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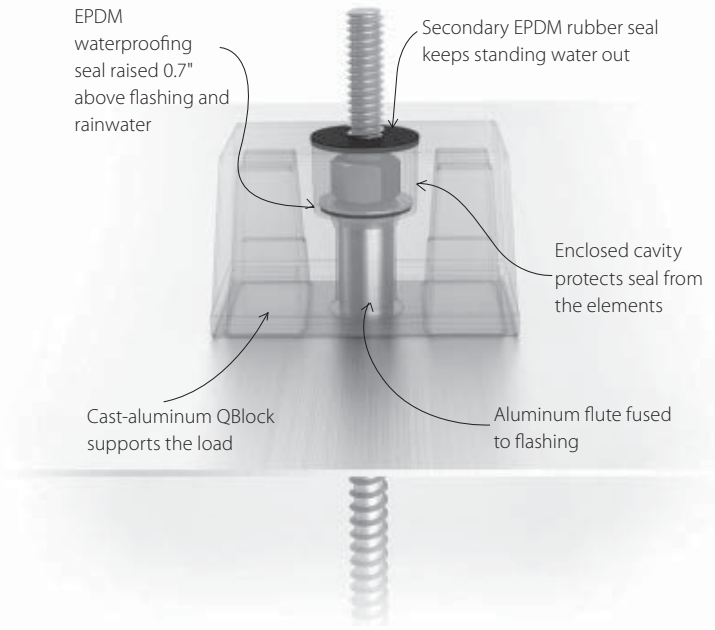

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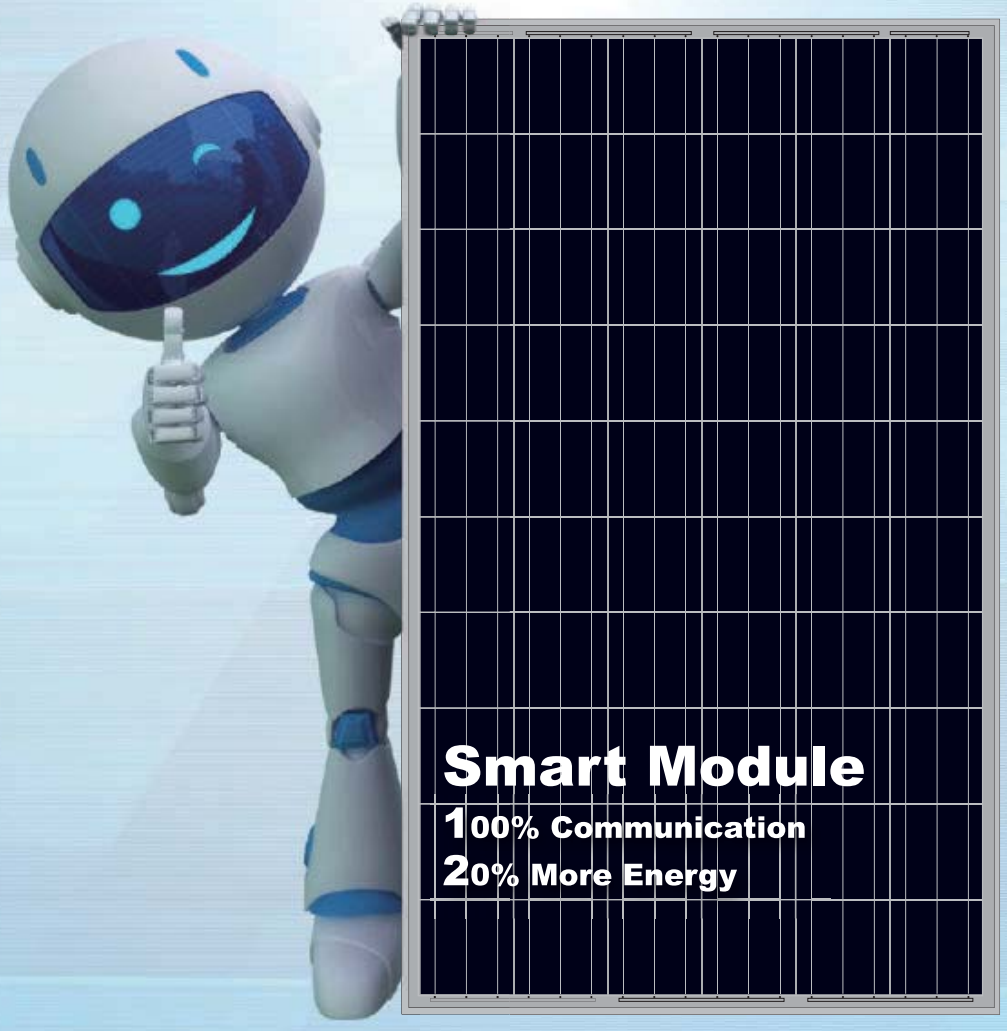

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WELCOME To The 2015 Renewable Energy Handbook!

Kathie Zipp
Managing Editor
Solar Power World
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Welcome to the fifth edition of our Renewable Energy Handbook.

If this is your first time taking a look at one of these editions, you may wonder why we go through the trouble of assembling an annual 300-plus-page hefty handbook. True, it's a big commitment on our part, but it's worth our time if it saves some of yours. Instead of scouring the web for product data sheets, you can find most of them in here and easily browse selections side by side to determine which is right for you. Instead of Google searching your questions about renewables, simply flip to a section and read up on the answers provided by industry experts. Need to find a good operations & maintenance partner? Find listings from major players who are eager to offer their services. This handbook—a textbook, almanac and directory all in one—is your one-stop-shop for information to help do business better.

Feel free to leave this issue on your desk, because our digital edition is lighter to carry on the road. You can also find it and more sortable component data in our online tools on *windpowerengineering.com* and *solarpowerworldonline.com*. You'll also find data on wind turbine models in our digital edition and online Turbine Selector Tool.

Each year we try to improve our handbook by modifying our editorial coverage and updating data in our component charts. Are you new to wind or solar? Find answers to common questions in our Basics sections. This year, we've also added data on integrated solar modules and solar hot water, as well as diversified the information on solar racking and mounting to better portray the options in the market.

We've made a great effort to deliver the most accurate and up-to-date information available at the time of publishing, but we realize it isn't perfect. If you have a comment, correction, addition or suggestion, by all means please contact me or any of the other editors involved in this publication. We are grateful for your assistance in ensuring our accuracy by updating the handbook online and noting for next year. We want this handbook to be the best it can be and we welcome your help.

Thanks for reading. We hope you enjoy! WPE & SPW

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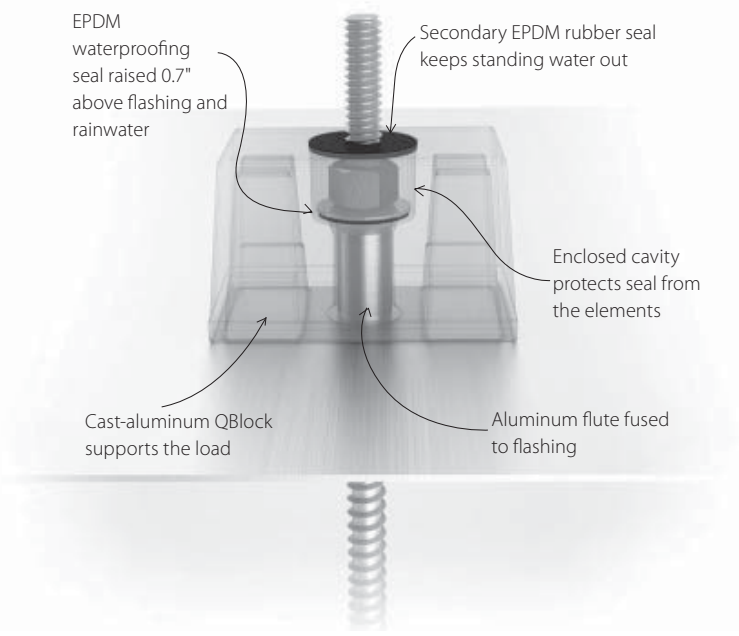

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WELCOME
To Your Solar Handbook

Steven Bushong
Associate Editor
Solar Power World
sbushong@wtwhmedia.com

Solar veterans know the industry exists at the intersection of environmentalism and business. And it's a big business, last year contributing $15 billion to the U.S economy and employing 143,000 people. The industry grew 20% from Q2 2013 to Q2 2014, according to SEIA.

One reason for the growth is continually decreasing component prices, which lower the total cost of energy. This means utilities are more likely to support utility-scale solar projects by buying the power they generate. On the consumer side, interest is ballooned by news of solar on places such as Walmart, the White House and local zoos. Just take a look at our solar project chart to see how development has grown since 2009.

Popular media reports the time for mainstream solar has come, as the technology becomes increasingly competitive with traditional fuel sources. In the future, household solar could be as common as refrigerators. Experts know this is the result of declining manufacturing prices coupled with innovative, smart technology that makes installing, using and tracking solar energy easier.

As the solar industry grows, we hope your business will grow, too. In this section of the 2015 Renewable Energy Handbook, we've assembled tools to help you keep up with the pace of progress. Instead of scouring the web for data sheets, we've compiled charts of available solar components so you can compare offerings side by side and see which will work best for your solar project. This year's edition contains not only updated information, but the addition of solar hot water and integrated module charts. We also restructured the racking and mounting products charts to better encompass the diverse options available in the market. We hope this helps you do business better.

Solar skeptics say the product of the industry's efforts today–15.9 GW of clean energy in the U.S.–are small compared to the energy produced by traditional power plants, and solar could never feasibly replace gas or nuclear power, but they're missing the point entirely. We are on an exciting journey of innovation to develop and distribute technology that can contribute to a more sustainable energy scheme and a cleaner world. With the effects of global climate change at our doorstep, there is no better time than now to enter the solar industry or increase your contribution.

That's why we develop this handbook every year. We want to create resources that will help you do business better, which will grow the economy and improve the environment. The industry can only rise from here. SPW

Enjoy this print edition, as well as the digital edition of this handbook which is available at www.solarpowerworldonline.com.

—The Solar Power World team

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Solar Basics

Whether you're a veteran of the industry or new to solar, it's good to understand the basics. Below are some of the most commonly asked questions in the solar industry.

Photos Courtesy of RevoluSun

What are the main types of solar technology?

Most solar technology falls into one of three categories: photovoltaic (PV), concentrated solar power (CSP) and solar thermal. Solar PV technology generates electricity from sunlight through an electronic process occurring naturally in certain types of material, called semiconductors. Solar PV can power anything from a calculator to a factory. CSP plants use mirrors to concentrate the energy from the sun to drive traditional steam turbines or engines that create electricity. Solar thermal technologies collect the energy from the sun to heat water for residential, commercial and industrial applications.[1]

Which solar sector (utility, commercial or residential) is growing fastest in the United States?

By megawatts installed, utility-scale solar installations saw the most added capacity in the first half of 2014. The sector added 625 MWdc in Q2 2014, up from 543 MWdc in Q2 2013. Still, more than a half-million homeowners and commercial customers installed solar PV through the first half of 2014. In fact, the residential market has seen the most consistent growth of any segment for years, and its momentum shows no signs of slowing. While individual commercial-scale projects are getting larger, the market overall has stumbled in recent years due to difficulties with financing and other issues, despite huge potential.[2]

How much does it cost to put solar on a house?

Depending on a system's design and location, the typical residential-scale solar system, sized between 3- and 7-kW, will cost between $18,000 and $40,000. According to SunRun, a third of the cost is panels and another 25% is in permitting and installation.[3] From Q1 2013 to Q1 2014, residential system prices fell 7%, from $4.91/W to $4.56/W, according to estimates provided to researchers.[4] The Open PV Project from NREL lists average costs for PV, with most states falling between $5 and $10/W.

How can I work in the solar industry?

As of 2013, there are more than 142,698 solar workers across all 50 states, a 20% increase over 2012.[11] Solar installers are key to the process of solar panel installation and maintenance. Installers are often self-employed as general contractors or employed by solar panel manufacturers or installation companies. Installers typically have a background in construction or as electricians. There is no formal training standard for installers, but courses are offered by a variety of institutions, such as trade schools, apprenticeship programs or by manufacturers. Many are licensed by the North American Board of Certified Energy Practitioners (NABCEP). Certification, while not necessary, can improve the job prospects of installers, and many larger projects require workers to be certified.[5]

What are some of the biggest solar companies?

According to the Solar Power World 2014 Top Solar Contractors list,[6] these are ten of the largest solar installation companies:

- First Solar of Tempe, Ariz.
- NRG Energy of Princeton, N.J.

- Rosendin Electric of San Jose, Calif.
- SolarCity of San Mateo, Calif.
- CSI Electrical Contractors of Santa Fe Springs, Calif.
- Strata Solar of Chapel Hill, N.C.
- E Light Wind and Solar of Englewood, Colo.
- AMEC of Atlanta, Ga.
- Mortenson Construction of Minneapolis, Minn.
- Signal Energy Constructors of Chattanooga, Tenn.

What is the history of solar energy?

Solar technology is old news. People have been using it since 7 B.C., although in ways decidedly less technical, such as lighting fires and heating their homes. As early as 212 BC, the Greek scientist, Archimedes, claimed to use the reflective properties of bronze shields to focus sunlight and to set fire to enemy wooden ships. In 1767, Swiss scientist Horace de Saussure was credited with building the world's first solar collector, later used by Sir John Herschel to cook food during his South Africa expedition in the 1830s. In 1839, French scientist Edmond Becquerel discovers the photovoltaic effect while experimenting with an electrolytic cell made up of two metal electrodes placed in an electricity-conducting solution—electricity—generation increased when exposed to light. And in 1908, William J. Bailley of the Carnegie Steel Company invents a solar collector copper coils and an insulated box— resembling the present design of a solar panel.[7]

Which states have the most solar installations?

According to the Open PV Project,[8] a database maintained by NREL, the following states lead the way in solar energy according to overall installed capacity:

- California, 134,759 project, 1.8 GW
- New Jersey, 8,790 projects, 845 MW
- Arizona, 17,338 projects, 775 MW

- Massachusetts, 9,766 projects, 266 MW
- Nevada, 1,518 projects, 214 MW

Who supports the solar industry?
About nine out of ten American voters agree that it is important for the U.S. to develop more solar. Support is also strong across the political spectrum, with 75% of Republicans, 89% of Independents and 94% of Democrats agreeing that the U.S. should use more solar.[9] President Obama has declared solar energy as a "win-win-win" for the environment, economy and job creation, and more than 300 companies have made public commitments to solar, including IKEA, Clif Bar and Kaiser Permanente.[10]

By Steven Bushong, Associate Editor

Sources:

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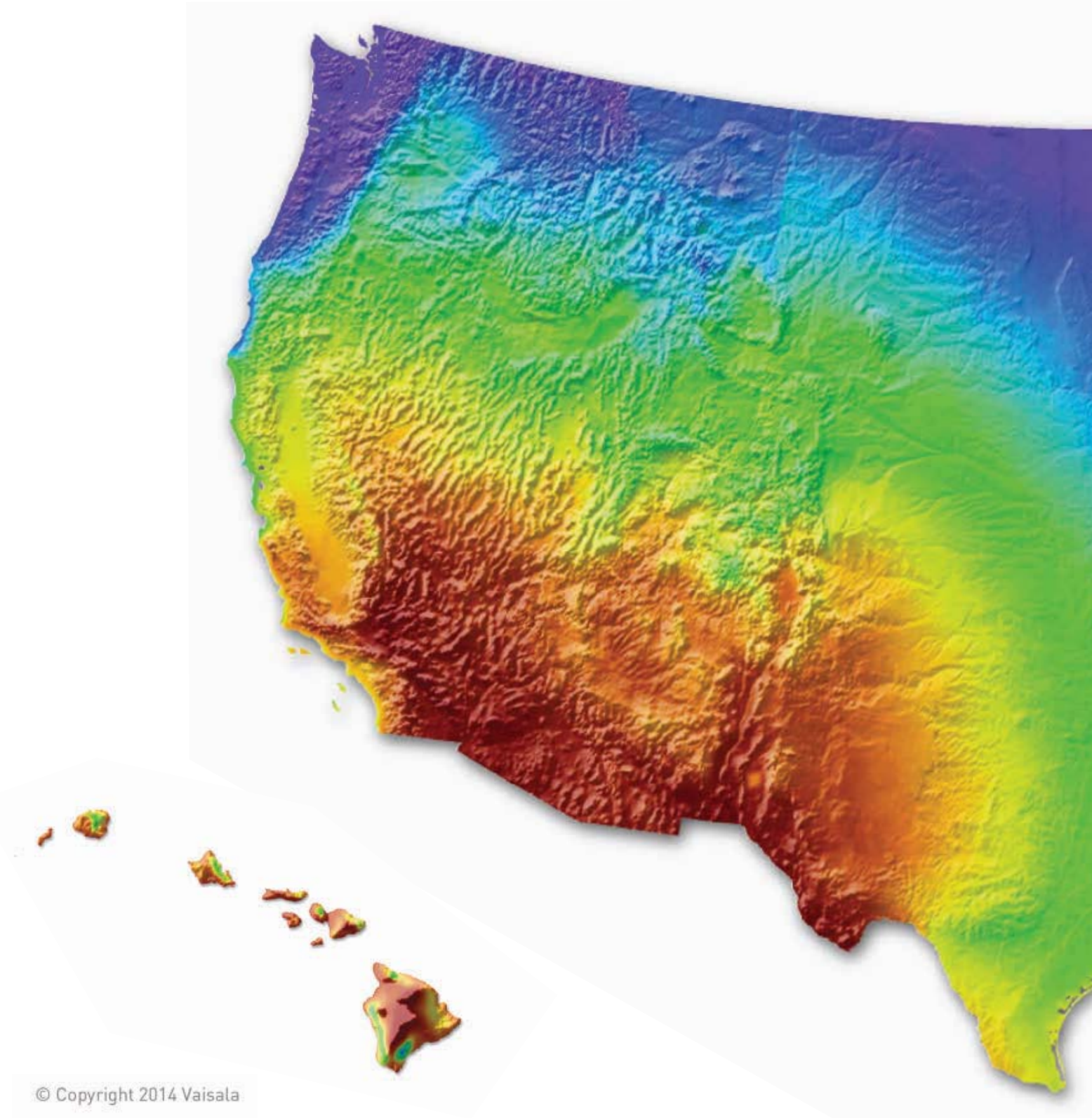
U.S. Solar Irradiance Map



