

A large solar panel array is shown in the foreground, tilted towards the right. The panels are dark blue with a white grid pattern. In the background, a snowy mountain slope leads down to a city and a range of mountains under a clear blue sky.

# ESTIMATING SOLAR PRODUCTION

**A GUIDE FOR USING PV WATTS  
PROVIDED BY: SOLARUNPLUGGED**

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# **PV Watts**

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Estimating Your PV Array Production

# Determining Your Solar Array Size

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One of the biggest questions that comes up in any photovoltaic system is “what size of photovoltaic array do I need?”. It doesn’t matter if you are looking at a grid-connected or off-grid photovoltaic (PV) array, you are going to need a way to determine the right size PV array for you.

This is where PV Watts comes in handy. Thanks to NREL, there is a free resource that can calculate and estimate the energy production for any array. With this tool, you can input the parameters of your PV array and quickly see what kind of energy production you should be able to achieve.

Where do you begin? The first step is to determine your energy needs and goals. What is it that you are trying to achieve with your PV array. Are you trying to offset your energy consumption from the grid? If the answer is yes, how much of that energy are you trying to offset? Or are you trying to insure your off-grid PV array is able to fully charge your batteries? No matter what your goals are, you need to have a good starting point before you use PV Watts.

**Step One: Acquire your energy consumption**

Get two years worth of energy usage history. This can be done by contacting your utility provider.

**Step Two: Estimate your average monthly consumption**

Add up your total kWh consumption for every month. Then divide the total kWh consumption by the number of months ( See Fig. 1)

Period Start	Usage (kWh)	Cost (\$)	Total Usage (kWh)	Average Usage (kWh) per
3/1/2015	1554	\$220.20	27,937	1,117
2/1/2015	1540	\$218.02		
1/1/2015	1845	\$259.11		
12/1/2014	1358	\$193.51		
11/1/2014	1055	\$152.69		
10/1/2014	997	\$144.92		
9/1/2014	1398	\$198.96		
8/1/2014	1062	\$152.56		
7/1/2014	1137	\$162.58		
6/1/2014	965	\$139.61		
5/1/2014	429	\$67.94		
4/1/2014	769	\$113.41		
3/1/2014	1260	\$179.09		
2/1/2014	1514	\$214.48		
1/1/2014	1096	\$158.53		
12/1/2013	1512	\$214.21		
11/1/2013	653	\$99.22		
10/1/2013	918	\$134.71		
9/1/2013	996	\$145.13		
8/1/2013	885	\$111.79		
7/1/2013	1321	\$152.00		
6/1/2013	776	\$99.73		
5/1/2013	702	\$91.54		
4/1/2013	982	\$122.51		
3/1/2013	1213	\$142.75		

Fig. 1

Using figure 1, you can see that the electrical consumption for this house was 1,117 kWh per month.



**Step Three: Convert the average monthly kWh to daily kWh**

Take the average monthly kWh and divide by 30. 30 represents the average number of days in a month.

$$1,117 \text{ kWh} / 30 = 37.23 \text{ kWh per day}$$

**Step Four: Convert the average daily kWh to kW per hour**

Most PV arrays produce their peak energy in the span of 4-6 hours a day. This 4-6 hours is called the Solar Window. To be safe, divide the daily kWh total by 5 hours.

$$37.23 \text{ kWh} / 5 \text{ hours} = 7.44 \text{ kW}$$

**Step Five: Account for inefficiencies**

Every PV array will not operate at 100% efficiency. Energy production will be lost due to wire losses, inverter inefficiencies, module miss-match, and more. The general rule of thumb is to use a de-rate factor of 0.77. Divide the kW from above by 0.77.

