy production. This can be used to compare against actual / measured production or alternative energy production simulations and the losses section can be further adjusted to align the energy production as needed.

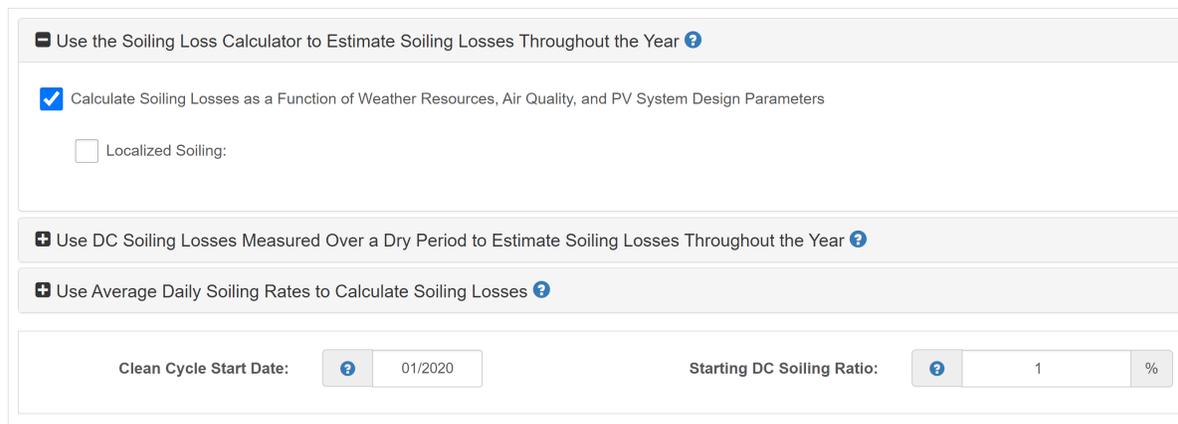
Soiling Profile:

Clicking the *Proceed* button at the bottom of the *PV System Info* page will take users to the *Soiling Profile* page.

In this section users will need to select from one of several options for calculating or uploading soiling loss data. The default option is to *Use the Soiling Loss Calculator to Estimate Soiling Losses Throughout the Year*. This option estimates soiling losses based-on PM10 data, weather data (RH, WS, WD, Precipitation) and tilt angle (including the stow angle from the PV System Info page).

Soiling Losses [?](#)

Please Select From One of the Following Soiling Loss [Calculation Options](#):



The screenshot shows a web interface for selecting soiling loss calculation options. It features three main radio button options, each with a help icon:

- Use the Soiling Loss Calculator to Estimate Soiling Losses Throughout the Year [?](#)
 - Calculate Soiling Losses as a Function of Weather Resources, Air Quality, and PV System Design Parameters
 - Localized Soiling:
- Use DC Soiling Losses Measured Over a Dry Period to Estimate Soiling Losses Throughout the Year [?](#)
- Use Average Daily Soiling Rates to Calculate Soiling Losses [?](#)

At the bottom, there are two input fields:

- Clean Cycle Start Date: [?](#)
- Starting DC Soiling Ratio: % [?](#)

In the case that there is very localized soiling due to local farm practices, grazing sheep, nearby roads...etc, users may select the *Localized Soiling* button. Choices range from Medium to Extreme Soiling. Select the month(s) during which the localized soiling is prevalent to increase the soiling rate on-top of the PM10 calculated soiling rate for the selected periods.

Other options for calculating soiling include using DC soiling losses measured over a dry period or using average daily soiling rates to calculate soiling. With either of these options the *PV SoilSayer 2.1* will fit the specified soiling rate to the selected weather dataset and interpolate to the hourly resolution for use in the soiling loss calculations.

Users may also select a *Clean Cycle Start Date* and *Starting DC Soiling Ratio*. The clean cycle start dates are only selectable on the first day of each month and will shift the cleaning algorithms to start on the specified date and with the specified starting soiling ratio.

If measured data is available, users can select from one of two options to upload hourly or daily measured soiling losses. In either of these cases the measured soiling loss data will be used without weather to calculate cleaning algorithms. Templates for data uploads are available from links inside the menus.