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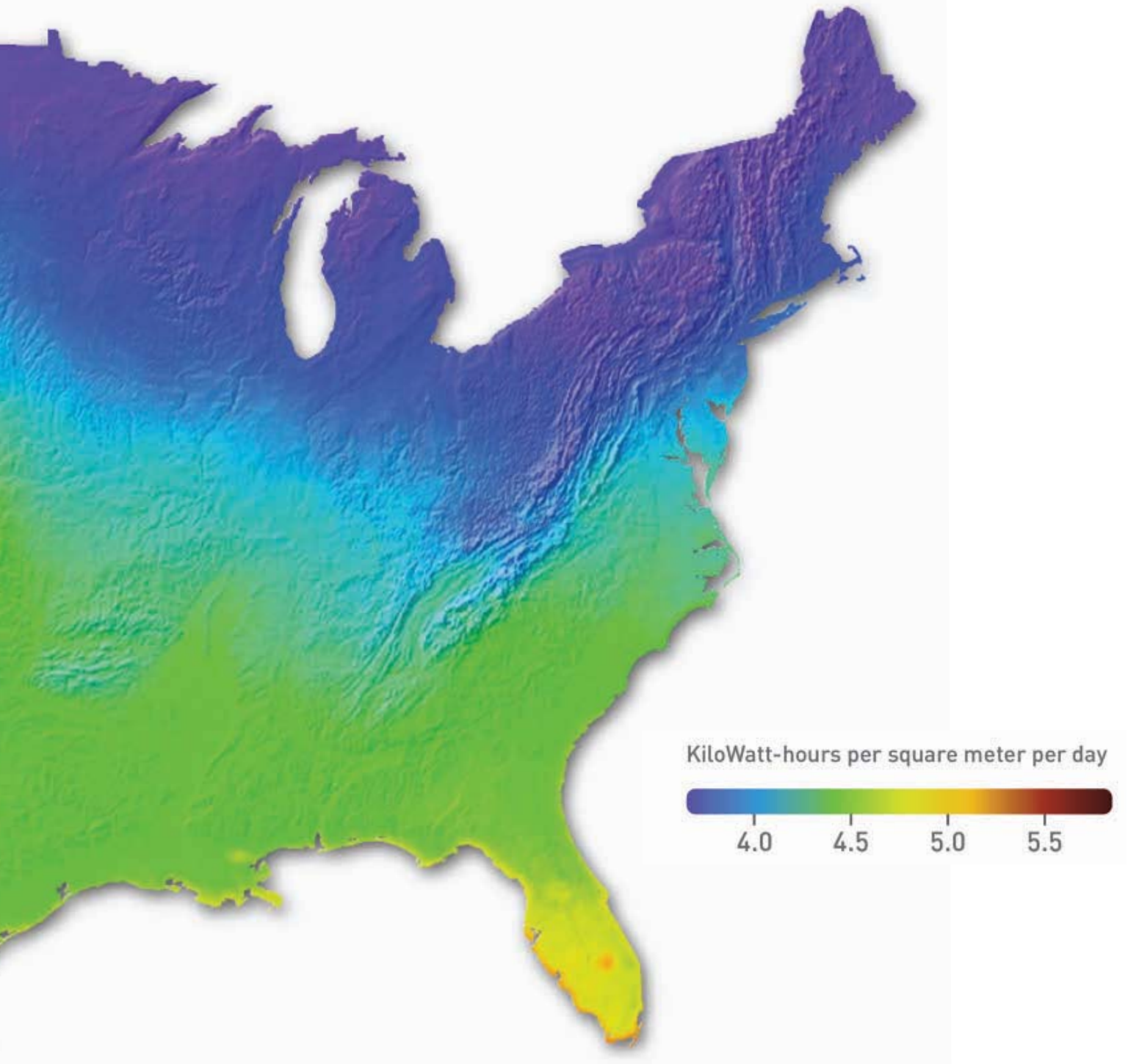
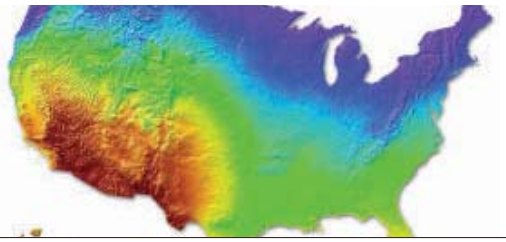


U.S. Solar Projects



Top Projects Of 2014	Project Name	Capacity MWs	State	Module Manufacturer
	Ivanpah	392	CA	Siemens
	Agua Caliente	290	AZ	First Solar
	Abengoa Mojave Solar Project	280	CA	
	Genesis Solar	250	CA	
	Crescent Dunes	110	NV	Alstom

Top Projects Of 2013	Project Name	Capacity MWs	State	Module Manufacturer
	Solana	200	AZ	Abengoa
	Centinela Solar Energy	170	CA	Yingli Green Energy
	Imperial Solar Energy Center South	130	CA	First Solar
	Campo Verde	139	CA	First Solar
	Arlington Valley Solar Project II	125	AZ	Kyocera
	Catalina Solar Project	110	CA	
	AV Solar Ranch One	115	CA	First Solar
	Mesquite Solar	66	AZ	Solar Frontier/First Solar
	Topaz Solar Farm	34	CA	First Solar
	McKenzie Road Solar Farm	30	CA	

Top Projects Of 2012	Project Name	Capacity MWs	State	Module Manufacturer
	Agua Caliente	250	AZ	First Solar
	California Valley Solar Ranch	250	CA	Sunpower
	Imperial Solar Energy Center South	130	CA	First Solar
	Copper Mountain 2	92	NV	First Solar
	Alpine Solar Project	66	CA	First Solar
	Silver State North Solar Project	55	NV	First Solar
	Alpaugh	50	CA	Trina/Canadian Solar
	Alamosa Solar Generating Project	30	CO	Amonix
	Avra Valley	25	AZ	First Solar
	McHenry Solar Farm	25	CA	SunPower

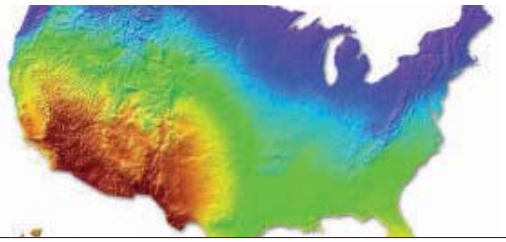
Editor's Note:
This information was obtained through sources such as SEIA reports, online research and contacting developers of these projects. If you're interested in making an edit let us know and we will include online.

	Type	Developer	Other Companies Involved	Owner	Power Purchaser
	CSP	BrightSource Energy/ Bechtel		NRG Energy, Google	PG&E, SCE
	PV	First Solar	NRG	MidAmerican Energy Holdings	PG&E
	CSP	Abengoa Solar			PG&E
	CSP	NextEra Energy Resources		NextEra Energy Resources	PG&E
	CSP	SolarReserve		SolarReserve	NV Energy

	Type	Developer	Other Companies Involved	Owner	Power Purchaser
	CSP	Abengoa		Abengoa	Arizona Public Service
	PV	LS Power	Fluor Corp.		San Diego Gas & Electric
	Thin-Film	First Solar	Sunpeak Power	Teneska	San Diego Gas & Electric
	Thin-Film	First Solar		Southern Company	San Diego Gas & Electric
	PV	LS Power		Prudential	San Diego Gas & Electric
	Thin-Film	EDF Renewables		Dominion Energy	San Diego Gas & Electric
	Thin-Film	First Solar		Exelon	PG&E
	PV	Sempra Generation		Sempra Generation	PG&E
	Thin-Film	First Solar		MidAmerican Energy Holdings	PG&E
	PV	Recurrent Energy			Sacramento Municipal Utility

	Type	Developer	Other Companies Involved	Owner	Power Purchaser
	Thin-Film	First Solar	First Solar	NRG Energy & MidAmerican Renewables	PG&E
	PV	SunPower/NRG Energy	Bechtel Power Corporation	NRG Energy	PG&E
	Thin-Film	First Solar	Sunpeak Power		San Diego Gas & Electric
	Thin-Film	First Solar			PG&E
	Thin-Film	First Solar			PG&E
	Thin-Film	First Solar	First Solar	Enbridge	NV Energy
	PV	GCL-Poly/Solar Project Solutions			PG&E
	CSP	Cogentrix	M.A. Mortenson	Xcel Energy	Public Service Company of Colorado
	Thin-Film	First Solar		NRG	Tuscon Electric Power
	PV	SunPower/ K Road Power	SunPower	Modesto Irrigation District	Modesto Irrigation District

U.S. Solar Projects



Top Projects Of 2011	Project Name	Capacity MWs	State	Module Manufacturer
	Avenal Park Solar Project	46	CA	Sharp
	San Luis Valley Solar Ranch	38	CO	SunPower
	Austin Energy PV Project	34	TX	
	Long Island	32	NY	BP Solar
	Roadrunner Solar Electric Facility	25	NM	First Solar

Top Projects Of 2010	Project Name	Capacity MWs	State	Module Manufacturer
	Martin Next Generation	75	FL	Solargenix
	Cimarron	30	CO	First Solar
	Chevron Oil Field	29	CA	BrightSource Energy
	Blue Wing	16.6	TX	First Solar
	Jacksonville Solar	15.0	FL	First Solar

	Type	Developer	Other Companies Involved	Owner	Power Purchaser
	PV	Eurus	Ryan Co	Eurus/ NRG Solar	Pacific Gas & Electric
	PV	SunPower/ Iberdrola	SunPower	Iberdrola	Xcel Energy
	PV	SunEdison	RES	Longsol Holdings	Austin Energy
	PV	BP Solar	BP Solar	BP Solar	Long Island Power Authority
	PV	First Solar/NRG Energy	First Solar	NRG Energy	El Paso Electric

	Type	Developer	Other Companies Involved	Owner	Power Purchaser
	CSP	Florida Power & Light	Lauren Engineers & Constructors	NextEra Energy	Florida Power & Light
	PV Thin Film	First Solar	Southern Company	Southern Company/Turner Renewable	Tri-State Generation
	CSP	Ivanpah	Juwi Solar	Chevron Energy Solutions	
	PV	Juwi Solar		Duke Energy	CPS Energy
	PV	Juwi Solar	Jacksonville Solar	Jacksonville Solar	Jacksonville Electric Authority

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)	
Andalay Solar *andalaysolar.com*	AX-250-0-1-DC4-0-B	250 W	227.18 W	3	16	Poly	600 Vdc	65.2 x 39.4 x 2 in	N/A	Yr1 @ 97%, Yr2 - Yr24 annual power decline < .7%, Yr 25 @ 80%	60	37.2 V	
AXITEC *www.axitecsolar.us*	AXIpower	250	225.4	0-5	15.37	Poly	(1000V)	64.57x39.06x1.57	12	25	60		
	AXIpower	260	231.5	0-5	15.98	Poly	(1000V)	64.57x39.06x1.57	12	25	60		
	AXIpower	300	270.5	0-5	15.46	Poly	(1000V)	77.01x39.06x1.57	12	25	72		
	AXIpower	310	276.0	0-5	15.98	Poly	(1000V)	77.01x39.06x1.57	12	25	72		
	AXIblack Poly	250	225.4	0-5	15.37	Poly	(1000V)	64.57x39.06x1.57	12	25	60		
	AXIblack premium	250	225.3	0-5	15.37	Mono	(1000V)	64.57x39.06x1.57	12	25	60		
	AXIblack premium	260	234.6	0-5	15.98	Mono	(1000V)	64.57x39.06x1.57	12	25	60		
Canadian Solar *www.canadiansolar.com*	CS6P-250P	250	229.6	0~+5W	15.54%	Poly	600V UL or 1000 V	64.5 x38.7 x1.57	25 Year Linear	10 Year	60	34.2V	
	CS6P-255P	255	234.3	0~+5W	15.85%	Poly	600V UL or 1000 V	64.5 x38.7 x1.57	25 Year Linear	10 Year	60	34.4V	
	CS6P-260P	260	239.1	0~+5W	16.16%	Poly	600V UL or 1000 V	64.5 x38.7 x1.57	25 Year Linear	10 Year	60	34.7V	
	CS6P-265P	265		0~+5W	16.16%	Poly	600V UL or 1000 V	64.5 x38.7 x1.57	25 Year Linear	10 Year	60	37.6V	
	CS6P-250M	250		0~+5W	15.54%	Mono	600V UL or 1000 V	64.5 x38.7 x1.57	25 Year Linear	10 Year	60	34.4V	
	CS6P-255M	255		0~+5W	15.85%	Mono	600V UL or 1000 V	64.5 x38.7 x1.57	25 Year Linear	10 Year	60	34.6V	
	CS6P-260M	260		0~+5W	16.16%	Mono	600V UL or 1000 V	64.5 x38.7 x1.57	25 Year Linear	10 Year	60	34.7V	
	CS6P-265M	265		0~+5W	16.47%	Mono	600V UL or 1000 V	64.5 x38.7 x1.57	25 Year Linear	10 Year	60	34.8V	
	CS6P-270M	270		0~+5W	16.79%	Mono	600V UL or 1000 V	64.5 x38.7 x1.57	25 Year Linear	10 Year	60	35.0V	
	NewEdge CS6P-250PX	250		0~+5W	15.54%	Poly	600V UL or 1000 V	64.5 x38.7 x1.57	25 Year Linear	10 Year	60	34.2V	
	NewEdge CS6P-255PX	255		0~+5W	15.85%	Poly	600V UL or 1000 V	64.5 x38.7 x1.57	25 Year Linear	10 Year	60	34.4V	

Editor's Note:
Manufacturers were contacted to obtain accurate information for this section. In the event that data was not received through a company representative, information was obtained through product brochures, data sheets and websites. If further information becomes available we will update online in our ***Module Specification Tool*** *available at www.solarpowerworldonline.com, and note for the 2016 print edition.*

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
	8.52 A	UL	N/A		Buy American Act Compliant	N/A	44.944°C ±1°	-0.45%	-0.15%	-0.06%	20
		ETL	1000 VDC	1000 VDC (UL)	Asia	Yes	45°C (±2K)	(-0.44%/K)	(-0.33%/K)	0.06%/K	25
		ETL	1000 VDC	1001 VDC (UL)	Asia	Yes	45°C (±2K)	(-0.44%/K)	(-0.33%/K)	0.06%/K	25
		ETL	1000 VDC	1000 VDC (UL)	Asia	Yes	45°C (±2K)	(-0.44%/K)	(-0.33%/K)	0.06%/K	25
		ETL	1000 VDC	1001 VDC (UL)	Asia	Yes	45°C (±2K)	(-0.44%/K)	(-0.33%/K)	0.06%/K	25
		ETL	1000 VDC	1000 VDC (UL)	Europe	Yes	45°C (±2K)	(-0.44%/K)	(-0.33%/K)	0.06%/K	25
		ETL	1000 VDC	1000 VDC (UL)	Asia	Yes	45°C (±2K)	(-0.40%/K)	(-0.32%/K)	0.04%/K	25
		ETL	1000 VDC	1000 VDC (UL)	Asia	Yes	45°C (±2K)	(-0.40%/K)	(-0.32%/K)	0.04%/K	25
	8.87A	IEC61215	1000V	Poly	China		45+-2ºC			0.065%/ºC	24
	9.00A	IEC61215	1000V	Poly	China		45+-2ºC			0.065%/ºC	24
	7.28A	IEC61215	1000V	Poly	China		45+-2ºC			0.065%/ºC	24
	9.10A	IEC61215	1000V	Poly	China		45+-2ºC			0.065%/ºC	24
	7.08A	IEC61215	1000V	Mono	China		45+-2ºC			0.065%/ºC	24
	7.18A	IEC61215	1000V	Mono	Canada		45+-2ºC			0.065%/ºC	24
	7.28A	IEC61215	1000V	Mono	Canada		45+-2ºC			0.065%/ºC	24
	7.37A	IEC61215	1000V	Mono	Canada		45+-2ºC			0.065%/ºC	24
	7.44A	IEC61215	1000V	Mono	Canada		45+-2ºC			0.065%/ºC	24
	7.19A	IEC61215	1000V	Poly	China		45+-2ºC			0.065%/ºC	24
	7.29A	IEC61215	1000V	Poly	China		45+-2ºC			0.065%/ºC	24

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)
Canadian Solar *(continued)*	Quartech CS6P-250P	250		0~+5W	15.54%	Poly	600V UL or 1000 V	64.5 x38.7 x1.57	25 Year Linear	10 year	60	34.2V
www.canadiansolar.com	Quartech CS6P-255P	255		0~+5W	15.85%	Poly	600V UL or 1000 V	64.5 x38.7 x1.57	25 Year Linear	10 Year	60	34.4V
	Quartech MaxPower CS6X-300P	300	275.6	0~+5W	15.63%	Poly	600V UL or 1000 V	76.93 x38.7 x1.57	25 Year Linear	10 Year	72	41.0V
	Quartech MaxPower CS6X-305P	305	280.3	0~+5W	15.90%	Poly	600V UL or 1000 V	76.93 x38.7 x1.57	25 Year Linear	10 Year	72	41.2V
	Diamond CS6K-250P-LG	250	N/A	0~+5W	15.54%	Poly	600V UL or 1000 V	65.4 x39.0 x0.23	30 year Linear	10 Year	60	34.2V
	Diamond CS6K-255P-LG	255	N/A	0~+5W	15.85%	Poly	600V UL or 1000 V	65.4 x39.0 x0.23	30 Year Linear	10 Year	60	34.4V
Centrosolar	VS-150C2	150	139.5	-0/+5	14.6%	CIGS	600	65.2 x 25.8 x 1.4	10	90% @ 10YR 80% @ 25YR	133	86.60
www.centrosolar america.com	VS-155C2	155	144.2	-0/+5	15.1%	CIGS	600	65.2 x 25.8 x 1.4	10	90% @ 10YR 80% @ 25YR	133	86.70
	E250	250	225.9	-0/+5	15.3%	POLY	600	64.57 x 39.06 x 1.57	10	90% @ 12YR 80% @ 25YR	60	37.47
	TP6 250xx	250	225.0	-0/+5	15.3%	POLY	600	64.96 x 38.98 x 1.5	12	≥ 97.5% end of 1st year ≥ 90 % end of 12th year ≥ 82% end of 25th year	60	37.40
	TP6 255xx	255	229.6	-0/+5	15.6%	POLY	600	64.96 x 38.98 x 1.5	12	≥ 97.5% end of 1st year ≥ 90 % end of 12th year ≥ 82% end of 25th year	60	38.10
Colored Solar	Polished Marble 235w	235	212.5	+/- 3	15.8	poly	no	64.6 x 39 X1.6	10	25 linear		
www.coloredsolar.com	Polished Slate 235w	235	212.5	+/- 3	15.8	poly	no	64.6 x 39 X1.6	10	25 linear		
	Forest Green 240w	240	217.2	+/- 3	16.0	poly	no	64.6 x 39 X1.6	10	25 linear		

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
	7.19A	IEC61215	1000V	Poly	China		45+-2ºC			0.065%/ºC	24
	7.29A	IEC61215	1000V	Poly	China		45+-2ºC			0.065%/ºC	24
	7.19A	IEC61215	1000V	Poly	China		45+-2ºC			0.065%/ºC	24
	7.27A	IEC61215	1000V	Poly	China		45+-2ºC			0.065%/ºC	24
	7.19A	IEC61215	1000V	Poly	China		45+-2ºC			0.065%/ºC	30
	7.29A	IEC61215	1000V	Poly	China		45+-2ºC			0.065%/ºC	30
	2.62	UL1703 INTERTEK	1000		TAIWAN	YES	46.5 ± 1°C	-0.30% / °C	-0.29% / °C	0.01% / °C	28
	2.62	UL1703 INTERTEK	1000		TAIWAN	YES	46.5 ± 1°C	-0.30% / °C	-0.29% / °C	0.01% / °C	28
	8.76	UL1703 INTERTEK	1000		CHINA	NO	45.3 ± 2°C	-0.459% / °C	-0.308% / °C	0.023% / °C	26
	8.76	UL1703 INTERTEK	1000		CANADA	YES	41.0 ± 2°C	-0.40% / °C	-0.34% / °C	0.06% / °C	25
	8.88	UL1703 INTERTEK	1000		CANADA	YES	41.0 ± 2°C	-0.40% / °C	-0.34% / °C	0.06% / °C	25
		ETL , IEC, CEC, FSEC					45.1		-0.36	0.08	
		ETL , IEC, CEC, FSEC					44.9		-0.37	0.09	
		ETL , IEC, CEC, FSEC					45		-0.36	0.09	