$$7.44 \text{ kW} / 0.77 = 9.67 \text{ kW}$$

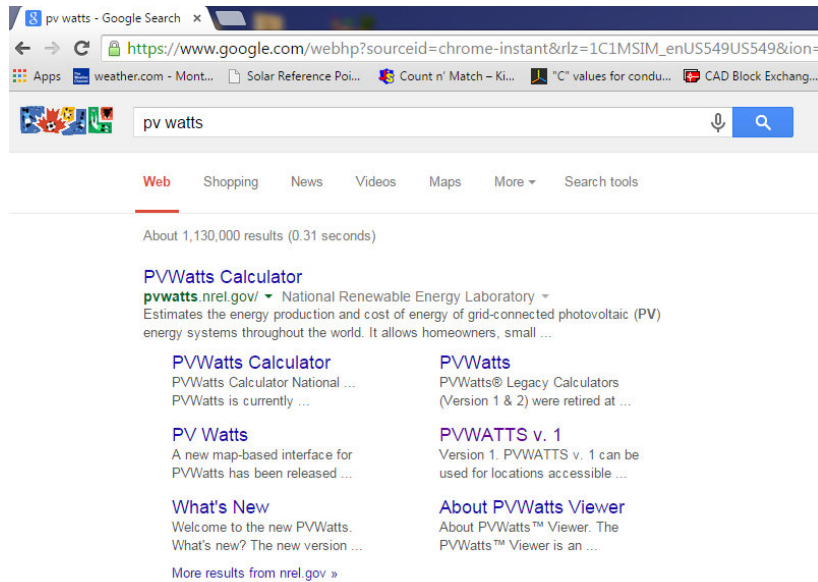
This is the size PV array you will start with for PV watts. Please note this array size is currently set to offset near 100% of your energy consumption.

## Step Six: Get to PV Watts

You can to PV Watts by clicking the link below or by typing in “PV Watts” into your web browser.

<http://rredc.nrel.gov/solar/calculators/PVWATTS/version1/>

If you choose to type in “PV Watts” into your web browser, you will see a screen like this:



Click on the PVWatts Calculator website. This will lead you to the next screen shown below.





## Step Seven: Enter your location

Type in you address or city in the get started box and then left click the GO button.



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## Step Eight: Choose your weather station

You will need to select a weather station. If your city or location does not have a weather station, choose the weather station closest to you.

Once you left click on the weather station, your screen will look like the one below. Move your cursor and click the “Go to system info” button.

**Selected weather data for your location**

(TMY3) DALLAS/ADDISON ARPT, TX 13 mi

**Optionally, Select Different Weather Data**

Currently, PVWatts® defaults to the closest TMY2 weather file (or international file). This will be the standard for the foreseeable future. We also offer the TMY3 locations and a 10 km gridded data set from SolarAnywhere®. We will not be including the older 40 km gridded data from PVWatts Version 2 as the other datasets are superior. The selected weather source pin is wrapped with a blue background. Click a different pin to select that source. If you enable SolarAnywhere® data for the continental US, then **double-click** anywhere on the map to select that grid cell (it must be enabled for each location). Refer to [Help](#) for more detailed information.

Enable SolarAnywhere® Gridded Data

**TMY3 Weather Data**

Location: DALLAS/ADDISON ARPT, TX  
Lat/Lng: 32.967, -96.833  
Elevation: 196

**Data Sources:**

- TMY2
- TMY3
- International

Map Satellite

Go to system info

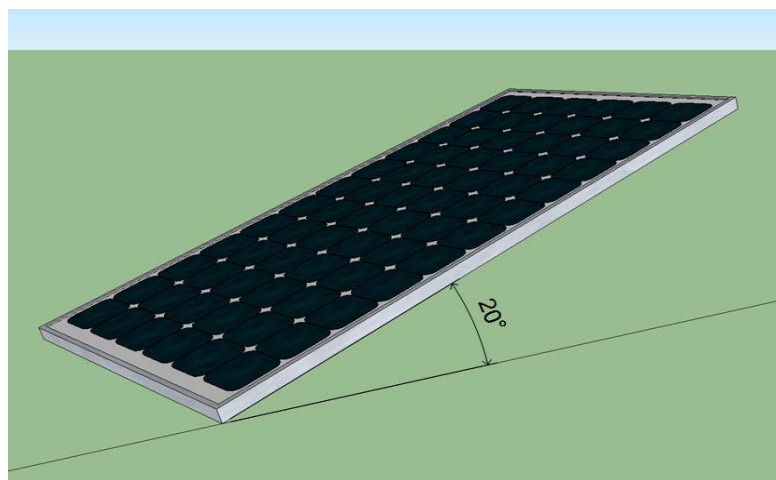
## Step Nine: Input your array info

On the system info screen, you have the option to input data specific to your PV array. This includes the array size in kilowatts (kW), module type, racking type, array tilt and array azimuth. While you can change all of these factors, it is recommended that you only change the ones you are sure about.