Rainfall Clean Events:

In the case that one of the soiling loss *calculation* options has been chosen, users will have the option to configure Rainfall Events. Note that rainfall events are disabled for all Soiling Loss Upload options as it is assumed that rainfall events are represented in the measured soiling losses.

The Rainfall Event parameters determine how much rain will clean the panels and how clean the panels will get after the rain. Currently there do not exist generalized, semi-physical models for determining the effects of rainfall on PV panels, therefore the *PV SoilSayer 2.1* provides users with a number of key parameters that define these events. The default values in this section will apply for most PV Systems, however, systems with a very small elevation angles (ie. less than 15 degrees) may require a higher Min / Max Rainfall Clean Amount and a higher Rainfall Clean Quality value.

Rainfall Clean Events [?](#)

Minimum Rainfall Clean Amount (Wet Season): mm/hr

[+ Advanced](#)

Rainfall Clean Quality: %

[+ Advanced](#)

Maximum Rainfall Clean Amount (Dry Season): mm/hr

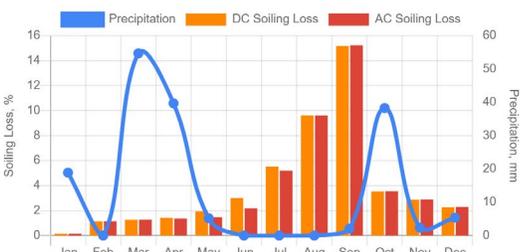
[+ Advanced](#)

[Calculate Soiling Losses](#) [?](#)

Monthly Average DC Soiling Losses:

Jan	0.2	%	Feb	1.2	%	Mar	1.3	%
Apr	1.4	%	May	1.9	%	Jun	3	%
Jul	5.5	%	Aug	9.6	%	Sep	15.2	%
Oct	3.5	%	Nov	2.9	%	Dec	2.3	%

Annual Soiling Losses vs Precipitation:



[Next](#)

Note: you must click the **Calculate Soiling Losses** button before proceeding in order for the *PV SoilSayer 2.1* to update the soiling calculations.

Users can review the resulting *Annual Soiling Losses vs Precipitation* calculations in the chart at the bottom of the screen. Users can also modify the estimated dc soiling losses as needed in the table to the left of the chart.

Clean Cycle Configuration:

After clicking the *Next* button at the bottom of the *Soiling Profile* page, you will be taken to the *Clean Cycle Configuration* page.

In this section users will need to configure the cleaning analysis including the value of the energy produced and the cost of the cleaning in order to calculate the financial returns / losses of the system for a specified clean cycle.

The default configuration, *Calculate Optimal Clean Cycle*, will result in the greatest financial gains. Entering a *Minimum Value of Energy Gain* will filter out any calculated clean events that do not result in the specified minimum return on investment.

There is also an option to utilize *Daily* or *Weekly Resolution*. The *Weekly Resolution* is the default and is adequate for initial clean cycle analysis and will return the optimal cleaning dates to within 5 days of the specified dates. For a more refined analysis you can select the *Daily Resolution* which will result in the specific day(s) that result in the greatest financial returns.

In the case that the PV system has already been manually cleaned, users can choose the, *Specify Year to Date Manual Clean Events*, menu and select previous clean dates on the calendar in order to optimize the clean cycle for the rest of the year.

Manage Sites Weather Resources PV System Info Soiling Profile Cleaning Configuration Report Wash Dashboard

Clean Cycle Configurations ?

Please select from one of the following clean cycle configuration options:

- Calculate Optimal Clean Cycle ?
 - Calculate Optimal Clean Cycle in order to minimize costs and maximise PV System performance

Minimum Value of Energy Gain ? \$ 5000 / per clean ?

