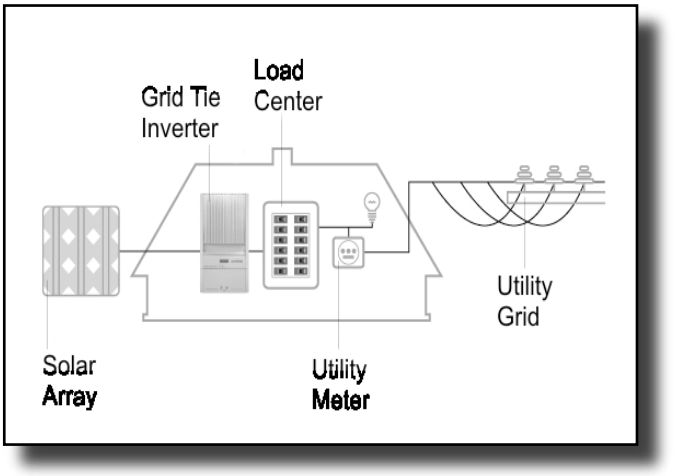
4 - UTILITY INTERTIE PV SYSTEM DESIGN

Utility Intertie Tie System Design

Budget, roof dimensions and other site-specific factors often call for custom system design. If you are planning to mount your array on a roof, decide which module best fits into the available roof space, taking into consideration obstructions such as chimneys, plumbing vents and skylights. See solar module section for dimensions of modules. A grid-connected PV system consists of PV modules, output cables, module mounting structures, AC and DC disconnect switches, inverter(s), grounding equipment and metering system.

The Worksheet below will help you decide what size PV array would be required to eliminate your electric bill. This will be the largest system that would be cost effective to install. A smaller system can reduce part of your bill, or eliminate higher cost electricity in locations that have progressively increasing rates as consumption increases. Use this information and the amount of available space to get a rough idea of your PV array size.



TO DETERMINE THE PV ARRAY SIZE FOR A GRID CONNECTED SYSTEM

Step 1 **FIND YOUR MONTHLY AVERAGE ELECTRICITY USEAGE FROM YOUR ELECTRIC BILL** _____

This will be in kilowatt-hours (kWh). Due to air conditioning, heating and other seasonal usage, it is a good idea to look at several bills. You can add the typical summer, fall, winter and spring bills and divide by four to find the average monthly usage.

Step 2 **FIND YOUR DAILY AVERAGE ELECTRICITY USE -** _____

Divide the monthly average number of kWh use by 30 (days).

Step 3 **FIND YOUR LOCATION'S AVERAGE PEAK SUN HOURS PER DAY** _____

See the chart and listings on pages 12 and 13. For example, the average for California is 5 peak sun hours

Step 4 **CALCULATE THE SYSTEM SIZE (AC WATTS) TO PROVIDE 100% OF YOUR ELECTRICITY** _____

Divide your daily average electricity use by the average sun hours per day. For example, if the daily average electricity use is 30 kWh, and the site is in California, then the system size would be: 30 kWh / 5 h = 6 kW AC

Step 5 **CALCULATE THE NUMBER OF PV MODULES REQUIRED FOR THIS SYSTEM** _____

Divide the system AC watts in Step 4 by the CEC watt rating of the modules to be used, then divide by the inverter efficiency, usually 0.94 and you get the total number of modules required. (Round this number up)

Use the chart on the next page to determine possible array size/inverter combinations

This chart shows inverter and module combinations for common modules used in grid connected systems. For a given inverter and module combination, the chart displays the acceptable number of series strings of modules and the number of modules per string for temperatures between 14ºF and 104ºF. Where the inverter will support more than one string of modules, the chart shows the number of modules that can be used with multiple strings. Sizing is accurate in locations where the maximum temperature is lower than 104ºF or the minimum temperature is higher than 14ºF. In locations where the minimum temperature is lower than 14ºF, the maximum number of modules per string may be lower. String sizes followed by *** may have some derating in full sun.

In the chart on the next page, the line labeled **CEC Watts** is the expected output of the modules at normal operating temperature, in full sun. The line below this, labeled **Ratio,** is the output at operating temperature divided by the label rating of the module. Modules with a higher ratio give you more actual output power per rated watt.

The approximate power output of a system in full sun will be the number of modules times the CEC rating of the modules times the inverter efficiency from second column on the table. Other factors, such as high or low temperature, shading, array orientation, roof pitch and dirt on the modules, will affect the system's actual output.