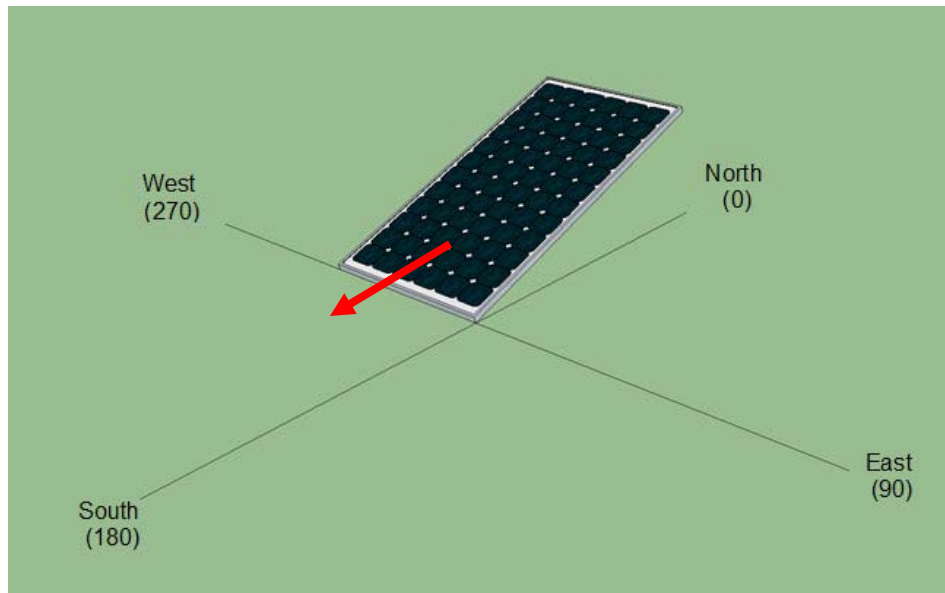
Input 9.67 kW from your earlier predictions. As for the module type and racking, you will leave those in their default “standard” and “fixed”. You can leave the systems losses(%) at the default 14 as well. In the last two fields, you should change the tilt and azimuth to match your location.

The screenshot displays the 'SYSTEM INFO' section of the PVWatts tool. The location is set to 'dallas, tx'. The 'SYSTEM INFO' tab is active, showing a list of input parameters for the PV array simulation. The parameters and their values are: DC System Size (9.67 kW), Module Type (Standard), Array Type (Fixed (open rack)), System Losses (14%), Tilt (20 deg), and Azimuth (180 deg). Red arrows highlight the Tilt and Azimuth fields. A 'RESTORE DEFAULTS' button is located at the top right of the form. Below the form is an 'Advanced Parameters' button. On the right side, there is a 'Draw Your System' section with a map interface and a 'Go to PVWatts results' button.

The tilt of the array is the angle the array sits above horizontal (see Below).



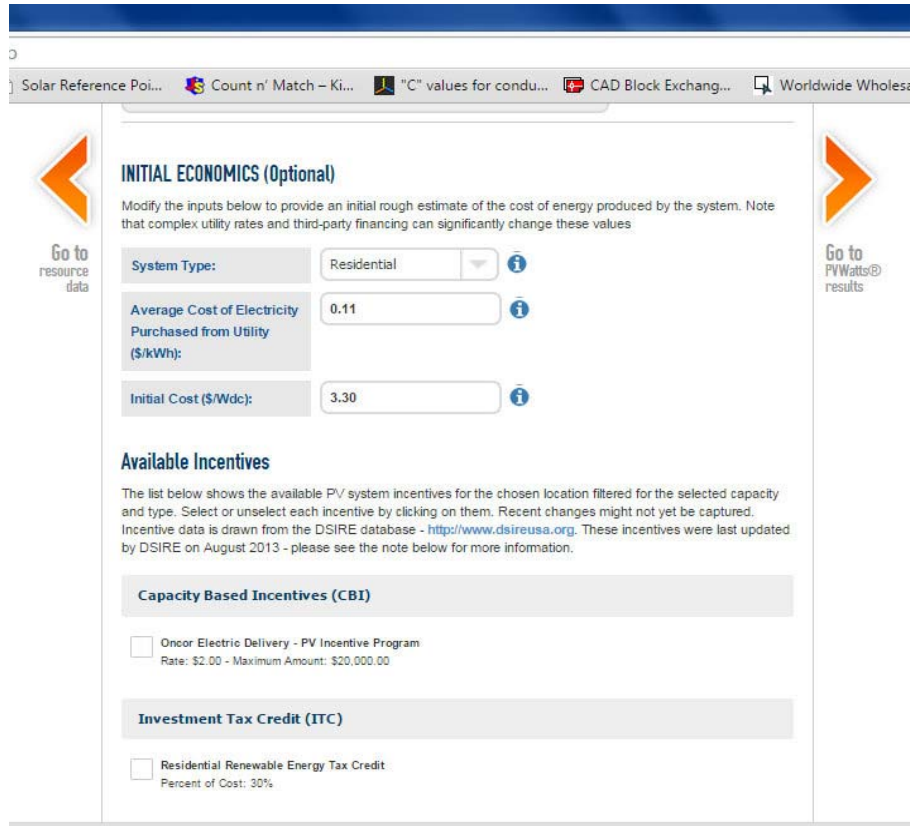
The azimuth of the array is the direction the array faces in relation to North, South, East and West (see Below).