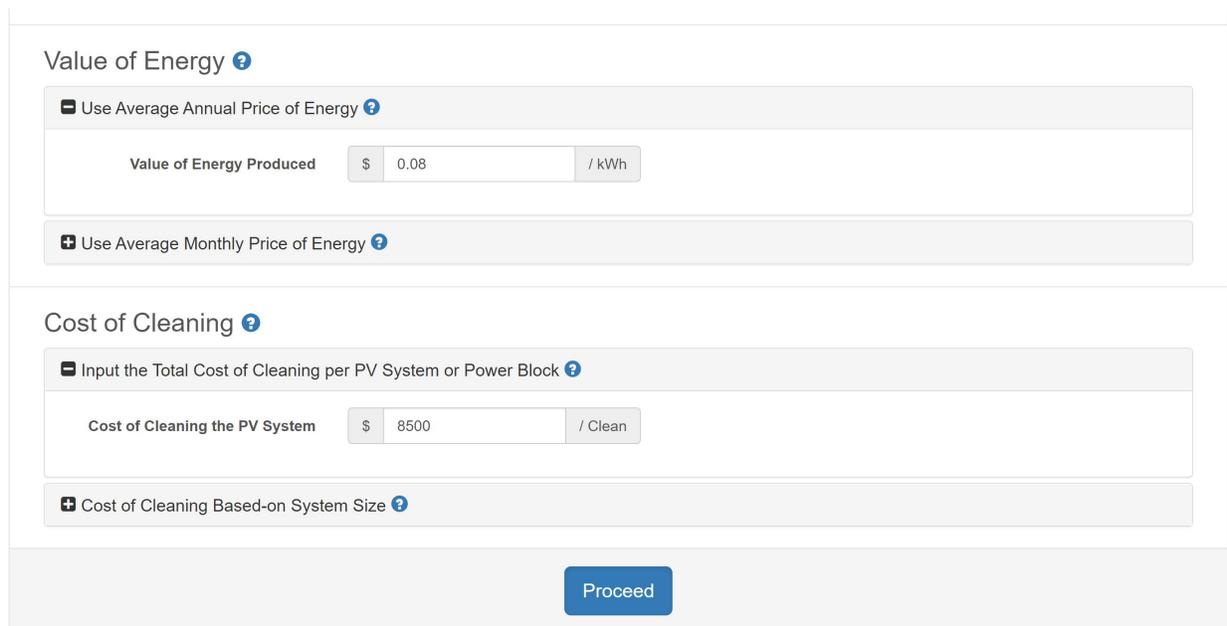
Daily Resolution
 Weekly Resolution
 - Specify Year to Date Manual Clean Events ?
 - Calculate Clean Cycle Based-on Specified Thresholds ?
 - Calculate Soiling Losses Based-on a Specified Clean Cycle ?

Manual Clean Quality: ? 0.5 % Number of Days Required to Clean: ? 15 days

Users can also select to configure the cleans based-on specified thresholds or cleaning cycles. These options will likely not result in the optimal cleaning cycle (the cleaning cycle which returns the greatest financial returns), however, can lead to insights into the potential gains / losses resulting from different cleaning triggers / schedules.

In the section below, users can also configure the *Manual Clean Quality* and the *Number of Days to Required to Clean* the PV system.

In the next section, users will need to select a value of the energy that is produced by the PV System. This is typically a PPA price or Feed-in Terrif, but could be the average market value of the energy produced (value of the cost offset). The values can be input as an *Average Annual Price of Energy* or a *Monthly Average Price of Energy*. For systems which have a variable rate (ie. TOD rates) the *Monthly Average Price of Energy* will provide a much more accurate estimation of the value of the energy produced by the PV system.



The screenshot shows two main configuration sections: 'Value of Energy' and 'Cost of Cleaning'. Each section has a radio button to select a calculation method and a corresponding input field.

Value of Energy

- Use Average Annual Price of Energy
- Value of Energy Produced: \$ 0.08 / kWh
- Use Average Monthly Price of Energy

Cost of Cleaning

- Input the Total Cost of Cleaning per PV System or Power Block
- Cost of Cleaning the PV System: \$ 8500 / Clean
- Cost of Cleaning Based-on System Size

At the bottom of the form is a blue 'Proceed' button.

Finally, the *Cost of Cleaning* is required to run the analysis. This value can be input as a Total System Cost per clean or as a Cost / kWp per clean.

Report:

After clicking the *Proceed* button at the bottom of the Cleaning Configuration page users will be taken to the *Report* page (this may take several minutes depending on the site location and configuration). Here users are able to review the results of the cleaning cycle analysis.

System Inputs:

Starting with the input section it is a good idea to review the inputs selected to make sure everything was entered correctly.

Total Annual Cost Savings – No Clean vs Clean:

Scrolling down the *Report* page there are several tables that present calculated values. In the *Total Annual Cost Savings – No Clean vs Clean*, section you can see the resulting energy production and financial gains / losses, comparing No Clean vs Clean scenarios as well as the *Total Net Annual Revenue Gain*.