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)	
Colored Solar *(continued)*	Emerald Green 235w	235	212.5	+/- 3	15.7	poly	no	64.6 x 39 X1.6	10	25 linear			
www.coloredsolar.com	Earth Brown 230w	230	211.0	+/- 3	15.5	poly	no	64.6 x 39 X1.6	10	25 linear			
	Sapphire Blue 230w	230	211.1	+/- 3	15.5	poly	no	64.6 x 39 X1.6	10	25 linear			
	Lavender 230w	230	211.1	+/- 3	15.4	poly	no	64.6 x 39 X1.6	10	25 linear			
	Ocean Blue 230w	230	211.2	+/- 3	15.5	poly	no	64.6 x 39 X1.6	10	25 linear			
	Metallic Gold 230w	230	211.2	+/- 3	15.5	poly	no	64.6 x 39 X1.6	10	25 linear			
	Pink Diamonds 245w	245	221.8	+/- 3	16.4	poly	no	64.6 x 39 X1.6	10	25 linear			
	Tile Red 230w	230	211.1	+/- 3	15.6	poly	no	64.6 x 39 X1.6	10	25 linear			
	STH 240	240	217.2	+/- 3	14.8	poly	no	64.6 x 39 X1.6	10	25 linear			
	STH 245	245	221.8	+/- 3	15.1	poly	no	64.6 x 39 X1.6	10	25 linear			
	STH 250	250	226.5	+/- 3	15.4	poly	no	64.6 x 39 X1.6	10	25 linear			
	STH 255	255	232.7	+/- 3	15.7	poly	no	64.6 x 39 X1.6	10	25 linear			
ecoSolargy	ECO250H 156P-60	250W	224.4W	0~+5W	15.4%	Poly	1000V / Yes	64.57x39.06x1.57	10	Linear Warranty (no less than 98%@1yr, no less than 80% @ 25yr)	60		
www.ecosolargy.com	ECO255H 156P-60	255W	229.1W	0~+5W	15.7%	Poly	1000V / Yes	64.57x39.06x1.57	10	Linear Warranty (no less than 98%@1yr, no less than 80% @ 25yr)	60		
	ECO260H 156P-60	260W	233.7W	0~+5W	16%	Poly	1000V / Yes	64.57x39.06x1.57	10	Linear Warranty (no less than 98%@1yr, no less than 80% @ 25yr)	60		

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
		ETL , IEC, CEC, FSEC					44.9		-0.37	0.09	
		ETL , IEC, CEC, FSEC					45		-0.37	0.08	
		ETL , IEC, CEC, FSEC					45.1		-0.36	0.08	
		ETL , IEC, CEC, FSEC					45		-0.37	0.09	
		ETL , IEC, CEC, FSEC					44.9		-0.37	0.09	
		ETL , IEC, CEC, FSEC					45.1		-0.37	0.09	
		ETL , IEC, CEC, FSEC					44.9		-0.36	0.08	
		ETL , IEC, CEC, FSEC					45		-0.37	0.08	
		ETL , IEC, CEC, FSEC					45		-0.35	0.05	
		ETL , IEC, CEC, FSEC					45		-0.35	0.05	
		ETL , IEC, CEC, FSEC					45		-0.35	0.05	
		ETL , IEC, CEC, FSEC					45		-0.35	0.05	
		UL/CEC/IEC61701/ IEC62716	1000V	250W Polycrystaline Module	China	No	45°C (±2°C)	-0.43	-0.32	0.046	26
		UL/CEC/IEC61701/ IEC62716	1000V	255W Polycrystaline Module	China	No	45°C (±2°C)	-0.43	-0.32	0.046	26
		UL/CEC/IEC61701/ IEC62716	1000V	260W Polycrystaline Module	China	No	45°C (±2°C)	-0.43	-0.32	0.046	26

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)	
ecoSolargy *(continued)*	ECO265H 156P-60	265W	238.3W	0~+5W	16.1%	Poly	1000V / Yes	64.57x39.06x1.57	10	Linear Warranty (no less than 98%@1yr, no less than 80% @ 25yr)	60		
www.ecosolargy.com	ECO270H 156P-60	270W	242.9W	0~+5W	16.3%	Poly	1000V / Yes	64.57x39.06x1.57	10	Linear Warranty (no less than 98%@1yr, no less than 80% @ 25yr)	60		
	ECO275H 156P-60	275W	247.6W	0~+5W	16.5%	Poly	1000V / Yes	64.57x39.06x1.57	10	Linear Warranty (no less than 98%@1yr, no less than 80% @ 25yr)	60		
	ECO285H 156P-72	285W	257.6W	0~+5W	14.7%	Poly	1000V / Yes	77x39.1x1.97	10	Linear Warranty (no less than 98%@1yr, no less than 80% @ 25yr)	72		
	ECO290H 156P-72	290W	262.2W	0~+5W	14.9%	Poly	1000V / Yes	77x39.1x1.97	10	Linear Warranty (no less than 98%@1yr, no less than 80% @ 25yr)	72		
	ECO295H 156P-72	295W	266.9W	0~+5W	15.2%	Poly	1000V / Yes	77x39.1x1.97	10	Linear Warranty (no less than 98%@1yr, no less than 80% @ 25yr)	72		
	ECO300H 156P-72	300W	271.5W	0~+5W	15.5%	Poly	1000V / Yes	77x39.1x1.97	10	Linear Warranty (no less than 98%@1yr, no less than 80% @ 25yr)	72		
	ECO305H 156P-72	305W	276.2W	0~+5W	15.7%	Poly	1000V / Yes	77x39.1x1.97	10	Linear Warranty (no less than 98%@1yr, no less than 80% @ 25yr)	72		
	ECO310H 156P-72	310W	280.8W	0~+5W	16%	Poly	1000V / Yes	77x39.1x1.97	10	Linear Warranty (no less than 98%@1yr, no less than 80% @ 25yr)	72		

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
		UL/CEC/IEC61701/ IEC62716	1000V	265W Polycrystaline Module	China	No	45°C (±2°C)	-0.43	-0.32	0.046	26
		UL/CEC/IEC61701/ IEC62716	1000V	270W Polycrystaline Module	China	No	45°C (±2°C)	-0.43	-0.32	0.046	26
		UL/CEC/IEC61701/ IEC62716	1000V	275W Polycrystaline Module	China	No	45°C (±2°C)	-0.43	-0.32	0.046	26
		UL/CEC/IEC61701/ IEC62716	1000V	285W Polycrystaline Module	China	No	45°C (±2°C)	-0.43	-0.3	0.06	21
		UL/CEC/IEC61701/ IEC62716	1000V	290W Polycrystaline Module	China	No	45°C (±2°C)	-0.43	-0.3	0.06	21
		UL/CEC/IEC61701/ IEC62716	1000V	295W Polycrystaline Module	China	No	45°C (±2°C)	-0.43	-0.3	0.06	21
		UL/CEC/IEC61701/ IEC62716	1000V	300W Polycrystaline Module	China	No	45°C (±2°C)	-0.43	-0.3	0.06	21
		UL/CEC/IEC61701/ IEC62716	1000V	305W Polycrystaline Module	China	No	45°C (±2°C)	-0.43	-0.3	0.06	21
		UL/CEC/IEC61701/ IEC62716	1000V	310W Polycrystaline Module	China	No	45°C (±2°C)	-0.43	-0.3	0.06	21

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)	
ecoSolargy *(continued)*	ECO315H 156P-72	315W	285.5W	0~+5W	16.2%	Poly	1000V / Yes	77x39.1x1.97	10	Linear Warranty (no less than 98%@1yr, no less than 80% @ 25yr)	72		
www.ecosolargy.com	ECO320H 156P-72	320W	290.1W	0~+5W	16.5%	Poly	1000V / Yes	77x39.1x1.97	10	Linear Warranty (no less than 98%@1yr, no less than 80% @ 25yr)	72		
	ECO325H 156P-72	325W	294.8W	0~+5W	16.7%	Poly	1000V / Yes	77x39.1x1.97	10	Linear Warranty (no less than 98%@1yr, no less than 80% @ 25yr)	72		
Eoplly New Energy Technology	EP156M/ 72-305W	305	268.7	+3/-0	15.7%	mono	600, Y	76.89x39.25x1.97	10	81%, 25 yr, linear	72	45.07	
www.eoplly.com	EP156M/ 72-300W	300	264.1	+3/-0	15.4%	mono	600, Y	76.89x39.25x1.97	10	81%, 25 yr, linear	72	44.86	
	EP156M/ 72-295W	295	259.6	+3/-0	15.1%	mono	600, Y	76.89x39.25x1.97	10	81%, 25 yr, linear	72	44.50	
	EP156M/ 72-290W	290	255.0	+3/-0	14.9%	mono	600, Y	76.89x39.25x1.97	10	81%, 25 yr, linear	72	44.25	
	EP156M B/60 250W	250	223.9	+3/-0	15.3%	mono	600, Y	64.57x39.1x1.57	10	81%, 25 yr, linear	60	37.26	
	EP156M B/60-245W	245	219.3	+3/-0	15.0%	mono	600, Y	64.57x39.1x1.57	10	81%, 25 yr, linear	60	37.08	
	EP156M B/60-240W	240	214.7	+3/-0	14.7%	mono	600, Y	64.57x39.1x1.57	10	81%, 25 yr, linear	60	36.90	
	EP156M B/60-235W	235	210.1	+3/-0	14.4%	mono	600, Y	64.57x39.1x1.57	10	81%, 25 yr, linear	60	36.72	
	EP156 P/72-295W	295	264.9	+3/-0	15.1%	poly	600, Y	76.89x39.25x1.97	10	81%, 25 yr, linear	60	44.86	
	EP156 P/72-290W	290	260.3	+3/-0	14.9%	poly	600, Y	76.89x39.25x1.97	10	81%, 25 yr, linear	60	44.64	
	EP156 P/72-285W	285	259.6	+3/-0	14.6%	poly	600, Y	76.89x39.25x1.97	10	81%, 25 yr, linear	60	44.43	
	EP156 P/72-280W	280	255.0	+3/-0	14.4%	poly	600, Y	76.89x39.25x1.97	10	81%, 25 yr, linear	60	43.83	

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
		UL/CEC/IEC61701/ IEC62716	1000V	315W Polycrystaline Module	China	No	45°C (±2°C)	-0.43	-0.3	0.06	21
		UL/CEC/IEC61701/ IEC62716	1000V	320W Polycrystaline Module	China	No	45°C (±2°C)	-0.43	-0.3	0.06	21
		UL/CEC/IEC61701/ IEC62716	1000V	325W Polycrystaline Module	China	No	45°C (±2°C)	-0.43	-0.3	0.06	21
	8.94	UL, IEC	1000	Silicon	Hai'an, China	Yes	47	-0.44	-0.39	0.07	23
	8.88	UL, IEC	1000	Silicon	Hai'an, China	Yes	47	-0.44	-0.39	0.07	23
	8.85	UL, IEC	1000	Silicon	Hai'an, China	Yes	47	-0.44	-0.39	0.07	23
	8.22	UL, IEC	1000	Silicon	Hai'an, China	Yes	47	-0.44	-0.39	0.07	23
	8.91	UL, IEC	1000	Silicon	Hai'an, China	Yes	46	-0.45	-0.4	0.07	28
	8.78	UL, IEC	1000	Silicon	Hai'an, China	Yes	46	-0.45	-0.4	0.07	28
	8.68	UL, IEC	1000	Silicon	Hai'an, China	Yes	46	-0.45	-0.4	0.07	28
	8.58	UL, IEC	1000	Silicon	Hai'an, China	Yes	46	-0.45	-0.4	0.07	23
	8.78	UL, IEC	1000	Silicon	Hai'an, China	Yes	43	-0.46	-0.34	0.06	23
	8.70	UL, IEC	1000	Silicon	Hai'an, China	Yes	43	-0.46	-0.34	0.06	23
	8.63	UL, IEC	1000	Silicon	Hai'an, China	Yes	43	-0.46	-0.34	0.06	23
	8.59	UL, IEC	1000	Silicon	Hai'an, China	Yes	43	-0.46	-0.34	0.06	23

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)
Eoplly New Energy Technology *(continued)*	EP156P/ 72-275W	275	250.3	+3/-0	14.1%	poly	600, Y	76.89x39.25x1.97	10	81%, 25 yr, linear	60	43.53
www.eoplly.com	EP156P/ 72-270W	270	241.3	+3/-0	13.9%	poly	600, Y	76.89x39.25x1.97	10	81%, 25 yr, linear	60	43.17
	EP156P/ 60-245W	245	220.0	+3/-0	15.0%	poly	600, Y	64.72x39.13x1.57	10	81%, 25 yr, linear	60	37.38
	EP156P/ 60-240W	240	214.5	+3/-0	14.7%	poly	600, Y	64.72x39.13x1.57	10	81%, 25 yr, linear	60	37.02
	EP156P/ 60-235W	235	209.9	+3/-0	14.4%	poly	600, Y	64.72x39.13x1.57	10	81%, 25 yr, linear	60	36.72
	EP125M/ 72-200W	200	177.8	+3/-0	15.7%	mono	600, Y	62.2x31.8x1.38	10	81%, 25 yr, linear	72	45.73
	EP125M/ 72-195W	195	173.2	+3/-0	14.9%	mono	600, Y	62.2x31.8x1.38	10	81%, 25 yr, linear	72	45.26
	EP125M/ 72-190W	190	168.6	+3/-0	14.9%	mono	600, Y	62.2x31.8x1.38	10	81%, 25 yr, linear	72	44.83
	EP125M/ 72-185W	185	165.7	+3/-0	14.5%	mono	600, Y	62.2x31.8x1.38	10	81%, 25 yr, linear	72	44.29
ET Solar	ET-P672310WW / ET-P672310WB	310	277.5	0~+5W	15.98	poly	600V/1000V	77.01×39.06×1.58 inch	10	25 linear performance warranty (81.4%@25th year)	72	45.8V
www.etsolar.com	ET-P672305WW / ET-P672305WB	305	272.9	0~+5W	15.72	poly	600V/1000V	77.01×39.06×1.58 inch	10	25 linear performance warranty (81.4%@25th year)	72	45.12V
	ET-P672300WW / ET-P672300WB	300	268.3	0~+5W	15.46	poly	600V/1000V	77.01×39.06×1.58 inch	10	25 linear performance warranty (81.4%@25th year)	72	44.89V
	ET-P672300WWG	300	270.8	0~+5W	15.46	poly	600V/1000V	77.01×39.06×1.58 inch	10	25 linear performance warranty (81.4%@25th year)	72	44.89V
	ET-P672295WW / ET-P672295WB	295	263.7	0~+5W	15.20	poly	600V/1000V	77.01×39.06×1.58 inch	10	25 linear performance warranty (81.4%@25th year)	72	44.78V
	ET-P672295WWG	295	266.1	0~+5W	15.20	poly	600V/1000V	77.01×39.06×1.58 inch	10	25 linear performance warranty (81.4%@25th year)	72	44.78V

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
	8.56	UL, IEC	1000	Silicon	Hai'an, China	Yes	43	-0.46	-0.34	0.06	23
	8.53	UL, IEC	1000	Silicon	Hai'an, China	Yes	43	-0.46	-0.34	0.06	23
	8.75	UL, IEC	1000	Silicon	Hai'an, China	Yes	46	-0.48	-0.35	0.06	28
	8.68	UL, IEC	1000	Silicon	Hai'an, China	Yes	46	-0.48	-0.35	0.06	28
	8.64	UL, IEC	1000	Silicon	Hai'an, China	Yes	46	-0.48	-0.35	0.06	28
	5.86	UL, IEC	1000	Silicon	Hai'an, China	Yes	47	-0.44	-0.39	0.06	29
	5.81	UL, IEC	1000	Silicon	Hai'an, China	Yes	47	-0.44	-0.39	0.06	29
	5.75	UL, IEC	1000	Silicon	Hai'an, China	Yes	47	-0.44	-0.39	0.06	29
	5.70	UL, IEC	1000	Silicon	Hai'an, China	Yes	47	-0.44	-0.39	0.06	29
	8.79A	ETL	1000V	ET-P672 Series	China/Malaysia/ Vietnam	Yes	45.3±2°C	-0.44%/°C	-0.34%/°C	0.04%/°C	26
	8.78A	ETL	1000V	ET-P672 Series	China/Malaysia/ Vietnam	Yes	45.3±2°C	-0.44%/°C	-0.34%/°C	0.04%/°C	26
	8.72A	ETL	1000V	ET-P672 Series	China/Malaysia/ Vietnam	Yes	45.3±2°C	-0.44%/°C	-0.34%/°C	0.04%/°C	26
	8.72A	ETL	1000V	ET-P672 Series	China/Malaysia/ Vietnam		45.3±2°C	-0.44%/°C	-0.34%/°C	0.04%/°C	26
	8.68A	ETL	1000V	ET-P672 Series	China/Malaysia/ Vietnam		45.3±2°C	-0.44%/°C	-0.34%/°C	0.04%/°C	26
	8.68A	ETL	1000V	ET-P672 Series	China/Malaysia/ Vietnam		45.3±2°C	-0.44%/°C	-0.34%/°C	0.04%/°C	26

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)
ET Solar *(continued)*	ET-P672290WWG	290	261.5	0~+5W	14.95	poly	600V/1000V	77.01×39.06×1.58 inch	10	25 linear performance warranty (81.4%@25th year)	72	44.75V
www.etsolar.com	ET-P660260WW/ET-P660260WB/ET-P660260WWZ/ET-P660260WBZ	260	235.2	0~+5W	15.98	poly	600V/1000V	64.57×39.06×1.58 inch)	10	25 linear performance warranty (81.4%@25th year)	60	38.09V
	ET-P660260WBZAC/ ET-P660260WBAC	260	235.2	0~+5W	15.98	poly	600V/1000V	64.57 x 39.06 x 2.26 inch)	10	25 linear performance warranty (81.4%@25th year)	60	38.09V
	ET-M660260BB	260	234.4	0~+5W	15.94	mono	600V	64.72×39.05×1.65 inch	10	25 linear performance warranty (81.4%@25th year)	60	37.6V
	ET-P660255WW/ ET-P660255WB/ ET-P660255WWZ/ ET-P660255WBZ	255	230.6	0~+5W	15.67	poly	600V/1000V	64.57×39.06×1.58 inch)	10	25 linear performance warranty (81.4%@25th year)	60	37.54V
	ET-P660255BB	255	229.0	0~+5W	15.67	poly	600V/1000V	64.57×39.06×1.58 inch)	10	25 linear performance warranty (81.4%@25th year)	60	37.54V
	ET-M660255BB	255	229.8	0~+5W	15.64	mono	600V	64.72×39.05×1.65 inch	10	25 linear performance warranty (81.4%@25th year)	60	37.6V
	ET-P660250WW/ ET-P660250WB/ ET-P660250WWZ/ ET-P660250WBZ	250	225.9	0~+5W	15.37	poly	600V/1000V	64.57×39.06×1.58 inch)	10	25 linear performance warranty (81.4%@25th year)	60	37.47V

ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
8.62A	ETL	1000V	ET-P672 Series	China/Malaysia/ Vietnam		45.3±2°C	-0.44%/°C	-0.34%/°C	0.04%/°C	26
8.84A	ETL	1000V	ET-P660 Series	US/China/Malaysia/ Vietnam		45.3±2°C	-0.44%/°C	-0.34%/°C	0.04%/°C	26
8.84A	ETL	1000V	ET-P660 Series	US/China		45.3±2°C	-0.44%/°C	-0.34%/°C	0.04%/°C	22
9.07A	ETL	1000V	ET-M660 Series	Korea		46±2°C	-0.43%/°C	-0.32%/°C	0.04%/°C	22
8.82A	ETL	1000V	ET-P660 Series	US/China/Malaysia/ Vietnam		45.3±2°C	-0.44%/°C	-0.34%/°C	0.04%/°C	26
8.82A	ETL	1000V	ET-P660 Series	US/China/Malaysia/ Vietnam		45.3±2°C	-0.44%/°C	-0.34%/°C	0.04%/°C	26
8.96A	ETL	1000V	ET-M660 Series	Korea		46±2°C	-0.43%/°C	-0.32%/°C	0.04%/°C	22
8.76A	ETL	1000V	ET-P660 Series	US/China/Malaysia/ Vietnam		45.3±2°C	-0.44%/°C	-0.34%/°C	0.04%/°C	26