Please note, this array is facing 180° or due South.

## Optional Step: Enter your financial data

You also have the option to enter in financial data if you so choose lower on the same system information page if you scroll down.



The screenshot shows a web browser window with several tabs open. The main content area is titled "INITIAL ECONOMICS (Optional)" and contains the following fields and sections:

- System Type:** A dropdown menu set to "Residential".
- Average Cost of Electricity Purchased from Utility (\$/kWh):** A text input field containing "0.11".
- Initial Cost (\$/Wdc):** A text input field containing "3.30".
- Available Incentives:** A section with a descriptive paragraph and two sub-sections:
  - Capacity Based Incentives (CBI):** Contains one checkbox labeled "Oncor Electric Delivery - PV Incentive Program" with a rate of "\$2.00" and a maximum amount of "\$20,000.00".
  - Investment Tax Credit (ITC):** Contains one checkbox labeled "Residential Renewable Energy Tax Credit" with a "Percent of Cost: 30%".

On the left and right sides of the form, there are orange arrow buttons. The left button is labeled "Go to resource data" and the right button is labeled "Go to PVWatts® results".

Once you have input all of the data for your PV array, click the “Go to PV Watts Results” button to see the estimation.

### Step Ten: Check your results

Under the column titled AC Energy (kWh), you can verify if the system meets your needs or not. This can be done by checking two things. First, take a look at the month by month kWh totals. Looking at this column, the kWh production per month ranges from 687 kWh to 1,430 kWh. This does fall within the 1,117 kWh requirement from earlier.

The second way to check the Array size is by taking the yearly total energy production value (see below). Based on the PV Watts output result, the yearly AC kWh production is 12,614. Taking the 1,117 kWh per month requirement and multiplying it by 12, gives you your yearly energy requirement.

$$1,117 \text{ kWh} \times 12 = 13,404 \text{ kWh}$$

My Location: **dallas, tx** [Change Location](#) Release Notice (?) [HELP](#) [FEEDBACK](#) ALL NREL SOLAR TOOLS

RESOURCE DATA SYSTEM INFO RESULTS

## RESULTS

Print Results

Go to system info

**12,614 kWh per Year \***

Month	Solar Radiation ( kWh / m <sup>2</sup> / day )	AC Energy ( kWh )	Energy Value ( \$ )
January	2.76	687	75
February	4.08	885	97
March	5.04	1,209	133
April	4.55	1,047	115
May	4.27	994	109
June	6.11	1,295	142
July	6.69	1,430	157
August	6.36	1,389	153
September	6.08	1,286	141
October	3.96	916	101
November	2.96	695	76
December	3.13	781	86
<b>Annual</b>	<b>4.67</b>	<b>12,614</b>	<b>\$ 1,385</b>

User Comments

A 9.67 kW Photovoltaic Array will produce roughly 6% less energy than is required. You can increase the array to 10.3 kW to achieve a 100% offset.



# **DSIRE**

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Finding Incentives

# Incentives

## Step One: Get to the DSIRE website

You can click the link below:

<http://www.dsireusa.org/>

You can also type in the word DSIRE in your web browser to find the webpage. Do make sure that you choose the webpage that looks like the one below.