UTILITY INTERTIE SYSTEM DESIGN - 5

Permissible number of modules per string - 14ºFMinimum Temp. - 104ºF Maximum Temp.									
Inverter		Module	Shell		Evergreen			Kyocera	Mitsubishi
			SQ165	SQ175	EC-110-GL	EC115-GL	EC120-GL	KC175	MF170
Brand & Model	CEC Efficiency	CEC Watts	149.1	158.3	98.4	103.1	107.6	154.9	152.5
		CEC % of nameplate	0.904	0.905	0.895	0.897	0.897	0.885	0.897
SMA SWR1800U	91.5%	one string	6 to 8	5 to 8	11 to 16	11 to 16	11 to 16	8 to 12	7 to 11
		two strings	6	5 to 6					
SMA SWR2500U	93.0%	one string	9 to 12	9 to 12	18 to 24	18 to 24	18 to 24	13 to 16	12 to 17
		two strings	9	9 ***					
SMA SB3800U	94.5%	one string	8 to 10	8 to 10	16 to 20	16 to 20	16 to 20	12 to 15	10 to 14
		two strings	8 to 10	8 to 10	16 to 20	16 to 20	16 to 18	12 to 13	10 to 13
		three strings	8 to 9	8					
SMA SB6000U	94.5%	two strings	9 to 12	9 to 12	18 to 24	18 to 24	18 to 24	13 to 18	12 to 17
		three strings	9 to 12	9 to 12	18 to 21	18 to 21	18 to 20	13 to 14	12 to 14
		four strings	9 to 11	9 to 10					
FRONIUS IG2000	93.5%	one string	7 to 8	6 to 8	12 to 20	12 to 20	12 to 20	8 to 14	8 to 14
		two strings	5 to 7	5 to 7					
		three strings	5						
FRONIUS IG3000	94.0%	one string			12 to 20	12 to 20	12 to 20	8 to 15	8 to 14
		two strings	5 to 8	5 to 8	12 to 14	12 to 14	12 to 14	8 to 9	8 to 9
		three strings	5 to 6	5 to 6					
		four strings	5						
FRONIUS IG4000	94.0%	two strings			12 to 20	12 to 20	12 to 20	8 to 13	8 to 13
		three strings	6 to 9	6 to 8	12 to 13	12 to 13	12 to 13	8	8
		four strings	5 to 6	5 to 6					
		five strings	5	5					
FRONIUS IG5100	94.5%	two strings			12 to 20	12 to 20	12 to 20	8 to 15	8 to 14
		three strings	8 to 9	7 to 9	12 to 17	12 to 17	12 to 17	8 to 11	8 to 11
		four strings	6 to 9	5 to 8	12 to 13	12 to 13	12 to 13	8	8
		five strings	5 to 9	5 to 6					
		six strings	5 to 6	5					
		seven strings	5						
XANTREX GT 2.5	94.0%	one string	8 to 12	7 to 12	16 to 24	16 to 24	15 to 24	11 to 18	10 to 17
		two strings	8 to 9	7 to 8					
XANTREX GT 3.0	94.5%	one string	8 to 12	7 to 12	16 to 24	16 to 24	15 to 24	11 to 18	10 to 17
		two strings	8 to 11	7 to 10	16 to 17	16	15		10 to 11
		three strings		7					
XANTREX GT 3.3	94.5%	one string	8 to 12	7 to 12	16 to 24	16 to 24	15 to 24	11 to 18	10 to 17
		two strings	8 to 12	7 to 11	16 to 18	16 to 17	15 to 17	11	10 to 12
		three strings	8	7					

String sizes followed by *** may have some derating in full sun.

6 - COMPLETE GRID TIE SYSTEMS

AEE Engineered Systems

AEE Grid-Tie Photovoltaic (PV) Power Systems are designed for use on residential and small commercial buildings. They consist of high quality photovoltaic modules, an inverter, array wiring, DC and AC disconnects, mounting structures to secure modules on the roof and technical support.

Our component kits include all of the above items. The pre-wired kits include the components above with the disconnects and inverter mounted on a powder coated back panel, pre-wired and tested. This simplifies the installation since all connections from the PV array are made to the DC disconnect and all connections to the existing load center are made to the AC disconnect. Wiring from the array to the DC disconnect, array ground wiring, and wiring from the AC disconnect to the main panel and all conduit must be supplied by the installer (your specific installation or utility may require additional AC disconnects). All components comply with the 2005 National Electrical Code (NEC-2005), IEEE Std 929-2000-Institute of Electrical and Electronics Engineers Recommended Practices for Utility Interface of Photovoltaic (PV) Systems, UL 1741-Underwriters Laboratories Standard for Safety and the ICBO 2000-International Building Code. The arrays and inverters are matched for maximum efficiency.

These modular systems can be combined to form larger systems to meet the customer's requirements. It is economical to put these systems together for use in 30 kilowatt or smaller systems. For larger systems, please contact a sales representative for a quote.

Use the table below to select a pre-packaged system that meets your needs. California Energy Commission bases their rebates on the system CEC rating in column 4 of the table. CEC system watts takes module output in normal operating conditions and inverter efficiency into account.