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)
ET Solar *(continued)*	ET-P66 0250BB	250	224.3	0~+5W	15.37	poly	600V/1000V	64.57×39.06×1.58 inch)	10	25 linear performance warranty (81.4%@25th year)	60	37.47V
www.etsolar.com	ET-P660250 WBZAC/ ET-P660250 WBAC	250	223.6	0~+5W	15.37	poly	600V/1000V	64.57 x 39.06 x 2.26 inch)	10	25 linear performance warranty (81.4%@25th year)	60	37.47V
	ET-P660 250BBZAC/ ET-P660 250BBAC	250	216.4	0~+5W	15.37	poly	600V/1000V	64.57 x 39.06 x 2.26 inch)	10	25 linear performance warranty (81.4%@25th year)	60	37.47V
	ET-P660 245WW/ ET-P660 245WB/ ET-P660 245WWZ/ ET-P660 245WBZ	245	221.3	0~+5W	15.06	poly	600V/1000V	64.57×39.06×1.58 inch)	10	25 linear performance warranty (81.4%@25th year)	60	37.27V
	ET-P660 245BB	245	219.7	0~+5W	15.06	poly	600V/1000V	64.57×39.06×1.58 inch)	10	25 linear performance warranty (81.4%@25th year)	60	37.27V
	ET-P660 240BB	240	215.1	0~+5W	14.75	poly	600V/1000V	64.57×39.06×1.58 inch)	10	25 linear performance warranty (81.4%@25th year)	60	37.17V
First Solar	FS-492/ FS-492A	92.5		5%	12.8	thin film	1000 UL	1200mm L x 600mm W x 6.8mm thick	10-Year Limited Product Warranty	25-Year Linear Performance Warranty - Ensures 97% rated power in first year, -0.7%/ year through year 25.	216	86
www.firstsolar.com	FS-495/ FS-495A	95		5%	13.2	thin film	1000 UL	1200mm L x 600mm W x 6.8mm thick	10-Year Limited Product Warranty	25-Year Linear Performance Warranty - Ensures 97% rated power in first year, -0.7%/ year through year 25.	216	86.5

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
	8.76A	ETL	1000V	ET-P660 Series	US/China/Malaysia/ Vietnam		45.3±2°C	-0.44%/°C	-0.34%/°C	0.04%/°C	26
	8.76A	ETL	1000V	ET-P660 Series	US/China		45.3±2°C	-0.44%/°C	-0.34%/°C	0.04%/°C	22
	8.76A	ETL	1000V	ET-P660 Series	US/China		45.3±2°C	-0.44%/°C	-0.34%/°C	0.04%/°C	22
	8.73A	ETL	1000V	ET-P660 Series	US/China/Malaysia/ Vietnam		45.3±2°C	-0.44%/°C	-0.34%/°C	0.04%/°C	26
	8.73A	ETL	1000V	ET-P660 Series	US/China/Malaysia/ Vietnam		45.3±2°C	-0.44%/°C	-0.34%/°C	0.04%/°C	26
	8.58A	ETL	1000V	ET-P660 Series	US/China/Malaysia/ Vietnam		45.3±2°C	-0.44%/°C	-0.34%/°C	0.04%/°C	26
	1.54	IEC, CE, ISO, UL, CSI	1500V	Thin Film	Perrysburg, Ohio and Kulim, Malaysia	Pending	Nominal Operating Cell Temperature: Module operation temperature at 800W/m2 irradiance, 20°C air temperature, 1m/s wind speed	-0.29%/C	-0.28%/C	+0.04%/C	50
	1.55	IEC, CE, ISO, UL, CSI	1500V	Thin Film	Perrysburg, Ohio and Kulim, Malaysia	Pending	Nominal Operating Cell Temperature: Module operation temperature at 800W/m2 irradiance, 20°C air temperature, 1m/s wind speed	-0.29%/C	-0.28%/C	+0.04%/C	50

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)	
First Solar *(continued)*	FS-497/ FS497A	97.5		5%	13.5	thin film	1000 UL	1200mm L x 600mm W x 6.8mm thick	10-Year Limited Product Warranty	25-Year Linear Performance Warranty - Ensures 97% rated power in first year, -0.7%/ year through year 25.	216	87	
www.firstsolar.com	FS-4100/ FS-4100A	100		5%	13.9	thin film	1000 UL	1200mm L x 600mm W x 6.8mm thick	10-Year Limited Product Warranty	25-Year Linear Performance Warranty - Ensures 97% rated power in first year, -0.7%/ year through year 25.	216	87.6	
	FS-4102A	102.5		5%	14.2	thin film	1000 UL	1200mm L x 600mm W x 6.8mm thick	10-Year Limited Product Warranty	25-Year Linear Performance Warranty - Ensures 97% rated power in first year, -0.7%/year through year 25.	216	88	
Hanwha Q CELLS	Q.PRO BFR-G3	255	189.7	0+-5	>=15.3%	Poly	600	68.5x44.5x46.0	12	83% @ 25 years	60	37.83	
www.q-cells.us	Q.PRO BFR-G3	260	193.4	0+-5	>=15.6%	Poly	600	68.5x44.5x46.0	12	83% @ 25 years	60	38.18	
	Q.PRO BFR-G3	265	197.1	0+-5	>=15.9%	Poly	600	68.5x44.5x46.0	12	83% @ 25 years	60	38.52	
	Q.PEAK BLK-G3	265	197.1	0+-5	>=15.9%	Mono	600	68.5x44.5x46.0	12	83% @ 25 years	60	38.22	

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
	1.55	IEC, CE, ISO, UL, CSI	1500V	Thin Film	Perrysburg, Ohio and Kulim, Malaysia	Pending	Nominal Operating Cell Temperature: Module operation temperature at 800W/m2 irradiance, 20°C air temperature, 1m/s wind speed	-0.29%/C	-0.28%/C	+0.04%/C	50
	1.57	IEC, CE, ISO, UL, CSI	1500V	Thin Film	Perrysburg, Ohio and Kulim, Malaysia	Pending	Nominal Operating Cell Temperature: Module operation temperature at 800W/m2 irradiance, 20°C air temperature, 1m/s wind speed	-0.29%/C	-0.28%/C	+0.04%/C	50
	1.57	IEC, CE, ISO, UL, CSI	1500V	Thin Film	Perrysburg, Ohio and Kulim, Malaysia	Pending	"Nominal Operating Cell Temperature: Module operation temperature at 800W/m2 irradiance, 20°C air temperature, 1m/s wind speed	-0.29%/C	-0.28%/C	+0.04%/C	50
	8.90	UL 1703; VDE Quality Tested; CE-compliant; IEC 61215 (Ed.2); IEC 61730 (Ed.1) application class A, CEC listed	1000	II	Poland	yes	45+/-3	-0.42	-0.3	0.04	29
	9.09	UL 1703; VDE Quality Tested; CE-compliant; IEC 61215 (Ed.2); IEC 61730 (Ed.1) application class A, CEC listed	1000	II	Poland	yes	45+/-3	-0.42	-0.3	0.04	29
	9.28	UL 1703; VDE Quality Tested; CE-compliant; IEC 61215 (Ed.2); IEC 61730 (Ed.1) application class A, CEC listed	1000	II	Poland	yes	45+/-3	-0.42	-0.3	0.04	29
	9.08	UL 1703; VDE Quality Tested; CE-compliant; IEC 61215 (Ed.2); IEC 61730 (Ed.1) application class A, CEC listed	1000	II	China	yes	45+/-3	-0.42	-0.3	0.04	29

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)
Hanwha Q CELLS *(continued)*	Q.PEAK BLK-G3	270	200.8	0+-5	>=16.2%	Mono	600	68.5x44.5x46.0	12	83% @ 25 years	60	38.51
www.q-cells.us	Q.PEAK BLK-G3	275	204.5	0+-5	>=16.5%	Mono	600	68.5x44.5x46.0	12	83% @ 25 years	60	38.80
	Q.PRO-G3	255	189.7	0+-5	>=15.3%	Poly	600	68.5x44.5x46.0	12	83% @ 25 years	60	37.83
	Q.PRO-G3	260	193.4	0+-5	>=15.6%	Poly	600	68.5x44.5x46.0	12	83% @ 25 years	60	38.18
	Q.PRO-G3	265	197.1	0+-5	>=15.9%	Poly	600	68.5x44.5x46.0	12	83% @ 25 years	60	38.52
	Q.PRO L	300	223	0+-5	>=15.5%	Poly	1000	79.1×43.1x46.5	12	83% @ 25 years	72	45.27
	Q.PRO L	305	227	0+-5	>=15.8%	Poly	1000	79.1×43.1x46.5	12	83% @ 25 years	72	45.56
	Q.PRO L	310	230	0+-5	>=16%	Poly	1000	79.1×43.1x46.5	12	83% @ 25 years	72	45.84

ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
9.14	UL 1703; VDE Quality Tested; CE-compliant; IEC 61215 (Ed.2); IEC 61730 (Ed.1) application class A, CEC listed	1000	II	China	yes	45+/-3	-0.42	-0.3	0.04	29
9.21	UL 1703; VDE Quality Tested; CE-compliant; IEC 61215 (Ed.2); IEC 61730 (Ed.1) application class A, CEC listed	1000	II	China	yes	45+/-3	-0.42	-0.3	0.04	29
8.90	UL 1703; VDE Quality Tested; CE-compliant; IEC 61215 (Ed.2); IEC 61730 (Ed.1) application class A, CEC listed	1000	II	China	yes	45+/-3	-0.42	-0.3	0.04	29
9.09	UL 1703; VDE Quality Tested; CE-compliant; IEC 61215 (Ed.2); IEC 61730 (Ed.1) application class A, CEC listed	1000	II	China	yes	45+/-3	-0.42	-0.3	0.04	29
9.28	UL 1703; VDE Quality Tested; CE-compliant; IEC 61215 (Ed.2); IEC 61730 (Ed.1) application class A, CEC listed	1000	II	China	yes	45+/-3	-0.42	-0.3	0.04	22
8.93	VDE Quality Tested, IEC 61215 (Ed. 2); IEC 61730 (Ed. 1), Application class A This data sheet complies with DIN EN 50380, CEC listed		II	China	yes	45+/-3	-0.42	-0.3	0.04	22
8.97	VDE Quality Tested, IEC 61215 (Ed. 2); IEC 61730 (Ed. 1), Application class A This data sheet complies with DIN EN 50380, CEC listed		II	China	yes	45+/-3	-0.42	-0.3	0.04	22
9.01	VDE Quality Tested, IEC 61215 (Ed. 2); IEC 61730 (Ed. 1), Application class A This data sheet complies with DIN EN 50380, CEC listed		II	China	yes	45+/-3	-0.42	-0.3	0.04	22

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)
Hanwha Q CELLS *(continued)* *www.q-cells.us*	Q.PRO L	315	234	0+-5	>=16.3%	Poly	1000	79.1×43.1x46.5	12	83% @ 25 years	72	46.13
Hanwha SolarOne *www.hanwha-solarone.com*	HSL60P6-PC-3-250	250.0	227.6	0, +5	15.0	Poly	1000V	65.75x39.36x1.26	12	82% @ 25	60	35.1
	HSL60P6-PC-3-250W	250.0	227.6	0, +5	15.0	Poly	1000V	65.75x39.36x1.26	12	82% @ 25	60	35.1
	HSL60P6-PC-3-255	255.0	232.2	0, +5	15.3	Poly	1000V	65.75x39.36x1.26	12	82% @ 25	60	35.4
	HSL60P6-PC-3-255W	255.0	232.2	0, +5	15.3	Poly	1000V	65.75x39.36x1.26	12	82% @ 25	60	35.4
	HSL60P6-PC-3-260	260.0	236.9	0, +5	15.6	Poly	1000V	65.75x39.36x1.26	12	82% @ 25	60	35.7
	HSL60P6-PC-3-260W	260.0	236.9	0, +5	15.6	Poly	1000V	65.75x39.36x1.26	12	82% @ 25	60	35.7
	HSL60P6-PC-3-265	265.0	241.6	0, +5	15.9	Poly	1000V	65.75x39.36x1.26	12	82% @ 25	60	35.9
	HSL60P6-PC-3-265W	265.0	241.6	0, +5	15.9	Poly	1000V	65.75x39.36x1.26	12	82% @ 25	60	35.9
	HSL72P6-PC-3-300	300.0	273.2	0, +5	15.3	Poly	1000V	77.64x39.06x1.57	12	82% @ 25	72	44.8
	HSL72P6-PC-3-300W	300.0	273.2	0, +5	15.3	Poly	1000V	77.64x39.06x1.57	12	82% @ 25	72	44.8
	HSL72P6-PC-3-305	305.0	277.9	0, +5	15.6	Poly	1000V	77.64x39.06x1.57	12	82% @ 25	72	45.0
	HSL72P6-PC-3-305W	305.0	277.9	0, +5	15.6	Poly	1000V	77.64x39.06x1.57	12	82% @ 25	72	45.0
	HSL72P6-PC-3-310	310.0	-	0, +5	15.8	Poly	1000V	77.64x39.06x1.57	12	82% @ 25	72	45.1
	HSL72P6-PC-3-310W	310.0	-	0, +5	15.8	Poly	1000V	77.64x39.06x1.57	12	82% @ 25	72	45.1
	HSL72P6-PC-3-315	315.0	-	0, +5	16.1	Poly	1000V	77.64x39.06x1.57	12	82% @ 25	72	45.3
	HSL72P6-PC-3-315W	315.0	-	0, +5	16.1	Poly	1000V	77.64x39.06x1.57	12	82% @ 25	72	45.3
	HSC60PA-x-S-245	245.0	220.4	0, +5	15.0	Poly	1000V	64.96x38.98x1.5	12	82% @ 25	60	37.7

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
	9.06	VDE Quality Tested, IEC 61215 (Ed. 2); IEC 61730 (Ed. 1), Application class A This data sheet complies with DIN EN 50380, CEC listed		II	China	yes	45+/-3	-0.42	-0.3	0.04	22
	7.05	UL/IEC	1000V	Crystalline	China	Yes	45°C (±3°C)	-0.41%	-0.31%	0.055%	832
	7.05	UL/IEC	1000V	Crystalline	China	Yes	45°C (±3°C)	-0.41%	-0.31%	0.055%	832
	7.16	UL/IEC	1000V	Crystalline	China	Yes	45°C (±3°C)	-0.41%	-0.31%	0.055%	832
	7.16	UL/IEC	1000V	Crystalline	China	Yes	45°C (±3°C)	-0.41%	-0.31%	0.055%	832
	7.26	UL/IEC	1000V	Crystalline	China	Yes	45°C (±3°C)	-0.41%	-0.31%	0.055%	832
	7.26	UL/IEC	1000V	Crystalline	China	Yes	45°C (±3°C)	-0.41%	-0.31%	0.055%	832
	7.37	UL/IEC	1000V	Crystalline	China	Yes	45°C (±3°C)	-0.41%	-0.31%	0.055%	832
	7.37	UL/IEC	1000V	Crystalline	China	Yes	45°C (±3°C)	-0.41%	-0.31%	0.055%	832
	8.70	UL/IEC	1000V	Crystalline	China	Yes	45°C (±3°C)	-0.41%	-0.31%	0.055%	550
	8.70	UL/IEC	1000V	Crystalline	China	Yes	45°C (±3°C)	-0.41%	-0.31%	0.055%	550
	8.81	UL/IEC	1000V	Crystalline	China	Yes	45°C (±3°C)	-0.41%	-0.31%	0.055%	550
	8.81	UL/IEC	1000V	Crystalline	China	Yes	45°C (±3°C)	-0.41%	-0.31%	0.055%	550
	8.91	UL/IEC	1000V	Crystalline	China	Yes	45°C (±3°C)	-0.41%	-0.31%	0.055%	550
	8.91	UL/IEC	1000V	Crystalline	China	Yes	45°C (±3°C)	-0.41%	-0.31%	0.055%	550
	9.02	UL/IEC	1000V	Crystalline	China	Yes	45°C (±3°C)	-0.41%	-0.31%	0.055%	550
	9.02	UL/IEC	1000V	Crystalline	China	Yes	45°C (±3°C)	-0.41%	-0.31%	0.055%	550
	8.65	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	900

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)
Hanwha SolarOne *(continued)*	HSC60PA-x-S-250	250.0	225.0	0, +5	15.3	Poly	1000V	64.96x38.98x1.5	12	82% @ 25	60	37.9
www.hanwha-solarone.com	HSC60PA-x-S-255	255.0	229.6	0, +5	15.6	Poly	1000V	64.96x38.98x1.5	12	82% @ 25	60	38.1
	HSC60MA-G-S-260	260.0	236.2	0, +5	16.0	Mono	1000V	64.96x38.98x1.5	12	82% @ 25	60	38.0
	HSC60MA-S-S-260	260.0	236.2	0, +5	16.0	Mono	1000V	64.96x38.98x1.5	12	82% @ 25	60	38.0
	HSC60PA-x-S-260	260.0	234.3	0, +5	16.0	Poly	1000V	64.96x38.98x1.5	12	82% @ 25	60	38.3
	HSC60MA-G-S-265	265.0	240.8	0, +5	16.2	Mono	1000V	64.96x38.98x1.5	12	82% @ 25	60	38.0
	HSC60MA-S-S-265	265.0	240.8	0, +5	16.2	Mono	1000V	64.96x38.98x1.5	12	82% @ 25	60	38.0
	HSC60PA-x-S-265	265.0	238.9	0, +5	16.2	Poly	1000V	64.96x38.98x1.5	12	82% @ 25	60	38.5
	HSC60MA-G-S-270	270.0	244.5	0, +5	16.5	Mono	1000V	64.96x38.98x1.5	12	82% @ 25	60	38.2
	HSC60MA-S-S-270	270.0	244.5	0, +5	16.5	Mono	1000V	64.96x38.98x1.5	12	82% @ 25	60	38.2
	HSC60MA-G-S-275	275.0	249.2	0, +5	16.8	Mono	1000V	64.96x38.98x1.5	12	82% @ 25	60	38.4
	HSC60MA-S-S-275	275.0	249.2	0, +5	16.8	Mono	1000V	64.96x38.98x1.5	12	82% @ 25	60	38.4
	HSC60MA-G-S-280	280.0	253.8	0, +5	17.1	Mono	1000V	64.96x38.98x1.5	12	82% @ 25	60	38.7
	HSC60MA-S-S-280	280.0	253.8	0, +5	17.1	Mono	1000V	64.96x38.98x1.5	12	82% @ 25	60	38.7
	HSC60MA-G-S-285	285.0	258.5	0, +5	17.5	Mono	1000V	64.96x38.98x1.5	12	82% @ 25	60	39.1
	HSC60MA-S-S-285	285.0	258.5	0, +5	17.5	Mono	1000V	64.96x38.98x1.5	12	82% @ 25	60	39.1
	HSC72PA-x-S-295	295.0	266.6	0, +5	15.1	Poly	1000V	77.56x38.98x1.5	12	82% @ 25	72	45.1
	HSC72PA-x-S-300	300.0	271.2	0, +5	15.4	Poly	1000V	77.56x38.98x1.5	12	82% @ 25	72	45.3
	HSC72PA-x-S-305	305.0	275.9	0, +5	15.6	Poly	1000V	77.56x38.98x1.5	12	82% @ 25	72	45.5
	HSC72PA-x-S-310	310.0	280.5	0, +5	15.9	Poly	1000V	77.56x38.98x1.5	12	82% @ 25	72	45.7
	HSC72PA-x-S-315	315.0	285.2	0, +5	16.2	Poly	1000V	77.56x38.98x1.5	12	82% @ 25	72	45.9
	HSC72PA-x-S-320	320.0	289.8	0, +5	16.4	Poly	1000V	77.56x38.98x1.5	12	82% @ 25	72	46.1

ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
8.76	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	900
8.88	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	900
9.01	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	900
9.01	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	900
9.01	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	900
9.11	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	900
9.11	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	900
9.12	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	900
9.22	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	900
9.22	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	900
9.31	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	900
9.31	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	900
9.40	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	900
9.40	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	900
9.47	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	900
9.47	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	900
8.58	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	660
8.68	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	660
8.78	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	660
8.86	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	660
8.94	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	660
9.06	UL/IEC	1000V	Crystalline	Canada	Yes	45°C (±3°C)	-0.42%	-0.33%	0.050%	660

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)	
itek Energy	IT 270 HE	270	n/a	-0/+5 W	16.49	mono	Yes	64.89x39.13x5	10	80% @ 25yr	60	38.9V	
www.itekenergy.com	IT 275 HE	275	n/a	-0/+5 W	16.80	mono	Yes	64.89x39.13x6	10	80% @ 25yr	60	39.0V	
	IT 280 HE	280	n/a	-0/+5 W	17.10	mono	Yes	64.89x39.13x7	10	80% @ 25yr	60	39.2V	
JA Solar	JAP6-60-260/3BB	260	260.0	0-+5W	15.90%	Poly	UL 600V	65x39x1.6	10	25	60	-0.33%	
www.Jasolar.com	JAP6-72-310/3BB	310	310.0	0-+5W	15.99%	Poly	UL 600V	77x39x1.8	10	25	72	-0.33%	
JinkoSolar	JKM300P-72	300	270.8	-0/+3	15.46	Polysilicon	1000 Vdc	77.01 X 39.05 X 1.57	10	97.5 for first year, then 0.7/ yr up to 25 years	72	-0.31%/C	
www.jinkosolar.com	JKM305P-72	305	276.6	-0/+3	15.72	Polysilicon	1000 Vdc	77.01 X 39.05 X 1.57	10	97.5 for first year, then 0.7/ yr up to 25 years	72	-0.31%C	
	JKM310P-72	310	281.2	-0/+3	15.98	Polysilicon	1000 Vdc	77.01 X 39.05 X 1.57	10	97.5 for first year, then 0.7/ yr up to 25 years	72	-0.31%C	
	JKM250P-60	250	229.6	-0/+3	15.27	Polysilicon	1000 Vdc	64.97 X 39.06 X 1.57	10	97.5 for first year, then 0.7/ yr up to 25 years	60	-0.31%C	
	JKM255P-60	255	230.2	-0/+3	15.58	Polysilicon	1000 Vdc	64.97 X 39.06 X 1.57	10	97.5 for first year, then 0.7/ yr up to 25 years	60	-0.31%C	
	JKM260P-60	260	235.8	-0/+3	15.89	Polysilicon	1000 Vdc	64.97 X 39.06 X 1.59	10	97.5 for first year, then 0.7/ yr up to 25 years	60	-0.31%C	
Kyocera	KD140GX-LFBS	140	124.9	+7/-0%	13.9	poly	600	59.06x26.30x1.81	10	10yrs: 90% 25yrs: 80%	36	22.1	
www.kyocerasolar.com	KD140SX-UFBS	140	N/A	+7/-0%	13.9	poly	600	59.06x26.30x1.81	10	10yrs: 90% 25yrs: 80%	36	22.1	
	KD250GX-LFB2	250	223.7	+5/-0%	15.1	poly	600	65.43x38.98x1.81	10	10yrs: 90% 25yrs: 80%	60	36.9	

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
	9.1A	CSA	600V	Pending	Bellingham, WA	No	48.2	-0.47%/C	-0.32%/C	0.04%/C	20/pallet
	9.2A	CSA	600V	Pending	Bellingham, WA	No	48.2	-0.47%/C	-0.32%/C	0.04%/C	20/pallet
	9.3A	CSA	600V	Pending	Bellingham, WA	No	48.2	-0.47%/C	-0.32%/C	0.04%/C	20/pallet
	0.058%	TUV/ETL/CEC	1000V	JAP6-60-260/3BB	shanghai/hefei	Yes	45°C (±2°C)	-0.41%	-0.33%	0.058%	26 PCS
	0.058%	TUV/ETL/CEC	1000V	JAP6-72-310/3BB	shanghai/hefei	Yes	45°C (±2°C)	-0.41%	-0.33%	0.058%	26 PCS
	.06	UL 1703			China						
	.06	UL 1703			China						
	.06	UL 1703			China						
	.06	UL 1704			China						
	.06	UL 1705			China						
	.06	UL 1706			China						
	8.68	UL1703 IEC61215 IEC61730 IEC61701	600	N/A	Mexico	No	45	-0.46%/°C	-0.36%/°C	-0.06%/°C	20
	8.68	UL1703 IEC61215 IEC61730 IEC61701	600	N/A	Mexico	No	45	-0.46%/°C	-0.36%/°C	-0.06%/°C	20
	9.09	UL1703 IEC61215 IEC61730 IEC61701	600	Type 2	Mexico	No	45	-0.46%/°C	-0.36%/°C	-0.06%/°C	20

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)
Kyocera *(continued)*	KD255GX-LFB2	255	228.3	+5/-0%	15.4	poly	600	65.43x38.98x1.81	10	10yrs: 90% 25yrs: 80%	60	37.6
www.kyocerasolar.com	KD260GX-LFB2	260	232.9	+5/-0%	15.8	poly	600	65.43x38.98x1.81	10	10yrs: 90% 25yrs: 80%	60	38.3
	KD265GX-LFB2	265	N/A	+5/-0%	16.1	poly	600	65.43x38.98x1.81	10	10yrs: 90% 25yrs: 80%	60	38.3
	KD325GX-LFB	325	290.4	+5/-0%	14.8	poly	600	65.43x51.97x1.81	10	10yrs: 90% 25yrs: 80%	80	49.7
	KD330GX-LFB	330	295.0	+5/-0%	15.0	poly	600	65.43x51.97x1.81	10	10yrs: 90% 25yrs: 80%	80	49.9
	KD335GX-LFB	335	299.6	+5/-0%	15.2	poly	600	65.43x51.97x1.81	10	10yrs: 90% 25yrs: 80%	80	50.1
	KU250-6BCA	250	223.7	+5/-0%	15.1	poly	1000	65.43x38.98x1.81	10	10yrs: 90% 25yrs: 80%	60	37.8
	KU255-6BCA	255	228.3	+5/-0%	15.4	poly	1000	65.43x38.98x1.81	10	10yrs: 90% 25yrs: 80%	60	38.0
	KU260-6BCA	260	232.9	+5/-0%	15.8	poly	1000	65.43x38.98x1.81	10	10yrs: 90% 25yrs: 80%	60	38.3
	KU265-6BCA	265	N/A	+5/-0%	16.1	poly	1000	65.43x38.98x1.81	10	10yrs: 90% 25yrs: 80%	60	38.3
	KU325-8BCA	325	290.4	+5/-0%	14.8	poly	1000	65.43x51.97x1.81	10	10yrs: 90% 25yrs: 80%	80	50.0
	KU330-8BCA	330	295.0	+5/-0%	15.0	poly	1000	65.43x51.97x1.81	10	10yrs: 90% 25yrs: 80%	80	50.3
	KU335-8BCA	335	299.6	+5/-0%	15.2	poly	1000	65.43x51.97x1.81	10	10yrs: 90% 25yrs: 80%	80	50.5

ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
9.09	UL1703 IEC61215 IEC61730 IEC61701	600	Type 2	Mexico	No	45	-0.46%/°C	-0.36%/°C	-0.06%/°C	20
9.09	UL1703 IEC61215 IEC61730 IEC61701	600	Type 2	Mexico	No	45	-0.45%/°C	-0.36%/°C	-0.06%/°C	20
9.26	(UL1703) IEC61215 IEC61730 IEC61701	600	Type 2	Mexico	No	45	-0.45%/°C	-0.36%/°C	-0.06%/°C	20
8.69	UL1703 IEC61215 IEC61730 IEC61701	600	Type 2	Mexico	No	45	-0.45%/°C	-0.36%/°C	-0.06%/°C	20
8.79	UL1703 IEC61215 IEC61730 IEC61701	600	Type 2	Mexico	No	45	-0.45%/°C	-0.36%/°C	-0.06%/°C	20
8.89	UL1703 IEC61215 IEC61730 IEC61701	600	Type 2	Mexico	No	45	-0.44%/°C	-0.36%/°C	-0.06%/°C	20
8.75	UL1703 IEC61215 IEC61730 IEC61701	1000	Type 2	Mexico	No	45	-0.46%/°C	-0.36%/°C	-0.06%/°C	20
8.83	UL1703 IEC61215 IEC61730 IEC61701	1000	Type 2	Mexico	No	45	-0.46%/°C	-0.36%/°C	-0.06%/°C	20
9.09	UL1703 IEC61215 IEC61730 IEC61701	1000	Type 2	Mexico	No	45	-0.45%/°C	-0.36%/°C	-0.06%/°C	20
9.26	(UL1703) IEC61215 IEC61730 IEC61701	1000	Type 2	Mexico	No	45	-0.45%/°C	-0.36%/°C	-0.06%/°C	20
8.68	UL1703 IEC61215 IEC61730 IEC61701	1000	Type 2	Mexico	No	45	-0.45%/°C	-0.36%/°C	-0.06%/°C	20
8.74	UL1703 IEC61215 IEC61730 IEC61701	1000	Type 2	Mexico	No	45	-0.45%/°C	-0.36%/°C	-0.06%/°C	20
8.80	UL1703 IEC61215 IEC61730 IEC61701	1000	Type 2	Mexico	No	45	-0.45%/°C	-0.36%/°C	-0.06%/°C	20

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)	
LG	LG300 A1C-B3 (Mono X ACe)	300		Please see the attached Spec sheet	18.30	Mono	See mfg data sheet	65.57 x 39.37 x 1.38	10	1) 1st year 98%, 2) After 2nd Year 0.7%p Annual degradation, 3) 81.2% for 25 years	60	See mfg data sheet	
www.lg.com	LG300N1 C-B3 (Mono X NeON)	300		0 ~+3	18.30	Mono	600	65.57 x 39.37 x 1.38	10	1) 1st year 98%, 2) After 2nd Year 0.7%p Annual degradation, 3) 81.2% for 25 years	60	39.8	
	LG305 N1C-B3 (Mono X NeON)	305		0 ~+3	18.60	Mono	600	65.57 x 39.37 x 1.38	10	1) 1st year 98%, 2) After 2nd Year 0.7%p Annual degradation, 3) 81.2% for 25 years	60	40.0	
	LG280S 1C-B3 (Mono X)	280		0 ~+3	17.10	Mono	1000	65.57 x 39.37 x 1.38	10	1) 1st year 98%, 2) After 2nd Year 0.7%p Annual degradation, 3) 81.2% for 25 years	60	38.8	
	LG270 S1K-B3 (Mono X Black)	270		0 ~+3	16.50	Mono	600	65.57 x 39.37 x 1.38	10	1) 1st year 98%, 2) After 2nd Year 0.7%p Annual degradation, 3) 81.2% for 25 years	60	38.6	
	LG265 S1K-B3 (Mono X Black)	265		0 ~+3	18.30	Mono	600	65.57 x 39.37 x 1.38	10	1) 1st year 98%, 2) After 2nd Year 0.7%p Annual degradation, 3) 81.2% for 25 years	60	38.4	
Lumos Solar	LSX245-60M-B	245	218	+0/-3%	14.1%	Mono	UL 1000V / IEC 1000V	65.5 x 41.0 x 1.4	10	25	60	37.2	
www.lumossolar.com	LSX245-60M-C	245	218	+0/-3%	14.1%	Mono	UL 1000V / IEC 1000V	65.5 x 41.0 x 1.4	10	25	60	37.2	
	LSX250-60M-B	250	223	+0/-3%	14.4%	Mono	UL 1000V / IEC 1000V	65.5 x 41.0 x 1.4	10	25	60	37.3	

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
	Please see the attached Spec sheet	See mfg data sheet	See mfg data sheet	AC Module	South Korea	Y	45°C (±2°C)	-0.41 % /°C	-0.29 % /°C	0.04 % /°C	27
	9.98	IEC 61215, IEC 61730-1/-2, UL 1703, ISO 9001, IEC 61701, IEC 62716	1000	DC Module	South Korea	Y	45°C (±2°C)	-0.41 % /°C	-0.29 % /°C	0.04 % /°C	27
	10.10	IEC 61215, IEC 61730-1/-2, UL 1703, ISO 9001, IEC 61701, IEC 62716	1000	DC Module	South Korea	Y	45°C (±2°C)	-0.41 % /°C	-0.29 % /°C	0.04 % /°C	27
	9.33	IEC 61215, IEC 61730-1/-2, UL 1703, ISO 9001, IEC 61701, IEC 62716	1000	DC Module	South Korea	Y	45°C (±2°C)	-0.43 % /°C	-0.31 % /°C	0.04 % /°C	27
	9.12	IEC 61215, IEC 61730-1/-2, UL 1703, ISO 9001, IEC 61701, IEC 62716	1000	DC Module	South Korea	Y	47°C (±2°C)	-0.44 % /°C	-0.31 % /°C	0.05 % /°C	27
	9.03	IEC 61215, IEC 61730-1/-2, UL 1703, ISO 9001, IEC 61701, IEC 62716	1000	DC Module	South Korea	Y	47°C (±2°C)	-0.44 % /°C	-0.31 % /°C	0.05 % /°C	27
	8.69	IEC, UL-1703 & CEC listed	UL 1000V / IEC 1000V	Mono, frameless	Ontario, Canada	No	47°C (±2°C)	-0.48%/°C	-0.35%/°C	-0.05%/°C	20
	8.69	IEC, UL-1703 & CEC listed	UL 1000V / IEC 1000V	Mono, frameless	Ontario, Canada	No	47°C (±2°C)	-0.48%/°C	-0.35%/°C	-0.05%/°C	20
	8.78	IEC, UL-1703 & CEC listed	UL 1000V / IEC 1000V	Mono, frameless	Ontario, Canada	No	47°C (±2°C)	-0.48%/°C	-0.35%/°C	-0.05%/°C	20

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)
Lumos Solar *(continued)*	LSX250-60M-C	250	223	+0/-3%	14.4%	Mono	UL 1000V / IEC 1000V	65.5 x 41.0 x 1.4	10	25	60	37.3
www.lumossolar.com	LSX255-60M-B	255	227	+0/-3%	14.7%	Mono	UL 1000V / IEC 1000V	65.5 x 41.0 x 1.4	10	25	60	37.5
	LSX255-60M-C	255	227	+0/-3%	14.7%	Mono	UL 1000V / IEC 1000V	65.5 x 41.0 x 1.4	10	25	60	37.5
	LSX260-60M-B	260	231	+0/-3%	15.0%	Mono	UL 1000V / IEC 1000V	65.5 x 41.0 x 1.4	10	25	60	37.6
	LSX260-60M-C	260	231	+0/-3%	15.0%	Mono	UL 1000V / IEC 1000V	65.5 x 41.0 x 1.4	10	25	60	37.6
MAGE SOLAR USA	245/6PJ	245		0/+7	15.06	poly	1000	64.57 x 39.05 x 1.57	10	80%/30yr	60	37.72
www.magesolarusa.com	250/6PJ	250		0/+8	15.35	poly	1000	64.57 x 39.05 x 1.57	10	80%/30yr	60	37.89
	255/6PJ	255		0/+8	15.67	poly	1000	64.57 x 39.05 x 1.57	10	80%/30yr	60	38.08
	255/6PL-US AC	255		0/+5	15.60	poly	1000	64.96 x 39.05 x 1.57	10	80%/30yr	60	37.61
	255/6 MC B	255		0/+5	15.60	mono	1000	64.96 x 39.05 x 1.57	10	80%/30yr	60	37.78
	255/6 PL US	255		0/+5	15.60	poly	1000	64.96 x 39.05 x 1.57	10	80%/30yr	60	37.61
	280/6 MC	280		0/+5	17.10	mono	1000	64.96 x 39.05 x 1.57	10	80%/30yr	60	38.85
	305/6 PC	305		0/+5	15.70	poly	1000	77.48 x 39.02 x 1.77	10	80%/30yr	72	45.33
Motech Industries	IM60C3	260	237.7	7.8	15.9	poly	1000V	65x39.1x1.57	10	80%@25yr	60	
www.motechsolar.com	IM60D3	260	237.7	7.8	15.9	poly	1000V	65x39.1x1.57	10	80%@25yr	60	
	IM60B3	260	236.5	7.8	15.9	poly	1000V	65x39.1x1.57	10	80%@25yr	60	
	IM72C3	315	281.7	9.45	16.2	poly	1000V	77.4x39.1.x1.57	10	80%@25yr	72	

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
	8.78	IEC, UL-1703 & CEC listed	UL 1000V / IEC 1000V	Mono, frameless	Ontario, Canada	No	47°C (±2°C)	-0.48%/°C	-0.35%/°C	-0.05%/°C	20
	8.86	IEC, UL-1703 & CEC listed	UL 1000V / IEC 1000V	Mono, frameless	Ontario, Canada	No	47°C (±2°C)	-0.48%/°C	-0.35%/°C	-0.05%/°C	20
	8.86	IEC, UL-1703 & CEC listed	UL 1000V / IEC 1000V	Mono, frameless	Ontario, Canada	No	47°C (±2°C)	-0.48%/°C	-0.35%/°C	-0.05%/°C	20
	8.94	IEC, UL-1703 & CEC listed	UL 1000V / IEC 1000V	Mono, frameless	Ontario, Canada	No	47°C (±2°C)	-0.48%/°C	-0.35%/°C	-0.05%/°C	20
	8.94	IEC, UL-1703 & CEC listed	UL 1000V / IEC 1000V	Mono, frameless	Ontario, Canada	No	47°C (±2°C)	-0.48%/°C	-0.35%/°C	-0.05%/°C	20
	8.53	UL 1703	1000	Module Flat Plate	Japan	No	+ 45 ±2	-0.420	-0.330	0.060	26
	8.61	UL 1703	1000	Module Flat Plate	Japan	No	+ 45 ±2	-0.420	-0.330	0.060	26
	8.65	UL 1703	1000	Module Flat Plate	Japan	No	+ 45 ±2	-0.420	-0.330	0.060	26
	8.89	UL 1703, ULC/ORD C-1703, IEC 61215, IEC 61730	1000	Module Flat Plate	Canada	No	+ 45 ±2	-0.440	-0.330	0.053	17
	8.86	UL 1703, ULC/ORD C-1703, IEC 61215, IEC 61730	1000	Module Flat Plate	Canada	No	+ 45 ±2	-0.428	-0.307	0.045	
	8.89	UL 1703, ULC/ORD C-1703, IEC 61215, IEC 61730	1000	Module Flat Plate	Canada	No	+ 45 ±2	-0.440	-0.334	0.053	20
	9.43	UL 1703, ULC/ORD C-1703, IEC 61215, IEC 61730	1000	Module Flat Plate	Canada	No	+ 45 ±2	-0.428	-0.307	0.045	20
	8.64	UL 1703, ULC/ORD C-1703, IEC 61215, IEC 61730	1000	Module Flat Plate	Canada	No	+ 45 ±2	-0.440	-0.334	0.053	20
		IEC61215/IEC61730/ UL1703/ JET	1000V	Type 2	Japan/ China/ Taiwan	No	46°C	-0.46 ±0.02(%/°C)	-0.34 ±0.01(%/°C)	+0.07 ±0.02(%/°C)	26
		IEC61215/IEC61730/ UL1703/ JET	1000V	Type 2	Japan/ China/ Taiwan	No	46°C	-0.46 ±0.02(%/°C)	-0.34 ±0.01(%/°C)	+0.07 ±0.02(%/°C)	26
		IEC61215/IEC61730/ UL1703/ JET	1000V	Type 2	Japan/ China/ Taiwan	No	46°C	-0.46 ±0.02(%/°C)	-0.34 ±0.01(%/°C)	+0.07 ±0.02(%/°C)	26
		IEC61215/IEC61730/ UL1703/ JET	1000V	Type 2	Japan/ China/ Taiwan	No	46°C	-0.46 ±0.02(%/°C)	-0.34 ±0.01(%/°C)	+0.07 ±0.02(%/°C)	26