**DSIRE: DSIRE Home**  
[www.dsireusa.org/](http://www.dsireusa.org/)  
The **Database of State Incentives for Renewable Energy (DSIRE)** is a comprehensive source of information on state, local, utility, and selected federal incentives ...

<a href="#">DSIRE Solar Portal</a> Summary Maps - Solar Policy Guide - Federal - ...	<a href="#">Pennsylvania ...</a> Pennsylvania. Incentives/Policies for Renewables & Efficiency ...
<a href="#">Federal</a> Federal. Incentives/Policies for Renewables & Efficiency ...	<a href="#">DSIRE: Incentives/Policies by ...</a> myDSIRE - Customize DSIRE for Your Organization. New York ...
<a href="#">Incentives/Policies by State</a> Incentives/Policies for Renewables & Efficiency ... State Rebate ...	<a href="#">New Jersey</a> New Jersey Property Assessed Clean Energy Municipal ...

[More results from dsireusa.org »](#)

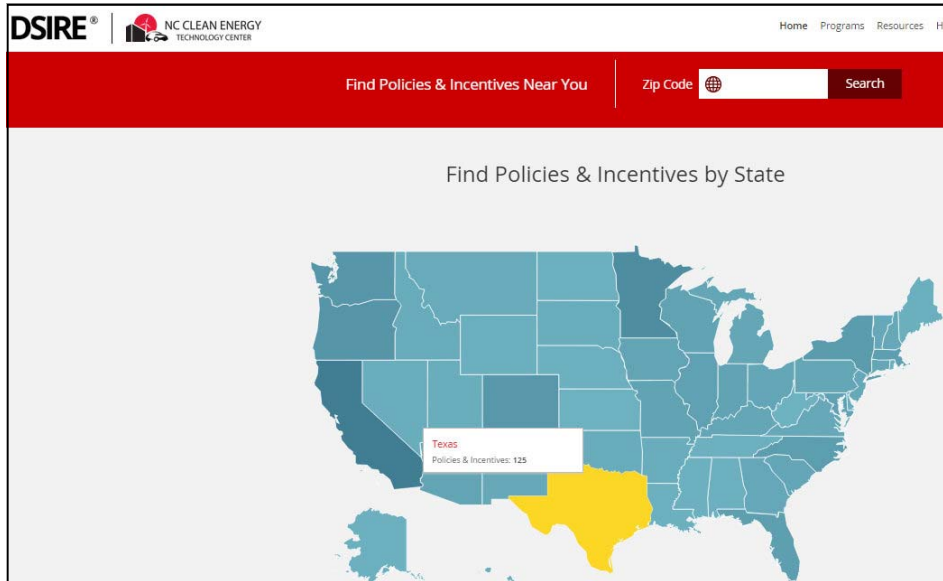
Click on the **DSIRE: DSIRE Home** link to get to the webpage itself.

Once that is done (or if you clicked the link on this page), you will be directed to the webpage, which looks like the picture below.



## Step Two: Choose your state

At this screen, you will now select the state in which you reside. In this case, Texas is being selected.



## Step Three: Find your Utility

Once you have selected your state, you will be directed to a new page listing all of the incentives available for your state. Scroll through the incentives until you find your utility provider.

The screenshot shows a list of incentives for Texas. The table has the following columns: Name, State/Territory, Category, Policy/Incentive Type, Created, and Last Updated. The table contains 15 rows of data.