Packaged Systems with Mitsubishi 170 Watt Modules (CEC=152.5)							Components		Pre-Wired	
PV Watts	Module Quantity	Series x Parallel	System CEC Watts	Inverter Brand and Model	Inverter Watts	Output VAC	Item Code	Price	Item Code	Price
1360	8	8 x 1	1141	Fronius IG2000	2000	240	10.6315	$10,798.00	10.6515	$11,092.00
2380	14	14 x 1	1986	SMA SWR2100	2100	240	10.6319	$15,790.00	10.6519	$16,264.00
2890	17	17 x 1	2437	Xantrex GT2.5	2500	240	10.6323	$19,780.00	NA	
3400	20	10 x 2	2882	Xantrex GT3.0	3000	240	10.6327	$23,164.00	NA	
3740	24	11 x 2	3170	Xantrex GT3.3	3300	240	10.6331	$25,540.00	NA	
4420	28	13 x 2	4035	SMA SB3800U	3800	240	10.6335	$32,649.00	10.6535	$32,943.00
5440	32	8 x 4	4612	Fronius IG5100	5100	240	10.6339	$37,552.00	10.6539	$37,896.00
7140	42	14 x 3	6053	SMA SB6000U	6000	240	10.6343	$49,237.00	10.6543	$49,581.00

Packaged Systems with Evergreen 115 Watt Modules (CEC=103.1)							Components		Pre-Wired	
PV Watts	Module Quantity	Series x Parallel	System CEC Watts	Inverter Brand and Model	Inverter Watts	Output VAC	Item Code	Price	Item Code	Price
1380	12	12 x 1	1157	Fronius IG2000	1100	240	10.6413	$10,410.00	10.6613	$10,704.00
2300	20	20 x 1	1918	SMA SWR2100	2000	240	10.6417	$14,615.00	10.6617	$14,909.00
2760	24	24 x 1	2326	Xantrex GT2.5	2500	240	10.6421	$17,977.00	NA	
3680	32	16 x 2	3118	Xantrex GT3.0	3000	240	10.6425	$23,371.00	NA	
4140	36	18 x 2	3507	SMA SB3800U	3800	240	10.6429	$27,288.00	10.6629	$27,582.00
4600	40	20 x 2	3897	SMA SB3800U	3800	240	10.6433	$29,750.00	10.6633	$30,044.00
5520	48	12 x 4	4677	Fronius IG5100	5100	240	10.6437	$35,801.00	10.6637	$36,145.00
6900	60	20 x 3	5846	SMA SB6000U	6000	240	10.6441	$45,079.00	10.6641	$45,423.00

GRID TIE SYSTEMS WITHBACKUP POWER - 7

AEE Engineered Systems with Battery Backup

These Grid-Interactive Renewable Energy Systems give you energy independence without leaving you in the dark when the grid goes down. They enable you to demonstrate your personal commitment to a renewable energy future. With these grid-interactive systems, backup AC power is made available in the event of a utility outage, providing reliable power and peace-of-mind. An average conversion efficiency of 89% to 91% using the California Energy Commission (CEC) test protocol provides greater savings and a shorter time period for system payback than previous designs.

Battery Backup Grid Interactive systems come with modules, array wiring, combiner boxes, roof mounting structures, inverters/control systems with all required over-current protection and disconnects (Your specific installation or utility may require additional AC disconnects). They require a 48 volt battery bank to operate. The size of the battery determines the amount of backup power available during power failure. Use the worksheet on the next page to determine battery bank size. Battery backup systems qualify for the California Energy Commission incentives and the Federal Tax Credit.

Grid-Interactive Systems with Inverters Installed Indoors (Batteries not included)

PV Watts	Module Quantity	Module Brand & Watts	System CEC Watts	Inverter Model	Backup Watts	Output VAC	Item Code	Price
460	4	Evergreen 115	375	Outback PS2 System with One GVFX3648	3600	120	10.6723	$7,620
2760	24	Evergreen 115	2252	Outback PS2 System with One GVFX3648	3600	120	10.6727	$20,717
5520	48	Evergreen 115	4503	Outback PS2 System with Two GVFX3648	7200	120/240	10.6731	$40,501

Grid-Interactive Systems with NEMA 3R Inverters for Outdoor Installation (Batteries not included)

PV Watts	Module Quantity	Module Brand & Watts	System CEC Watts	Inverter Model	Backup Watts	Output VAC	Item Code	Price
460	4	Evergreen 115	375	Outback PS1 System with One GVFX3648	3000	120	10.6745	$7,948
2760	24	Evergreen 115	2252	Outback PS1 System with One GVFX3648	3000	120	10.6749	$20,884
5520	48	Evergreen 115	4404	Beacon Power M5 Inverter	5000	120	10.6753	$38,910

Battery Packs for Systems Above

Watt Hours Storage to 80% Discharge	Battery Quantity	System Amp Hours	Battery Model	Battery Rack	NEMA 3R Outdoor	Item Code	Price
3750	4	98	MK S31-SLD-G	Outback PS1 Battery Enclosure (w/ PS1 only)	Yes	10.6781	$1,586
7500	8	196	MK S31-SLD-G	Outback PSR Battery Rack	No	10.6783	$2,889
7500	8	196	MK S31-SLD-G	Outback PSR Battery Rack w/ 3RK Cover	Yes	10.6785	$3,038
11250	12	294	MK S31-SLD-G	Outback PSR Battery Rack	No	10.6787	$4,017
11250	12	294	MK S31-SLD-G	Outback PSR Battery Rack w/ 3RK Cover	Yes	10.6789	$4,166