Total Annual Cost Savings - No Clean vs. Clean			
Total Amount of AC Energy Gain Clean vs. No Clean	Total Value of AC Energy Gain Clean vs No Clean	Total Cost of Cleaning	Total Net Annual Revenue Gain Clean vs No Clean
1,956,486.48 kWh	\$ 156,518.92	\$ 34,000.00	\$ 122,518.92

Manual Clean Events			
Manual Clean Date	Payoff Date	Total AC Energy Gain	Total Value of Energy Gain
May 25, 2020	Jun 18, 2020	238,146.68 kWh	\$ 19,051.73
Jul 14, 2020	Jul 25, 2020	531,486.83 kWh	\$ 42,518.95
Sep 12, 2020	Sep 20, 2020	544,940.97 kWh	\$ 43,595.28
Nov 1, 2020	Nov 9, 2020	641,912.00 kWh	\$ 51,352.96

Manual Clean Events:

The *Manual Clean Events* table provides a detailed calculation of all calculated clean events including the calculated *Manual Clean Date*, the *Payoff Date* (date at which the net value of gain is \$0), *Total Energy Gain* for the calculated clean event and *Total Value of Energy Gain* (before cleaning costs). Note that not all calculated cleans will payoff (unless choosing to calculate the optimal clean cycle) and not all manual clean events result in equal gains.

Avg. Soiling Rates and Ratios:

The *Avg Soiling Rates / Ratios* section of the report provides the calculated *Average Soiling Rates* and *Average Soiling Ratios* for the specified cleaning configuration. Note that the calculated *Avg. Daily and Hourly Soiling Rates %* values can be used as inputs to 3rd party performance modeling systems (ie. PVSyst) in order to align the cleaning cycles with the investment case performance model.

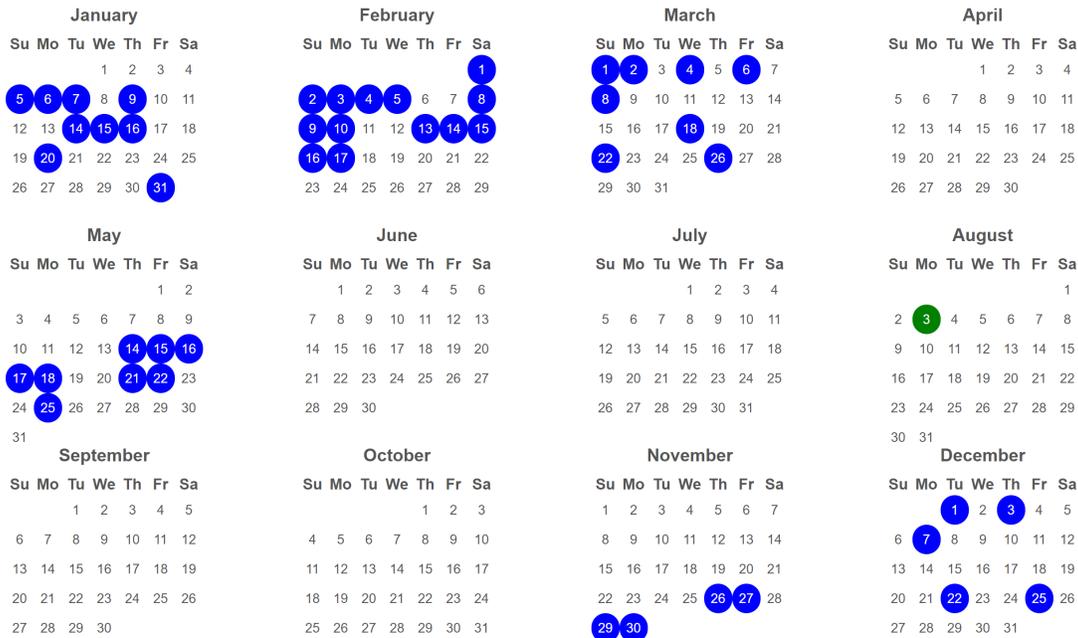
Average Soiling Rates

Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. Daily Soiling Rates, %	0.1135	0.1004	0.0762	0.1072	0.1316	0.1229	0.1361	0.1506	0.2367	0.3095	0.3236	0.1503
Avg. Hourly Soiling Rates, %	0.0047	0.0042	0.0032	0.0045	0.0055	0.0051	0.0057	0.0063	0.0099	0.0129	0.0135	0.0063