Name	State/Territory	Category	Policy/Incentive Type	Created	Last Updated
Fannie Mae Green Initiative - Loan Program	US	Financial Incentive	Loan Program	05/28/2015	06/12/2015
Texas-New Mexico Power Company - SCORE/CitySmart, Commercial Solutions, and Small Business Programs	TX	Financial Incentive	Rebate Program	05/29/2006	06/11/2015
AEP Texas North Company - SMART Source Solar PV Rebate Program	TX	Financial Incentive	Rebate Program	09/16/2009	06/11/2015
El Paso Electric Company - Small Business and Large Commercial Programs	TX	Financial Incentive	Rebate Program	12/16/2009	06/11/2015
Austin Energy - Multi-Family Energy Efficiency Rebate Program	TX	Financial Incentive	Rebate Program	08/23/2006	06/11/2015
Bryan Texas Utilities - SmartHOME Program	TX	Financial Incentive	Rebate Program	06/07/2013	06/11/2015
Oncor Electric Delivery - Government and Education Facilities Program	TX	Financial Incentive	Rebate Program	09/23/2008	06/11/2015
Austin Energy - Residential Energy Efficiency Rebate Program	TX	Financial Incentive	Rebate Program	08/22/2006	06/10/2015
Brownsville Public Utilities Board - Green Living Residential Rebate Program	TX	Financial Incentive	Rebate Program	08/02/2012	06/10/2015
Texas Gas Service - Commercial Energy Efficiency Rebate Program	TX	Financial Incentive	Rebate Program	05/29/2006	06/10/2015
Austin Energy - Commercial Energy Management Rebate Program	TX	Financial Incentive	Rebate Program	08/22/2006	06/10/2015
City of San Marcos - Energy Efficient Home Rebate Program	TX	Financial Incentive	Rebate Program	02/03/2012	06/10/2015
AEP (Central and North) - Residential Energy Efficiency Programs	TX	Financial Incentive	Rebate Program	09/29/2010	06/10/2015
Solar Rights	TX	Regulatory Policy	Solar/Wind Access Policy	06/24/2011	06/10/2015
Guadalupe Valley Electric Cooperative - Residential Energy Efficiency Rebate Programs	TX	Financial Incentive	Rebate Program	03/31/2009	06/09/2015
CoSew Electric Cooperative - Commercial Energy Efficient Lighting Rebate Program	TX	Financial Incentive	Rebate Program	04/19/2011	06/09/2015

## **Step Four: Find your Incentive**

You will notice that there are a lot of different incentives available on this webpage. Photovoltaics is just one of many. There are incentives for pretty much every type of energy conservation method. In this case, ONCOR is selected.

<a href="#">City of Austin - Renewables Portfolio Standard</a>	TX	Regulatory Policy	Renewables Portfolio Standard	06/09/2003	04/27/2015
<a href="#">City of Brenham - Net Metering</a>	TX	Regulatory Policy	Net Metering	01/31/2011	04/27/2015
<a href="#">El Paso Electric - Net Metering</a>	TX	Regulatory Policy	Net Metering	09/12/2014	04/27/2015
<a href="#">San Antonio City Public Service (CPS Energy) - Renewable Portfolio Goal</a>	TX	Regulatory Policy	Renewables Portfolio Standard	04/02/2007	04/27/2015
<a href="#">San Antonio City Public Service (CPS Energy) - Net Metering</a>	TX	Regulatory Policy	Net Metering	09/15/2014	04/27/2015
<a href="#">Austin Energy - Net Metering</a>	TX	Regulatory Policy	Net Metering	01/01/2000	04/27/2015
<a href="#">Austin Energy - Value of Solar Residential Rate</a>	TX	Regulatory Policy	Value of Solar Tariff	02/05/2015	04/27/2015
<a href="#">Xcel Energy - Residential and Hard-to-Reach Standard Offer Program</a>	TX	Financial Incentive	Rebate Program	06/12/2006	04/27/2015
<a href="#">Oncor Electric Delivery - Solar Photovoltaic Standard Offer Program</a>	TX	Financial Incentive	Rebate Program	12/09/2008	04/27/2015
<a href="#">City of Austin - Green Power Purchasing</a>	TX	Regulatory Policy	Green Power Purchasing	10/24/2007	04/27/2015
<a href="#">City of Dallas - Green Building Policy for Municipal Buildings</a>	TX	Regulatory Policy	Energy Standards for Public Buildings	10/05/2007	04/27/2015
<a href="#">City of Dallas - Green Building Policy for Municipal Buildings</a>	TX	Regulatory Policy	Energy Standards for Public Buildings	03/26/2007	04/27/2015

## **Step Five: Review the Incentive**

At this point, you will now be lead into the actual incentives available from Oncor for a Photovoltaic System.

The first part of the incentive program will list the details of the available incentives. Read this information carefully to make sure it applies to your project.

The next section you need to be aware of on the Incentives page is the Summary. The summary helps you to confirm the details of the incentive program as well as lists the contact person for questions.

**Summary**

Oncor Electric Delivery offers rebates to its customers that install photovoltaic (PV) systems on homes or other buildings.\* Oncor customers of all rate classes (e.g., residential, commercial) are eligible to participate in the program. The term "customer" means "the entity with financial responsibility for paying the electric bill for the meter behind which the distributed solar energy equipment is to be installed." Rebates may be assigned to the customer, a service provider, or a third party.