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)	
REC	Peak Energy Series	255	229.7	-0/+5	15.5	Poly	600	65.55x39.02x1.5	10/12	25	60	37.60	
www.RECGroup.com	Peak Energy Series	260	234.3	-0/+5	15.8	Poly	600	65.55x39.02x1.5	10/12	25	60	37.80	
	Peak Energy Series	265	241.3	-0/+5	16.1	Poly	600	65.55x39.02x1.5	10/12	25	60	38.10	
	Peak Energy 72 Series	300	274.3	-0/+5	15.3	Poly	1000	77.5x39.02x1.75	10	25	72	44.90	
	Peak Energy 72 Series	305	279.0	-0/+5	15.6	Poly	1000	77.5x39.02x1.75	10	25	72	45.10	
	Peak Energy 72 Series	310	283.7	-0/+5	15.8	Poly	1000	77.5x39.02x1.75	10	25	72	45.30	
	Peak Energy 72 Series	315	288.4	-0/+5	16.1	Poly	1000	77.5x39.02x1.75	10	25	72	45.50	
	Twin Peak Series	265	241.3	-0/+5	16.1	Poly	1000	65.55x39.02x1.5	10/12	25	120 (half cut)	37.70	
	Twin Peak Series	270	243.3	-0/+5	16.4	Poly	1000	65.55x39.02x1.5	10/12	25	120 (half cut)	38.00	
	Twin Peak Series	275	247.97	-0/+5	16.7	Poly	1000	65.55x39.02x1.5	10/12	25	120 (half cut)	38.30	
RECOM		300	300	5	15.50%	Poly	1000	77x39x2	10	25	72		
www.recom.gr		260	260	5	16%	Mono	1000	64.6x39.0x1.6	10	25	60		
Renesola Jiangsu	JC310M-24/Ab	310	284.0	0~+5	16.0	poly	yes	77.00x39.06x1.57	10	25	72	45.0 V	
www.renesola.com	JC305M-24/Ab	305	279.3	0~+5	15.7	poly	yes	77.00x39.06x1.57	10	25	72	44.9 V	
	JC300M-24/Ab	300	274.6	0~+5	15.5	poly	yes	77.00x39.06x1.57	10	25	72	44.8V	

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
	8.95	IEC/UL/JET	1000	type 1	Singapore	yes	45.7	-0.40%/°C	-0.27 %/°C	0.024 %/°C	24
	9.01	IEC/UL/JET	1000	type 1	Singapore	yes	45.7	-0.40%/°C	-0.27 %/°C	0.024 %/°C	24
	9.08	IEC/UL/JET	1000	type 1	Singapore	yes	45.7	-0.40%/°C	-0.27 %/°C	0.024 %/°C	24
	8.86	IEC/UL	1000	type 1	Singapore	yes	46.6	-0.38%/°C	-0.27 %/°C	0.013 %/°C	21
	8.95	IEC/UL	1000	type 1	Singapore	yes	46.6	-0.38%/°C	-0.27 %/°C	0.013 %/°C	21
	9.02	IEC/UL	1000	type 1	Singapore	yes	46.6	-0.38%/°C	-0.27 %/°C	0.013 %/°C	21
	9.09	IEC/UL	1000	type 1	Singapore	yes	46.6	-0.38%/°C	-0.27 %/°C	0.013 %/°C	21
	9.21	IEC/UL	1000	type 1	Singapore	yes	45.7	-0.40%/°C	-0.27 %/°C	0.024 %/°C	24
	9.29	IEC/UL	1000	type 1	Singapore	yes	45.7	-0.40%/°C	-0.27 %/°C	0.024 %/°C	24
	9.38	IEC/UL	1000	type 1	Singapore	yes	45.7	-0.40%/°C	-0.27 %/°C	0.024 %/°C	24
	8.80A	IEC61215,IEC 61730,UL1703, PV cycle	1000V	JC310M-24/Ab	China	yes	45°C ±2°C	-0.40%	-0.30%	0.04%	25
	8.73A	IEC61215,IEC 61730,UL1704, PV cycle	1000V	JC305M-24/Ab	China	yes	45°C ±2°C	-0.40%	-0.30%	0.04%	25
	8.69A	IEC61215,IEC 61730,UL1704, PV cycle	1000V	JC300M-24/Ab	China	yes	45°C ±2°C	-0.40%	-0.30%	0.04%	25

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)
Renesola Jiangsu *(continued)*	JC260M-24/Bb	260	238.2	0~+5	16.0	poly	yes	64.57x39.06x1.57	10	25	60	37.6V
www.renesola.com	JC255M-24/Bb	255	233.5	0~+5	15.7	poly	yes	64.57x39.06x1.57	10	25	60	37.5V
	JC250M-24/Bb	250	228.8	0~+5	15.4	poly	yes	64.57x39.06x1.57	10	25	60	37.4V
	JC265S-24/Bb	265		0~+5	16.3	mono	yes	64.57x39.06x1.57	10	25	60	37.9V
	JC260S-24/Bb	260	237.7	0~+5	16.0	mono	yes	64.57x39.06x1.57	10	25	60	37.7V
	JC255S-24/Bb	255	233.0	0~+5	15.7	mono	yes	64.57x39.06x1.57	10	25	60	37.6V
	JC250S-24/Bb	250	228.3	0~+5	15.4	mono	yes	64.57x39.06x1.57	10	25	60	37.5V
	JC260S-24/Bb-b	260	237.7	0~+5	16.0	mono	yes	64.57x39.06x1.57	10	25	60	37.7V
	JC255S-24/Bb-b	255	233.0	0~+5	15.7	mono	yes	64.57x39.06x1.57	10	25	60	37.6V
	JC250S-24/Bb-b	250	228.3	0~+5	15.4	mono	yes	64.57x39.06x1.57	10	25	60	37.5V
	JC205S-24/Db	205		0~+5	16.1	mono	yes	62.20x31.81x1.38	10	25	72	45.4V
	JC200S-24/Db	200	180.6	0~+5	15.7	mono	yes	62.20x31.81x1.38	10	25	72	45.3V
	JC195S-24/Db	195	176.0	0~+5	15.3	mono	yes	62.20x31.81x1.38	10	25	72	45.0V
	JC190S-24/Db	190	172.8	0~+5	14.9	mono	yes	62.20x31.81x1.38	10	25	72	44.9V
	JC200S-24/Db-b	200		0~+5	15.7	mono	yes	62.20x31.81x1.38	10	25	72	45.3V
	JC195S-24/Db-b	195		0~+5	15.3	mono	yes	62.20x31.81x1.38	10	25	72	45.0V
	JC190S-24/Db-b	190		0~+5	14.9	mono	yes	62.20x31.81x1.38	10	25	72	44.9V

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
	8.95A	IEC61215,IEC 61730,UL1705, PV cycle	1000V	JC260M-24/Bb	China	yes	45°C ±2°C	-0.40%	-0.30%	0.04%	25
	8.86A	IEC61215,IEC 61730,UL1706, PV cycle	1000V	JC255M-24/Bb	China	yes	45°C ±2°C	-0.40%	-0.30%	0.04%	25
	8.83A	IEC61215,IEC 61730,UL1707, PV cycle	1000V	JC250M-24/Bb	China	yes	45°C ±2°C	-0.40%	-0.30%	0.04%	25
	9.19A	IEC61215,IEC 61730,UL1708, PV cycle	1000V	JC265S-24/Bb	China	yes	45°C ±2°C	-0.43%	-0.31%	0.03%	25
	9.10A	IEC61215,IEC 61730,UL1709, PV cycle	1000V	JC260S-24/Bb	China	yes	45°C ±2°C	-0.43%	-0.31%	0.03%	25
	8.99A	IEC61215,IEC 61730,UL1710, PV cycle	1000V	JC255S-24/Bb	China	yes	45°C ±2°C	-0.43%	-0.31%	0.03%	25
	8.87A	IEC61215,IEC 61730,UL1710, PV cycle	1000V	JC250S-24/Bb	China	yes	45°C ±2°C	-0.43%	-0.31%	0.03%	25
	9.10A	IEC61215,IEC 61730,UL1710, PV cycle	1000V	JC260S-24/Bb-b	China	yes	45°C ±2°C	-0.43%	-0.31%	0.03%	25
	8.99A	IEC61215,IEC 61730,UL1710, PV cycle	1000V	JC255S-24/Bb-b	China	yes	45°C ±2°C	-0.43%	-0.31%	0.03%	25
	8.87A	IEC61215,IEC 61730,UL1710, PV cycle	1000V	JC250S-24/Bb-b	China	yes	45°C ±2°C	-0.43%	-0.31%	0.03%	25
	5.79A	IEC61215,IEC 61730,UL1710, PV cycle	1000V	JC205S-24/Db	China	yes	45°C ±2°C	-0.43%	-0.31%	0.03%	31
	5.70A	IEC61215,IEC 61730,UL1710, PV cycle	1000V	JC200S-24/Db	China	yes	45°C ±2°C	-0.43%	-0.31%	0.03%	31
	5.61A	IEC61215,IEC 61730,UL1710, PV cycle	1000V	JC195S-24/Db	China	yes	45°C ±2°C	-0.43%	-0.31%	0.03%	31
	5.49A	IEC61215,IEC 61730,UL1710, PV cycle	1000V	JC190S-24/Db	China	yes	45°C ±2°C	-0.43%	-0.31%	0.03%	31
	5.70A	IEC61215,IEC 61730,UL1710, PV cycle	1000V	JC200S-24/Db-b	China	yes	45°C ±2°C	-0.43%	-0.31%	0.03%	31
	5.61A	IEC61215,IEC 61730,UL1710, PV cycle	1000V	JC195S-24/Db-b	China	yes	45°C ±2°C	-0.43%	-0.31%	0.03%	31
	5.49A	IEC61215,IEC 61730,UL1710, PV cycle	1000V	JC190S-24/Db-b	China	yes	45°C ±2°C	-0.43%	-0.31%	0.03%	31

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)
Silicon Energy	SiE-210	210	193.2	6.3	15.4	poly	600 (Yes)	46 x 46x 0.5	5	80% @ 30	49	30.7
www.silicon-energy.com	SiE-V-275	275	248.3	8.3	16.4	mono	600 (Yes)	66 x 39.5 x 1.2	10	80% @ 30	60	38.5
SolarWorld	SW Plus Mono	280	209	2.0%	16.7	Mono	Yes	65.94x39.41x1.22	10	80% @ 25	60	39.5
www.solarworld.com	SW Plus Mono	275	205	2.0%	16.4	Mono	Yes	65.94x39.41x1.22	10	80% @ 25	60	39.4
	SW Plus Mono	270	201	2.0%	16.1	Mono	Yes	65.94x39.41x1.22	10	80% @ 25	60	39.2
	SW Plus Mono Black	275	203	2.0%	16.4	Mono	Yes	65.94x39.41x1.22	10	80% @ 25	60	39.4
	SW Plus Mono Black	270	199	2.0%	16.1	Mono	Yes	65.94x39.41x1.22	10	80% @ 25	60	39.2
	SW Protect Mono	275	205	2.0%	16.4	Mono	Yes	65.94x39.41x1.22	10	86.85% @ 30	60	39.4
	SW Protect Mono	270	201	2.0%	16.1	Mono	Yes	65.94x39.41x1.22	10	86.85% @ 30	60	39.2
	SW Protect Mono Black	270	199	2.0%	16.1	Mono	Yes	65.94x39.41x1.22	10	86.85% @ 30	60	39.2
	SW Protect Mono Black	265	196	2.0%	15.8	Mono	Yes	65.94x39.41x1.22	10	86.85% @ 30	60	39.0
	SW Pro-Series Poly	250	185	2.0%	14.9	Poly	Yes	65.94x39.41x1.22	10	80% @ 25	60	37.6
	SW Pro-Series XL Mono	315	241	2.0%	16.0	Mono	Yes	78.15x39.98x1.81	10	80% @ 25	72	45.6
	SW Pro-Series XL Mono	310	237	2.0%	15.8	Mono	Yes	78.15x39.98x1.81	10	80% @ 25	72	45.4
Stion	Elevation 4 STL-140A	140	130	-/+ 2.5 W	13.1%	CIGS	1000	65 x 25.6 x 1.06	10	25	134	78.8
www.stion.com	Elevation 4 STL-145A	145	135	-/+ 2.5 W	13.5%	CIGS	1000	65 x 25.6 x 1.06	10	25	134	79.6
	Elevation 4 STL-150A	150	139	-/+ 2.5 W	14.0%	CIGS	1000	65 x 25.6 x 1.06	10	25	134	80.8

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
	8.8	UL 1703	NA	Flat Plate	WA and MN	No	43	-0.42%	-0.31%	0.04%	25
	9.0	UL 1703	NA	Flat Plate	MN	No	46	-0.45%	-0.30%	0.04%	25
	9.71		1000	1	USA	Yes	46	-0.410	-0.300	0.040	30
	9.58		1000	1	USA	Yes	46	-0.410	-0.300	0.040	30
	9.44		1000	1	USA	Yes	46	-0.450	-0.300	0.040	30
	9.58		1000	1	USA	Yes	48	-0.430	-0.310	0.044	30
	9.44		1000	1	USA	Yes	48	-0.430	-0.310	0.043	30
	9.58		1000	3	USA	Yes	46	-0.410	-0.300	0.040	30
	9.44		1000	3	USA	Yes	46	-0.410	-0.300	0.040	30
	9.44		1000	3	USA	Yes	48	-0.430	-0.310	0.040	30
	9.31		1000	3	USA	Yes	46	-0.410	-0.300	0.040	30
	8.81		1000	1	USA	Yes	46	-0.450	-0.370	0.081	30
	9.35		1000	1	Germany	Yes	46	-0.430	-0.304	-0.042	30
	9.28		1000	1	Germany	Yes	46	-0.430	-0.304	-0.042	30
	2.7	UL1703, IEC 61646, IEC 61730-1&@	1000	Type 10	Hattiesburg, MS, USA	Yes	45	-0.26%/K	-0.24%/K	0.004%/K	50
	2.7	UL1703, IEC 61646, IEC 61730-1&@	1000	Type 10	Hattiesburg, MS, USA	Yes	45	-0.26%/K	-0.24%/K	0.004%/K	50
	2.7	UL1703, IEC 61646, IEC 61730-1&@	1000	Type 10	Hattiesburg, MS, USA	Yes	45	-0.26%/K	-0.24%/K	0.004%/K	50

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)	
Stion *(continued)*	Elevation 4 STL-155A	155		-/+ 2.5 W	14.5%	CIGS	1000	65 x 25.6 x 1.06	10	25	134	82.0	
www.stion.com	Elevation 4 STL-160A	160		-/+ 2.5 W	14.9%	CIGS	1000	65 x 25.6 x 1.06	10	25	134	83.2	
	Elevation 4 STO-140A	140	130	-/+ 2.5 W	12.9%	CIGS	1000	65.2 x 25.8 x 1.4	10	25	134	78.8	
	Elevation 4 STO-145A	145	135	-/+ 2.5 W	13.3%	CIGS	1000	65.2 x 25.8 x 1.4	10	25	134	79.6	
	Elevation 4 STO-150A	150	139	-/+ 2.5 W	13.8%	CIGS	1000	65.2 x 25.8 x 1.4	10	25	134	80.8	
	Elevation 4 STO-155A	155		-/+ 2.5 W	14.3%	CIGS	1000	65.2 x 25.8 x 1.4	10	25	134	82.0	
	Elevation 4 STO-160A	160		-/+ 2.5 W	14.7%	CIGS	1000	65.2 x 25.8 x 1.4	10	25	134	83.2	
Suniva	OPT270-60-X-XXX	270	240.3	-0/+3%	16.60	mono	1000	65.04x38.66x1.57	10 year	25-year linear	60	-0.335	
www.suniva.com	OPT275-60-X-XXX	275	244.5	-0/+3%	16.95	mono	1000	65.04x38.66x1.57	10 year	25-year linear	60	-0.335	
	OPT280-60-X-XXX	280	249.1	-0/+3%	17.26	mono	1000	65.04x38.66x1.57	10 year	25-year linear	60	-0.335	
	OPT270-60-X-XBX	270	242.0	+/-2.5Wp	16.63	mono	1000	65.04x38.66x1.57	10 year	25-year linear	60	-0.335	
	OPT275-60-X-XBX	275	246.2	+/-2.5Wp	16.95	mono	1000	65.04x38.66x1.57	10 year	25-year linear	60	-0.335	
	OPT280-60-X-XBX	280		+/-2.5Wp	17.26	mono	1000	65.04x38.66x1.57	10 year	25-year linear	60	-0.335	
	OPT320-72-X-XXX	320	282.5	-0/+3%	16.27	mono	1000	77.6x39x1.5	10 year	25-year linear	72	-0.335	
	OPT325-72-X-XXX	325	287.1	-0/+3%	16.79	mono	1000	77.6x39x1.5	10 year	25-year linear	72	-0.335	
	OPT330-72-X-XXX	330	291.7	-0/+3%	16.92	mono	1000	77.6x39x1.5	10 year	25-year linear	72	-0.335	

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
	2.8	UL1703, IEC 61646, IEC 61730-1&@	1000	Type 10	Hattiesburg, MS, USA	Yes	45	-0.26%/K	-0.24%/K	0.004%/K	50
	2.8	UL1703, IEC 61646, IEC 61730-1&@	1000	Type 10	Hattiesburg, MS, USA	Yes	45	-0.26%/K	-0.24%/K	0.004%/K	50
	2.7	UL1703, IEC 61646, IEC 61730-1&@	1000		Hattiesburg, MS, USA	Yes	45	-0.26%/K	-0.24%/K	0.004%/K	25
	2.7	UL1703, IEC 61646, IEC 61730-1&@	1000		Hattiesburg, MS, USA	Yes	45	-0.26%/K	-0.24%/K	0.004%/K	25
	2.7	UL1703, IEC 61646, IEC 61730-1&@	1000		Hattiesburg, MS, USA	Yes	45	-0.26%/K	-0.24%/K	0.004%/K	25
	2.8	UL1703, IEC 61646, IEC 61730-1&@	1000		Hattiesburg, MS, USA	Yes	45	-0.26%/K	-0.24%/K	0.004%/K	25
	2.8	UL1703, IEC 61646, IEC 61730-1&@	1000		Hattiesburg, MS, USA	Yes	45	-0.26%/K	-0.24%/K	0.004%/K	25
	0.047	UL1703 / IEC	1000	1 or 2	US	Yes	46.0	-0.420	-0.335	0.047	25
	0.047	UL1703 / IEC	1000	1 or 2	US	Yes	46.0	-0.420	-0.335	0.047	25
	0.047	UL1703 / IEC	1000	1 or 2	US	Yes	46.0	-0.420	-0.335	0.047	25
	0.047	UL1703 / IEC	1000	1 or 2	US	Yes	46.0	-0.420	-0.335	0.047	25
	0.047	UL1703 / IEC	1000	1 or 2	US	Yes	46.0	-0.420	-0.335	0.047	25
	0.047	UL1703 / IEC	1000	1 or 2	US	Yes	46.0	-0.420	-0.335	0.047	25
	0.047	UL1703 / IEC	1000	1 or 2	US/North America	Yes	46.0	-0.420	-0.335	0.047	22
	0.047	UL1703 / IEC	1000	1 or 2	US/North America	Yes	46.0	-0.420	-0.335	0.047	22
	0.047	UL1703 / IEC	1000	1 or 2	US/North America	Yes	46.0	-0.420	-0.335	0.047	22