Annual PV Clean Cycle Calendar:

The *Annual PV Clean Cycle Calendar* provides an overview of the annual clean events, both rainfall clean events and manual clean events. Note that daily / hourly precipitation is derived from selected weather resources but rainfall event thresholds are defined based-on user defined *Rainfall Clean Events* values on the *Soiling Profile* page. Therefore, a *Rainfall Clean Event* will only display on the calendar if the amount of precipitation exceeds the defined values for cleaning the panels.

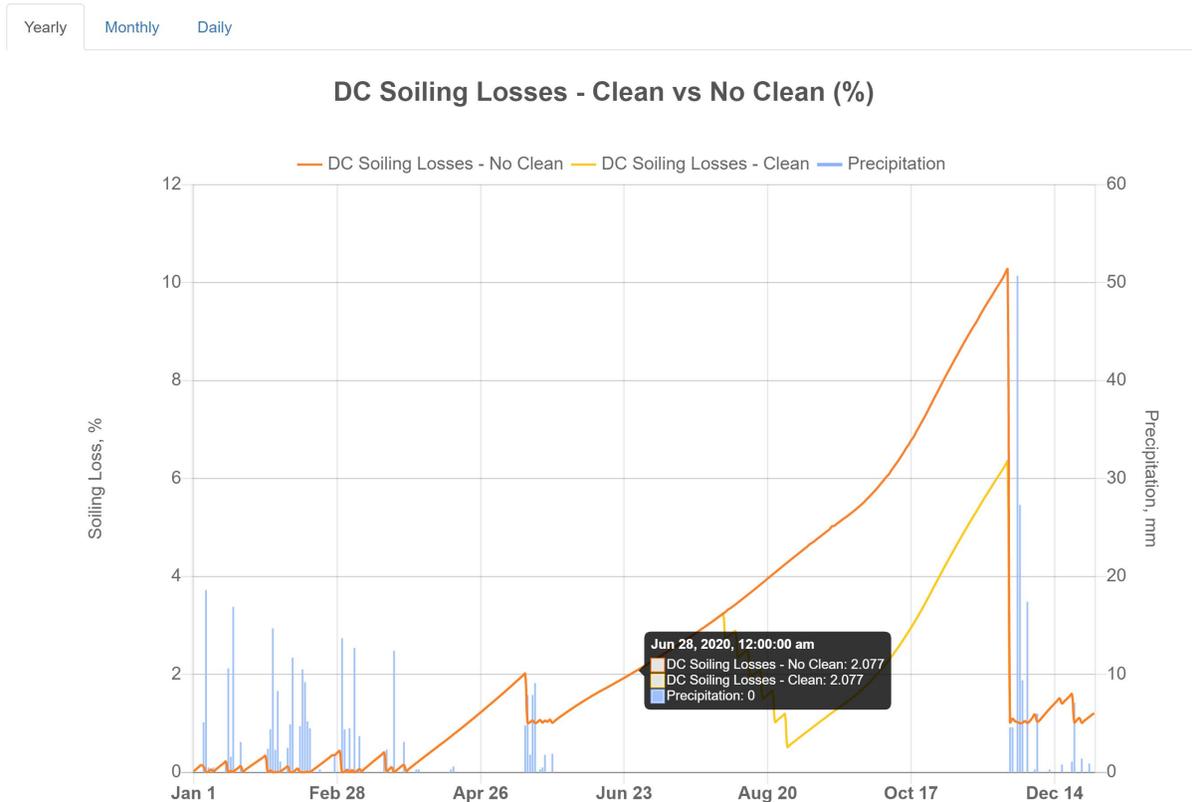
Annual PV Clean Cycle Calendar



● Rainfall Clean Event
 ● Manual Clean Event
 ● Muddy Rain
 ● Sandstorm Event

Charts:

There are a number of charts that provide visualization of detailed analysis. The chart resolution can be selected to display *Yearly*, *Monthly* or *Daily* values for all charts.