**Rebate Amount**

In 2015, rebates are a one-time payment of \$538.80 per kilowatt (kW)-AC and \$0.3462 per kilowatt hour (kWh)-AC for both residential and non-residential customers (e.g., businesses, governments, nonprofits, etc.). Under this incentive scheme, a typical 5.3 kW residential rooftop PV system can earn a total rebate of approximately \$8,600.

The maximum rebate is equivalent to 20% of the most recent funding allocation. Individual systems must be 1 kW or larger, unless they are to be used by schools for educational purposes. In addition, systems may not be sized to produce energy in excess of that required to meet annual on-site energy consumption. Customers may only apply for one rebate per point of service, as defined by a unique meter ESI-ID number. Customers with multiple points of service are therefore permitted to apply for multiple rebates, subject to a 20% maximum rebate cap and other program limits (e.g., limits on total incentives available to a single customer).

**Eligibility**

A residential customer's home must have electric delivery service provided by Oncor. Systems must be new, connected to the grid on the customer side of the meter and meet all applicable code and utility interconnection requirements. All installations must be performed by service providers who meet specific program eligibility requirements. Service providers are also subject to ongoing quality assurance standards and are required to attend technical training sessions. Installations may be subject to a variety of inspection and performance monitoring requirements in the short- and long-term. System owners will initially retain title to renewable energy certificates (RECs) produced by their system. However, Oncor reserves the right to claim RECs produced by rebated systems at a later time.

For more information, visit the program website.

\*The Oncor program began as a pilot program in 2009 and provided rebates in 2009, 2010, 2011 and 2012. Oncor pays incentives to eligible Service Providers who market, sell/lease, and install solar photovoltaic systems to commercial and residential customers served by Oncor.

\*\*Oncor reserves the right to raise the incentive cap if the total amount of incentives for reserved projects is not sufficient to meet the program incentive budget.

**Contact**

**Share**

**Kristy Tyra**  
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 Oncor  
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 1616 Woodall Rodgers 5M027  
 Dallas, TX 75202  
 Phone:  
 (214) 486-2750  
 E-Mail:  
[kristy.tyra@oncor.com](mailto:kristy.tyra@oncor.com)

04/27/2015 by Heather Calderwood.  
 Rebate incentive has changed.

**Step Six: Make contact**

At this time, you still need to make an effort to verify the rate as well as verify your eligibility directly from the source. You can do this by calling or emailing the listed contact (shown above).

It is important to check with your Utility Provider for the most current incentives being offered. The DSIRE website does their best to have the most accurate up to date information they can. However, incentives are often changing very quickly causing some information on the DSIRE website to be inaccurate. Do not solely base your system cost off of the DSIRE website only.

Now go out and get that Photovoltaic Array started.

# Glossary of Terms

**Ampere (A)** The unit for the electric current; the flow of electrons.

**Array** Any number of Photovoltaic modules connected together electrically to provide a single electrical output.

**Battery** Two or more “cells” electrically connected for storing electrical energy.

**Battery Capacity** The total number of ampere-hours that can be withdrawn from a fully charged cell or battery.

**Current** The flow of electric charge in a conductor between two points having a difference in potential.

**Electric Current** The A flow of electrons; electricity.

**Electricity** A form of energy that is carried through wires and is used to operate machines, lights, etc.

**Grid** A integrated system of electricity distribution, usually covering a large area. This is used by the Utility to distribute electricity.

**Kilowatt (kW)** 1000 watts.

**Kilowatt-Hour (kWh)** 1000 watt hours.

**Module** The smallest environmentally protected, essentially planar assembly of solar cells and ancillary parts.

**Off –Grid** A system which operates independently of the utility lines (Grid).

**Photovoltaic System** (informally, **PV system**) A complete set of components for converting sunlight into electricity.

**Renewable Energy** Energy from a source that is not depleted when used, such as wind or solar power.

**Voltage** The amount of force required to move 1 amp through 1 ohm of resistance.

**Watt** Unit of electrical power (Voltage x Amperage)

**Watt-Hour (Wh)** A quantity of electrical energy when one watt is used for one hour.



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Don't hesitate to contact us with any questions you may have.

Sincerely,

*The Solar Unplugged Team*

[www.SolarUnplugged.com](http://www.SolarUnplugged.com)