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)	
Sunpower	SPR-X21-345	345	323.3	+5/-0	21.2%	mono	600V	61.4 x 41.2 x 1.8	25	95% @yr 5 87% @yr 25 (linear)	96	-0.25%	
www.sunpower.com	SPR-X21-345-COM	345	320.2	+5/-3	21.2%	mono	1000V	61.4 x 41.2 x 1.8	25	95% @yr 5 87% @yr 25 (linear)	96	-0.25%	
	SPR-X21-335-BLK	335	313.7	+5/-0	20.5%	mono	600V	61.4 x 41.2 x 1.8	25	95% @yr 5 87% @yr 25 (linear)	96	-0.25%	
	SPR-X21-335	335	313.7	+5/-0	20.5%	mono	600V	61.4 x 41.2 x 1.8	25	95% @yr 5 87% @yr 25 (linear)	96	-0.25%	
	SPR-X21-255	255	241.7	+5/-0	20.5%	mono	600V	61.4 x 31.4 x 1.8	25	"95% @yr 5 87% @yr 25 (linear)"	72	-0.25%	
	SPR-X20-327-BLK	327	306.1	+5/-0	20.1%	mono	600V	61.4 x 41.2 x 1.8	25	95% @yr 5 87% @yr 25 (linear)	96	-0.25%	
	SPR-X20-250-BLK	250	231.7	+5/-0	20.1%	mono	600V	61.4 x 31.4 x 1.8	25	95% @yr 5 87% @yr 25 (linear)	72	-0.25%	
	SPR-E20-435-COM	435	400.2	+5/-3	20.1%	mono	1000V	81.4 x 41.2 x 1.8	25	95% @yr 5 87% @yr 25 (linear)	128	-0.28%	
	SPR-E20-327-COM	327	301.4	+5/-3	20.1%	mono	1000V	61.4 x 41.2 x 1.8	25	95% @yr 5 87% @yr 25 (linear)	96	-0.27%	
	SPR-E20-327	327	301.4	+5/-0	20.1%	mono	600V	61.4 x 41.2 x 1.8	25	95% @yr 5 87% @yr 25 (linear)	96	-0.27%	
	SPR-E19-320	320	294.8	+5/-0	19.6%	mono	600V	61.4 x 41.2 x 1.8	25	95% @yr 5 87% @yr 25 (linear)	96	-0.27%	
	SPR-E20-245	245	225.5	+5/-0	19.7%	mono	600V	61.4 x 31.4 x 1.8	25	95% @yr 5 87% @yr 25 (linear)"	72	-0.27%	
	SPR-E19-410-COM	410	380.4	+5/-3	19.0%	mono	1000V	81.4 x 41.2 x 1.8	25	95% @yr 5 87% @yr 25 (linear)	128	-0.28%	
	SPR-E19-310-COM	310	285.3	+5/-3	19.0%	mono	1000V	61.4 x 41.2 x 1.8	25	95% @yr 5 87% @yr 25 (linear)	96	-0.27%	
	SPR-E19-235	235	216.0	+5/-0	18.9%	mono	600V	61.4 x 31.4 x 1.8	25	95% @yr 5 87% @yr 25 (linear)	72	-0.27%	
tenKsolar *tenksolar.com*					15.8	Poly	57	77.4x51.575x1.8			57		

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
	0.05%	UL, IEC and others	1000	Type 2	various	No	42	-0.30%	-0.25%	0.05%	20
	0.05%	UL, IEC and others	1000	Type 2	various	No	42	-0.30%	-0.25%	0.05%	40
	0.06%	UL, IEC and others	1000	Type 2	various	No	43	-0.30%	-0.25%	0.06%	20
	0.06%	UL, IEC and others	1000	Type 2	various	No	42	-0.30%	-0.25%	0.06%	20
	0.06%	UL, IEC and others	1000	Type 2	various	No	42	-0.30%	-0.25%	0.06%	20
	0.06%	UL, IEC and others	1000	Type 2	various	No	43	-0.30%	-0.25%	0.06%	20
	0.06%	UL, IEC and others	1000	Type 2	various	No	43	-0.30%	-0.25%	0.06%	20
	0.05%	UL, IEC and others	1000	Type 2	various	Yes	45	-0.38%	-0.28%	0.05%	40
	0.05%	UL, IEC and others	1000	Type 2	various	Yes	45	-0.38%	-0.27%	0.05%	40
	0.05%	UL, IEC and others	1000	Type 2	various	No	45	-0.38%	-0.27%	0.05%	20
	0.06%	UL, IEC and others	1000	Type 2	various	No	45	-0.38%	-0.27%	0.06%	20
	0.05%	UL, IEC and others	1000	Type 2	various	No	45	-0.38%	-0.27%	0.05%	20
	0.06%	UL, IEC and others	1000	Type 2	various	Yes	45	-0.38%	-0.28%	0.06%	40
	0.06%	UL, IEC and others	1000	Type 2	various	Yes	45	-0.38%	-0.27%	0.06%	40
	0.06%	UL, IEC and others	1000	Type 2	various	No	45	-0.38%	-0.27%	0.06%	20

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)	
Trina Solar	PA/D05	245	222.9	0 / +3%	15.0	Poly	Yes	64.95 x 39.05 x 1.37	10 Years	80% @ 25yrs.	60	37.8	
www.trinasolar.com	PA/D05	250	227.5	0 / +3%	15.3	Poly	Yes	64.95 x 39.05 x 1.38	10 Years	80% @ 25yrs.	60	38.0	
	PA/D05	255	232.2	0 / +3%	15.6	Poly	Yes	64.95 x 39.05 x 1.39	10 Years	80% @ 25yrs.	60	38.1	
	PA/D05	260	236.9	0 / +3%	15.9	Poly	Yes	64.95 x 39.05 x 1.40	10 Years	80% @ 25yrs.	60	38.2	
	PA/ D05.05	235	213.5	0 / +3%	14.4	Poly	Yes	64.95 x 39.05 x 1.41	10 Years	80% @ 25yrs.	60	37.2	
	PA/ D05.05	240	218.1	0 / +3%	14.7	Poly	Yes	64.95 x 39.05 x 1.42	10 Years	80% @ 25yrs.	60	37.3	
	PA/ D05.05	245	222.8	0 / +3%	15.0	Poly	Yes	64.95 x 39.05 x 1.43	10 Years	80% @ 25yrs.	60	37.5	
	PA/ D05.05	250	227.4	0 / +3%	15.3	Poly	Yes	64.95 x 39.05 x 1.44	10 Years	80% @ 25yrs.	60	37.6	
	PA/ D05.08	245	222.9	0 / +3%	15.0	Poly	Yes	64.95 x 39.05 x 1.45	10 Years	80% @ 25yrs.	60	37.8	
	PA/ D05.08	250	227.5	0 / +3%	15.3	Poly	Yes	64.95 x 39.05 x 1.46	10 Years	80% @ 25yrs.	60	38.0	
	PA/ D05.08	255	232.2	0 / +3%	15.6	Poly	Yes	64.95 x 39.05 x 1.47	10 Years	80% @ 25yrs.	60	38.1	
	PA/ D05.08	260	236.9	0 / +3%	15.9	Poly	Yes	64.95 x 39.05 x 1.48	10 Years	80% @ 25yrs.	60	38.2	
	PA/ D05.18	240	218.2	0 / +3%	14.7	Poly	Yes	64.95 x 39.05 x 1.49	10 Years	80% @ 25yrs.	60	37.3	
	PA/ D05.18	245	222.9	0 / +3%	15.0	Poly	Yes	64.95 x 39.05 x 1.50	10 Years	80% @ 25yrs.	60	37.5	
	PA/ D05.18	250	227.5	0 / +3%	15.3	Poly	Yes	64.95 x 39.05 x 1.51	10 Years	80% @ 25yrs.	60	37.6	
	PA/ D05.18	255	232.2	0 / +3%	15.6	Poly	Yes	64.95 x 39.05 x 1.52	10 Years	80% @ 25yrs.	60	37.7	
	PA/ D05.18	260	236.9	0 / +3%	15.9	Poly	Yes	64.95 x 39.05 x 1.53	10 Years	80% @ 25yrs.	60	37.9	
	PDG5	240	221	0 / +3%	14.3	Poly	Yes	66.33 x 39.25 x .25	10 Years	85% @ 30yrs.	60	37.3	
	PDG5	245	225.7	0 / +3%	14.6	Poly	Yes	66.33 x 39.25 x .25	10 Years	85% @ 30yrs.	60	37.4	
	PDG5	250	230.4	0 / +3%	14.9	Poly	Yes	66.33 x 39.25 x .25	10 Years	85% @ 30yrs.	60	37.5	
	PDG5	255	235.1	0 / +3%	15.2	Poly	Yes	66.33 x 39.25 x .25	10 Years	85% @ 30yrs.	60	37.6	
	PA/ D05.002	245	222.9	0 / +3%	15.0	Poly	Yes	64.95 x 39.05 x 1.59	10 Years	80% @ 25yrs.	60	33.0	
	PA/ D05.002	250	227.5	0 / +3%	15.3	Poly	Yes	64.95 x 39.05 x 1.60	10 Years	80% @ 25yrs.	60	33.0	

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
	8.75	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 2	China	Yes	182	-0.41	-0.32	0.05	30
	8.79	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 2	China	Yes	186	-0.41	-0.32	0.05	30
	8.88	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 2	China	Yes	190	-0.41	-0.32	0.05	30
	9.00	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 2	China	Yes	193	-0.41	-0.32	0.05	30
	8.55	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 1	China	Yes	171	-0.45	-0.31	0.05	29
	8.62	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 1	China	Yes	174	-0.45	-0.31	0.05	29
	8.68	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 1	China	Yes	178	-0.45	-0.31	0.05	29
	8.85	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 1	China	Yes	181	-0.45	-0.31	0.05	29
	8.75	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 2	China	Yes	182	-0.41	-0.32	0.05	30
	8.79	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 2	China	Yes	186	-0.41	-0.32	0.05	30
	8.88	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 2	China	Yes	190	-0.41	-0.32	0.05	30
	9.00	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 2	China	Yes	193	-0.41	-0.32	0.05	30
	8.62	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 1	China	Yes	174	-0.43	-0.32	0.047	25
	8.68	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 1	China	Yes	178	-0.43	-0.32	0.047	25
	8.85	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 1	China	Yes	181	-0.43	-0.32	0.047	25
	8.92	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 1	China	Yes	184	-0.43	-0.32	0.047	25
	9.00	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 1	China	Yes	188	-0.43	-0.32	0.047	25
	8.50	UL, ISO, CSA, TUV	1000	Type 15	China	Yes	174	-0.43	-0.32	0.047	30
	8.60	UL, ISO, CSA, TUV	1000	Type 15	China	Yes	178	-0.43	-0.32	0.047	30
	8.70	UL, ISO, CSA, TUV	1000	Type 15	China	Yes	181	-0.43	-0.32	0.047	30
	8.80	UL, ISO, CSA, TUV	1000	Type 15	China	Yes	185	-0.43	-0.32	0.047	30
	9.50	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 2	China	Yes	182	-0.41	0.00	0.05	30
	9.50	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 2	China	Yes	186	-0.41	0.00	0.05	30

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)
Trina Solar *(continued)*	PA/ D05.002	255	232.2	0 / +3%	15.6	Poly	Yes	64.95 x 39.05 x 1.61	10 Years	80% @ 25yrs.	60	33.0
www.trinasolar.com	PA/ D05.002	260	236.9	0 / +3%	15.9	Poly	Yes	64.95 x 39.05 x 1.62	10 Years	80% @ 25yrs.	60	33.0
	PA/ D05.082	245	222.9	0 / +3%	15.0	Poly	Yes	64.95 x 39.05 x 1.63	10 Years	80% @ 25yrs.	60	33.0
	PA/ D05.082	250	227.5	0 / +3%	15.3	Poly	Yes	64.95 x 39.05 x 1.64	10 Years	80% @ 25yrs.	60	33.0
	PA/ D05.082	255	232.2	0 / +3%	15.6	Poly	Yes	64.95 x 39.05 x 1.65	10 Years	80% @ 25yrs.	60	33.0
	PA/ D05.082	260	236.9	0 / +3%	15.9	Poly	Yes	64.95 x 39.05 x 1.65	10 Years	80% @ 25yrs.	60	33.0
	PD14.002	295	268.5	0 / +3%	15.2	Poly	Yes	77.0 x 39.05 x 1.57	10 Years	80% @ 25yrs.	72	39.4
	PD14.002	300	273.1	0 / +3%	15.5	Poly	Yes	77.0 x 39.05 x 1.57	10 Years	80% @ 25yrs.	72	39.4
	PD14.002	305	277.8	0 / +3%	15.7	Poly	Yes	77.0 x 39.05 x 1.57	10 Years	80% @ 25yrs.	72	39.4
	PD14.002	310	282.5	0 / +3%	16.0	Poly	Yes	77.0 x 39.05 x 1.57	10 Years	80% @ 25yrs.	72	39.4
	PD14.002	290	263.8	0 / +3%	14.9	Poly	Yes	77.0 x 39.05 x 1.57	10 Years	80% @ 25yrs.	72	44.7
	PD14	295	268.5	0 / +3%	15.2	Poly	Yes	77.0 x 39.05 x 1.57	10 Years	80% @ 25yrs.	72	44.9
	PD14	300	273.1	0 / +3%	15.5	Poly	Yes	77.0 x 39.05 x 1.57	10 Years	80% @ 25yrs.	72	45.2
	PD14	305	277.8	0 / +3%	15.7	Poly	Yes	77.0 x 39.05 x 1.57	10 Years	80% @ 25yrs.	72	45.3
	PD14	310	282.5	0 / +3%	16.0	Poly	Yes	77.0 x 39.05 x 1.57	10 Years	80% @ 25yrs.	72	45.4
Upsolar	UP-M250P	250	222.3	[0,+5W]	15.4%	poly	1,000V	64.6 x 39.1 x 1.57	10	-0.7%	60	38.0
www.upsolar.com	UP-M255P	255	231.3	[0,+5W]	15.7%	poly	1,000V	64.6 x 39.1 x 1.57	10	-0.7%	60	38.2
	UP-M260P	260	236.0	[0,+5W]	16.0%	poly	1,000V	64.6 x 39.1 x 1.57	10	-0.7%	60	38.4
	UP-M260M	260	234.1	[0,+5W]	16.0%	mono	1,000V	64.6 x 39.1 x 1.57	10	-0.7%	60	38.3
	UP-M265M	265	238.7	[0,+5W]	16.3%	mono	1,000V	64.6 x 39.1 x 1.57	10	-0.7%	60	38.6
	UP-M270M	270	243.4	[0,+5W]	16.6%	mono	1,000V	64.6 x 39.1 x 1.57	10	-0.7%	60	38.9

ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
9.50	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 2	China	Yes	190	-0.41	0.00	0.05	30
9.50	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 2	China	Yes	193	-0.41	0.00	0.05	30
9.50	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 2	China	Yes	182	-0.41	0.00	0.05	30
9.50	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 2	China	Yes	186	-0.41	0.00	0.05	30
9.50	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 2	China	Yes	190	-0.41	0.00	0.05	30
9.50	UL, ISO, CSA, TUV	(A)600/ (D)1000	Type 2	China	Yes	193	-0.41	0.00	0.05	30
9.50	UL, ISO, CSA, TUV	1000	Type 2	China	Yes	220	-0.41	0.00	0.05	26
9.50	UL, ISO, CSA, TUV	1000	Type 2	China	Yes	223	-0.41	0.00	0.05	26
9.50	UL, ISO, CSA, TUV	1000	Type 2	China	Yes	227	-0.41	0.00	0.05	26
9.50	UL, ISO, CSA, TUV	1000	Type 2	China	Yes	231	-0.41	0.00	0.05	26
8.50	UL, ISO, CSA, TUV	1000	Type 2	China	Yes	211	-0.44	-0.33	0.046	24
8.53	UL, ISO, CSA, TUV	1000	Type 2	China	Yes	214	-0.44	-0.33	0.046	24
8.55	UL, ISO, CSA, TUV	1000	Type 2	China	Yes	218	-0.44	-0.33	0.046	24
8.60	UL, ISO, CSA, TUV	1000	Type 2	China	Yes	221	-0.44	-0.33	0.046	24
8.75	UL, ISO, CSA, TUV	1000	Type 2	China	Yes	224	-0.44	-0.33	0.046	24
8.50	UL 1703, IEC	1,000 V	type 1	Tariff-free manufacturing countries, varied	Yes	45°C ± 2°C	-0.43 %/°C	-0.3 %/°C	+0.05 %/°C	26
8.55	UL 1703, IEC	1,000 V	type 1	Tariff-free manufacturing countries, varied	Yes	45°C ± 2°C	-0.43 %/°C	-0.3 %/°C	+0.05 %/°C	26
8.60	UL 1703, IEC	1,000 V	type 1	Tariff-free manufacturing countries, varied	Yes	45°C ± 2°C	-0.43 %/°C	-0.3 %/°C	+0.05 %/°C	26
8.96	UL 1703, IEC	1,000 V	type 1	Tariff-free manufacturing countries, varied	Yes	45°C ± 2°C	-0.43 %/°C	-0.3 %/°C	+0.05 %/°C	26
9.04	UL 1703, IEC	1,000 V	type 1	Tariff-free manufacturing countries, varied	Yes	45°C ± 2°C	-0.43 %/°C	-0.3 %/°C	+0.05 %/°C	26
9.12	UL 1703, IEC	1,000 V	type 1	Tariff-free manufacturing countries, varied	Yes	45°C ± 2°C	-0.43 %/°C	-0.3 %/°C	+0.05 %/°C	26