Download Reports and Spreadsheets:

Users can download a PDF version of the report by clicking the **Download PDF** button at the bottom of the Report page. A spreadsheet with hourly calculated values can be accessed by clicking the **Download Spreadsheet** button at the bottom of the Report page.

Download PDF

Download Spreadsheet

After running a report, users can return to any page by clicking on the desired tab, in order to edit inputs and re-run the report.

Wash Dashboard:

The Wash Dashboard provides users with an overview of the scheduled cleanings for the year as well as summary charts and email notifications.

Users who have previously completed a site Report will be directed to the Wash Dashboard upon logging-in to the PV SoilSayer. If no previous site Report has been completed, users will be directed to the Manage Sites page.

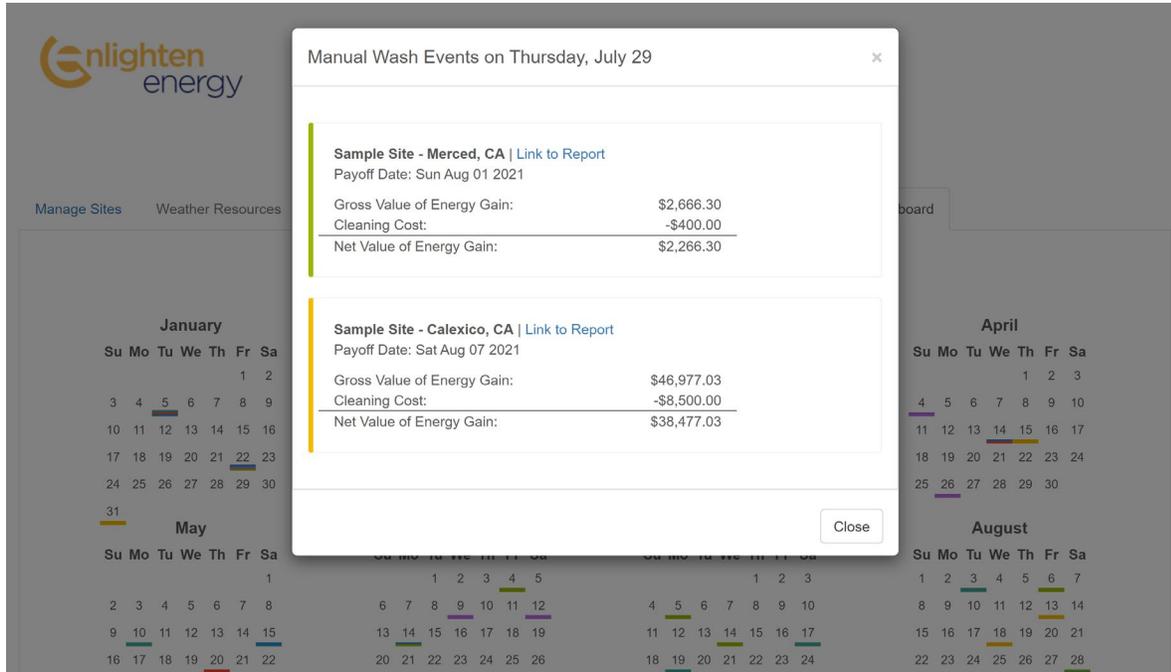
In order for site clean cycles to be automatically updated, users must select the “Update Site Reports” button and choose either “Daily” or “Weekly” on the *Weather Resources* page.

Clean Cycle Calendar:

Users can view scheduled cleanings on an interactive Clean Cycle Calendar. Hovering over a scheduled clean event provides the calculated, Net Value of Energy Gain for each site.



Clicking on the calendar brings-up a dialogue box with further cost details including the estimated Payoff Date, Gross Value of Energy Gain, Cleaning Cost, and the Net Value of Energy Gain. A link to the detailed site Report is also provided for each clean event in the dialogue box for each clean event.



Email Notifications:

Users can choose to enable email notifications to alert in advance of upcoming clean events.

Email Alerts

Settings Updated

Send an Email Notification for Pending Manual Clean Events [?](#)

of Days to Alert Prior to Scheduled Clean: days

Select the checkbox and input the number of days prior to the scheduled clean to send the email notification. Note that notifications will only be sent to the registered email address. Registered email addresses may also be a distribution email address.

Click the "Save" button at the bottom of the page to ensure that the email settings have been saved.



Questions ?

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