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)
Upsolar *(continued)*	UP-M300P	300	267.7	[0,+5W]	15.5%	poly	1,000V	77.0 x 39.1 x 1.97	10	-0.7%	72	45.6
www.upsolar.com	UP-M305P	305	274.3	[0,+5W]	15.7%	poly	1,000V	77.0 x 39.1 x 1.97	10	-0.7%	72	45.8
	UP-M310P	310	279.0	[0,+5W]	16.0%	poly	1,000V	77.0 x 39.1 x 1.97	10	-0.7%	72	46.0
	UP-M310M	310	listed in Q4-2014	[0,+5W]	16.0%	mono	1,000V	77.0 x 39.1 x 1.97	10	-0.7%	72	45.8
	UP-M315M	315	listed in Q4-2014	[0,+5W]	16.2%	mono	1,000V	77.0 x 39.1 x 1.97	10	-0.7%	72	46.1
	UP-M320M	320	listed in Q4-2014	[0,+5W]	16.5%	mono	1,000V	77.0 x 39.1 x 1.97	10	-0.7%	72	46.4
	UP-M250P-T	250	222.3	[0,+5W]	15.4%	poly	1,000V	64.6 x 39.1 x 1.57	10	-0.7%	60	32.4
	UP-M255P-T	255	231.3	[0,+5W]	15.7%	poly	1,000V	64.6 x 39.1 x 1.57	10	-0.7%	60	32.6
	UP-M260P-T	260	236.0	[0,+5W]	16.0%	poly	1,000V	64.6 x 39.1 x 1.57	10	-0.7%	60	32.9
	UP-M300P-T	300	267.7	[0,+5W]	15.5%	poly	1,000V	77.0 x 39.1 x 1.97	10	-0.7%	72	38.1
	UP-M305P-T	305	274.3	[0,+5W]	15.7%	poly	1,000V	77.0 x 39.1 x 1.97	10	-0.7%	72	38.3
	UP-M310P-T	310	279.0	[0,+5W]	16.0%	poly	1,000V	77.0 x 39.1 x 1.97	10	-0.7%	72	38.5
Vikram Solar *vikramsolar.com*	Eldora VSP. 60.250.03	250	232.50	-0/4.99	15.37	Poly	1000, Yes	1640mm x 992mm x 40mm	10	25 (90% at 12 years, 80% at 25 years)	60	37.45
WINAICO	WST-250P6	250	229.6	0~+5W	15.06	poly	1000 V	65.55 x 39.33 x 1.38 in	25	0.7%	60	37.52
www.winaico.com	WST-255P6	255	234.3	0~+5W	15.35	poly	1000 V	65.55 x 39.33 x 1.38 in	25	0.7%	60	37.72
	WST-260P6	260	239.0	0~+5W	15.65	poly	1000 V	65.55 x 39.33 x 1.38 in	25	0.7%	60	37.92

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
	8.66	UL 1703, IEC	1,000 V	type 1	Tariff-free manufacturing countries, varied	Yes	45°C ± 2°C	-0.43 %/°C	-0.3 %/°C	+0.05 %/°C	20
	8.74	UL 1703, IEC	1,000 V	type 1	Tariff-free manufacturing countries, varied	Yes	45°C ± 2°C	-0.43 %/°C	-0.3 %/°C	+0.05 %/°C	20
	8.82	UL 1703, IEC	1,000 V	type 1	Tariff-free manufacturing countries, varied	Yes	45°C ± 2°C	-0.43 %/°C	-0.3 %/°C	+0.05 %/°C	20
	8.96	UL 1703, IEC	1,000 V	type 1	Tariff-free manufacturing countries, varied	Yes	45°C ± 2°C	-0.43 %/°C	-0.3 %/°C	+0.05 %/°C	20
	9.04	UL 1703, IEC	1,000 V	type 1	Tariff-free manufacturing countries, varied	Yes	45°C ± 2°C	-0.43 %/°C	-0.3 %/°C	+0.05 %/°C	20
	9.12	UL 1703, IEC	1,000 V	type 1	Tariff-free manufacturing countries, varied	Yes	45°C ± 2°C	-0.43 %/°C	-0.3 %/°C	+0.05 %/°C	20
	8.50	UL 1703, IEC	1,000 V	type 1	Tariff-free manufacturing countries, varied	Yes	45°C ± 2°C	-0.43 %/°C	-0.3 %/°C	+0.05 %/°C	26
	8.55	UL 1703, IEC	1,000 V	type 1	Tariff-free manufacturing countries, varied	Yes	45°C ± 2°C	-0.43 %/°C	-0.3 %/°C	+0.05 %/°C	26
	8.60	UL 1703, IEC	1,000 V	type 1	Tariff-free manufacturing countries, varied	Yes	45°C ± 2°C	-0.43 %/°C	-0.3 %/°C	+0.05 %/°C	26
	8.66	UL 1703, IEC	1,000 V	type 1	Tariff-free manufacturing countries, varied	Yes	45°C ± 2°C	-0.43 %/°C	-0.3 %/°C	+0.05 %/°C	20
	8.74	UL 1703, IEC	1,000 V	type 1	Tariff-free manufacturing countries, varied	Yes	45°C ± 2°C	-0.43 %/°C	-0.3 %/°C	+0.05 %/°C	20
	8.82	UL 1703, IEC	1,000 V	type 1	Tariff-free manufacturing countries, varied	Yes	45°C ± 2°C	-0.43 %/°C	-0.3 %/°C	+0.05 %/°C	20
	8.70	UL 1703, CEC	1000	Flat-Plate Photovoltaic Modules and Panels, ULC ORD/ C1703-01	India	Yes	45°	-0.41 % /°C	-0.31 % /°C	0.058 % /°C	28
	8.53	UL 1703	1000V	Type 4	Taiwan	Yes	44.7°C	–0.43 %/°C	–0.33 %/°C	0.06 %/°C	27
	8.60	UL 1703	1000V	Type 4	Taiwan	Yes	44.7°C	–0.43 %/°C	–0.33 %/°C	0.06 %/°C	27
	8.67	UL 1703	1000V	Type 4	Taiwan	Yes	44.7°C	–0.43 %/°C	–0.33 %/°C	0.06 %/°C	27

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)	
WINAICO *(continued)*	WSP-260P6	260	239.0	0~+5W	15.65	poly	1000 V	65.55 x 39.33 x 1.57 in	25	0.7%	60	37.92	
www.winaico.com	WSP-260M6 blackline	260	234.9	0~+5W	15.65	Mono	600 V	65.55 x 39.33 x 1.57 in	25	0.7%	60	37.67	
	WSP-265M6 blackline	265	239.6	0~+5W	15.93	Mono	600 V	65.55 x 39.33 x 1.57 in	25	0.7%	60	37.86	
	WSP-270M6 blackline	270	244.2	0~+5W	16.23	Mono	600 V	65.55 x 39.33 x 1.57 in	25	0.7%	60	38.06	
	WSP-275M6 blackline	275	248.9	0~+5W	16.53	Mono	600 V	65.55 x 39.33 x 1.57 in	25	0.7%	60	38.25	
	WSP-280M6 blackline	280	253.5	0~+5W	16.84	Mono	600 V	65.55 x 39.33 x 1.57 in	25	0.7%	60	38.45	
	WSP-285M6 blackline	285	-	0~+5W	17.15	Mono	600 V	65.55 x 39.33 x 1.57 in	25	0.7%	60	38.64	
	WSP-280M6 PERC	280	253.5	0~+5W	16.84	Mono	600 V	65.55 x 39.33 x 1.57 in	25	0.7%	60	38.45	
	WSP-285M6 PERC	285	-	0~+5W	17.15	Mono	600 V	65.55 x 39.33 x 1.57 in	25	0.7%	60	38.64	
	WSP-290M6 PERC	290	-	0~+5W	17.44	Mono	600 V	65.55 x 39.33 x 1.57 in	25	0.7%	60	38.83	
Yingli Solar	YGE-Z 60 Cell Series: YL260P-29b	260	See CEC website for updated PTC ranking	0/+3%	15.9	Poly	1000	64.96in (1650mm) / 38.98in (990mm) / 1.57in (40mm)	10	25	60	37.7 V	
www.yinglisolar.com	YGE-Z 60 Cell Series: YL255P-29b	255	See CEC website for updated PTC ranking	0/+3%	15.6	Poly	1000	64.96in (1650mm) / 38.98in (990mm) / 1.57in (40mm)	10	25	60	37.7 V	
	YGE-Z 60 Cell Series: YL250P-29b	250	See CEC website for updated PTC ranking	0/+3%	15.3	Poly	1000	64.96in (1650mm) / 38.98in (990mm) / 1.57in (40mm)	10	25	60	37.6 V	

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
	8.67	UL 1703	1000V	Type 4	Taiwan	Yes	44.7°C	–0.43 %/°C	–0.33 %/°C	0.06 %/°C	27
	9.05	UL 1703	1000V	Type 4	Taiwan	Yes	44.7°C	–0.44 %/°C	–0.34 %/°C	0.06 %/°C	24
	9.14	UL 1703	1000V	Type 4	Taiwan	Yes	44.7°C	–0.44 %/°C	–0.34 %/°C	0.06 %/°C	24
	9.24	UL 1703	1000V	Type 4	Taiwan	Yes	44.7°C	–0.44 %/°C	–0.34 %/°C	0.06 %/°C	24
	9.34	UL 1703	1000V	Type 4	Taiwan	Yes	44.7°C	–0.44 %/°C	–0.34 %/°C	0.06 %/°C	24
	9.44	UL 1703	1000V	Type 4	Taiwan	Yes	44.7°C	–0.44 %/°C	–0.34 %/°C	0.06 %/°C	24
	9.54	UL 1703	1000V	Type 4	Taiwan	Yes	44.7°C	–0.44 %/°C	–0.34 %/°C	0.06 %/°C	24
	9.44	UL 1703	1000V	Type 4	Taiwan	Yes	44.7°C	–0.4371 %/°C	–0.3094 %/°C	0.0466 %/°C	24
	9.54	UL 1703	1000V	Type 4	Taiwan	Yes	44.7°C	–0.4371 %/°C	–0.3094 %/°C	0.0466 %/°C	24
	9.64	UL 1703	1000V	Type 4	Taiwan	No	44.7°C	–0.4371 %/°C	–0.3094 %/°C	0.0466 %/°C	24
	9.09	UL, IEC	1000	YL260P-29b	China	Yes	46 +/-2	-0.43	-0.32	0.05	26
	9.01	UL, IEC	1000	YL255P-29b	China	Yes	46 +/-2	-0.43	-0.32	0.05	26
	8.92	UL, IEC	1000	YL250P-29b	China	Yes	46 +/-2	-0.43	-0.32	0.05	26

U.S. Solar Panel Models

Silicon & Thin-Film Solar Modules

MANUFACTURER	MODEL	STC POWER, (W)	CEC PTC POWER, (W)	STC POWER TOLERANCE, -/+, (W)	STC MODULE EFFICIENCY, %	CELL TYPE (POLY/ MONO)	MAX SYSTEM VOLTAGE LISTED TO UL1703, (VDC)	DIMENSIONS, LXWXD, (IN.)	MATERIALS WARRANTY, (YR)	POWER WARRANTY, (% @ YR)	NUMBER OF CELLS	VOC (-31%/K)
Yingli Solar *(continued)*	YGE-Z 60 Cell Series: YL245P-29b	245	See CEC website for updated PTC ranking	0/+3%	15.0	Poly	1000	64.96in (1650mm) / 38.98in (990mm) / 1.57in (40mm)	10	25	60	37.5 V
www.yinglisolar.com	YGE-Z 60 Cell Series: YL240P-29b	240	See CEC website for updated PTC ranking	0/+3%	14.7	Poly	1000	64.96in (1650mm) / 38.98in (990mm) / 1.57in (40mm)	10	25	60	37.5 V

Solar Hot Water

COMPANY	MODEL	EVACUATED TUBE OR FLAT-PLATE COLLECTOR	INTENDED USE	APPLICABLE SYSTEM DESIGN	PEAK OUTPUT
Apricus *www.apricus.com*	ETC-30	Evacuated Tube	Residential, Multi-Family and Commercial	Drainback, forced circulation, steamback, closed loop, direct flow, pre-heat, etc.	1,944 W / 6,632 Btu/hr
Stiebel Eltron	SOL 27 Premium S	Flat-Plate	Residential, Multi-Family and Commercial	Closed-loop glycol forced circulation	2 Kw
www.stiebel-eltron-usa.com	SOL 27 Premium W	Flat-Plate	Residential, Multi-Family and Commercial	Closed-loop glycol forced circulation	2 Kw
SunEarth	Empire Series	Flat-Plate	Residential, Multi-Family and Commercial	Glycol forced circulation, drainback, open-loop, etc.	55,624 BTU's Per Day
sunearthinc.com	ThermoRay Series	Flat-Plate	Residential, Multi-Family and Commercial	Glycol forced circulation, drainback, open-loop, etc.	60,163 BTU's Per Day
	SunBelt	Flat-Plate	Residential	Glycol forced circulation, drainback, open-loop, etc.	54,601 BTU's Per Day
Sunvelope Solar	FPE-21	Glazed Flat-Plate	Any application	Open loop, even in freezing areas	29,000 BTU/panel/day
www.sunvelope.com	FPE-30	Glazed Flat-Plate	Any application	Open loop, even in freezing areas	41,500BTU/day/panel

	ISC (0.03%/K)	CERTIFICATION	IEC SYSTEM VOLTAGE	MODULE TYPE (PER UL1703)	MANUFACTURING LOCATION(S) AS LISTED ON MODULE	3RD PARTY VERIFIED PAN FILES (YES/NO)	NOMINAL OPERATING CELL TEMPERATURE (NOCT) 44°C (±2°C)	TEMP. COEFFICIENT OF PMAX	TEMP. COEFFICIENT OF VOC	TEMP. COEFFICIENT OF ISC	# MODULES IN A BOX/ PALLET
	8.83	UL, IEC	1000	YL245P-29b	China	Yes	46 +/-2	-0.43	-0.32	0.05	26
	8.75	UL, IEC	1000	YL240P-29b	China	Yes	46 +/-2	-0.43	-0.32	0.05	26

	DIMENSIONS	MOUNTING HARDWARE INCLUDED?	WARRANTY	CERTIFICATIONS
	2.0 m x 2.2 m (78.9" x 86.4")	Standard flush mount frame	10-yr tubes and heat pipes, 15 yr manifolds and frames	SRCC OG-100 and OG-300, CSA
	2171 mm x 1171 mm	Mounting hardware is sold separately	10 years	SRCC, Keymark, CSA
	2171 mm x 1171 mm	Mounting hardware is sold separately	10 years	SRCC, Keymark, CSA
	4' x 10'	No	10 years	OG-100
	4' x 10'	No	10 years	OG-100
	4' x 10'	No	10 years	OG-100
	3' x 7'	Yes	10 years	SRCC 10001919
	3' x 10'	Yes	10 years	SRCC 10001928

U.S. Solar Panel Models

Integrated Solar Modules

MODULE MANUFACTURER	MODEL/PRODUCT NAME	MICROINVERTER/ OPTIMIZER MANUFACTURER	NOMINAL OUTPUT (WP)	NOMINAL VOLTAGE (V)	NOMINAL CURRENT (A)	
Andalay Solar	AX-250-0-1-DC4-0-B	Enphase Energy	215 Wp	240 V	8.52 A	
andalaysolar.com						
Axitec USA	AXIplus SE (Poly)	SolarEdge	250	31.45	8.65	
www.axitecsolar.us	AXIplus SE black (Mono) All Black	SolarEdge	250	29.65	8.47	
	AXIplus Tigo (Poly)	Tigo Energy	250	27.85	8.29	
	AXIplus Tigo black (Mono) All Black	Tigo Energy	250	26.05	8.11	
Canadian Solar	Residential AC CS6P-250M	Confidential	250W	30.4V	8.22A	
www.canadiansolar.com	Residential AC CS6P-255M	Confidential	255W	30.5V	8.35A	
	Residential AC CS6P-260M	Confidential	260W	30.7V	8.48A	
	Residential AC with Quartech CS6P-250P	Confidential	250W	30.1V	8.30A	
	Residential AC with Quartech CS6P-255P	Confidential	255W	30.2V	8.43A	
	Residential AC with Quartech CS6P-260P	Confidential	260W	30.3V	8.60A	
ET Solar	(ET-P672310WW * ET-P672310WB)/Cell Optimizer Module	Maxim DC Optimizer	310	37.71	8.23	
www.etsolar.com	(ET-P672305WW * ET-P672305WB)/Cell Optimizer Module	Maxim DC Optimizer	305	37.18	8.21	
	(ET-P672300WW * ET-P672300WB)/Cell Optimizer Module	Maxim DC Optimizer	300	36.68	8.18	
	(ET-P660260WW * ET-P660260WB)/Cell Optimizer Module	Maxim DC Optimizer	260	31.48	8.26	
	(ET-P660255WW * ET-P660255WB)/Cell Optimizer Module	Maxim DC Optimizer	255	30.91	8.25	
	ET-P660255BB/Cell Optimizer Module	Maxim DC Optimizer	255	30.91	8.25	
	(ET-P660250WW * ET-P660250WB)/Cell Optimizer Module	Maxim DC Optimizer	250	30.34	8.24	
	(ET-P660260WBZAC * ET-P660260WBAC)/ET AC Module	SolarBridge Technologies	260	31.48	8.26	
	ET-P660250WBZAC * ET-P660250WBAC)/ET AC Module	SolarBridge Technologies	250	30.34	8.24	
	(ET-P660250BBZAC* ET-P660250BBAC)/ET AC Module	SolarBridge Technologies	250	30.34	8.24	
JA Solar	JAP6(TG)-60	Tigo Energy	See mfg data sheet	See mfg data sheet	See mfg data sheet	
www.jasolar.com	JAP6(SE)-60	SolarEdge	See mfg data sheet	See mfg data sheet	See mfg data sheet	
Jinko Solar	JKMS270P-60	Tigo Energy	270	31.7	8.52	
www.jinkosolar.com	JKMS315P-72	Tigo Energy	315	37.2	8.48	

	MODULE EFFICIENCY (%)	MODULES PER CONTAINER	CONTAINER SIZE	DEGREES C	YEARS	LB
	15.7	20 modules/pallet	540	44.944°C ±1°	25	51.6
	15.37	700	40'	-0.33/ 0.06 / -0.47	12	42.99
	15.37	700	40'	-0.32/ 0.04 / -0.40	12	42.99
	15.37	700	40'	-0.33/ 0.06 / -0.49	12	42.99
	15.37	700	40'	-0.32/ 0.04 / -0.40	12	42.99
	15.54%	616	40'	43-47	25	41.4
	15.85%	616	40'	43-47	25	41.4
	16.16%	616	40'	43-47	25	41.4
	15.54%	616	40'	43-47	25	41.4
	15.85%	616	40'	43-47	25	41.4
	16.16%	616	40'	43-47	25	41.4
	15.98	572	40' HQ	NOCT 45.3±2	25	57.98
	15.72	572	40' HQ	NOCT 45.3±2	25	57.98
	15.46	572	40' HQ	NOCT 45.3±2	25	57.98
	15.98	728	40' GP	NOCT 45.3±2	25	41.45
	15.67	728	40' GP	NOCT 45.3±2	25	41.45
	15.67	728	40' GP	NOCT 45.3±2	25	41.45
	15.37	728	40' GP	NOCT 45.3±2	25	41.45
	15.98	616	40' GP	NOCT 45.3±2	25	47.59
	15.37	616	40' GP	NOCT 45.3±2	25	47.59
	15.37	616	40' GP	NOCT 45.3±2	25	47.59
	See mfg data sheet	728	40 inch high	-40-85 °C	25	41.5
	See mfg data sheet	728	40 inch high	-40-85 °C	25	42
	16.5	700	11.8*2.34*2.57	-40°C~+85°C	25	41.9
	16.23	550	11.8*2.34*2.57	-40°C~+85°C	25	58.4

U.S. Solar Panel Models

Integrated Solar Modules

MODULE MANUFACTURER	MODEL/PRODUCT NAME	MICROINVERTER/ OPTIMIZER MANUFACTURER	NOMINAL OUTPUT (WP)	NOMINAL VOLTAGE (V)	NOMINAL CURRENT (A)	
Luxor Solar	Eco Smart Line LX-230P	Tigo Energy	230	29.86	7.71	
www.luxor-solar.com	Eco Smart Line LX-235P	Tigo Energy	235	30.08	7.82	
	Eco Smart Line LX-240P	Tigo Energy	240	30.29	7.93	
	Eco Smart Line LX-245P	Tigo Energy	245	30.5	8.04	
	Eco Smart Line LX-250P	Tigo Energy	250	30.73	8.13	
Mage Solar USA	255 / 6PL US-AC	SolarBridge Technologies	238	208/240	1.14/.99	
www.magesolarusa.com						
Silfab Solar	SSA 260M	Tigo Energy	260	34.2	9.04	
www.silfab.ca	SSA 265M	Tigo Energy	265	34.2	9.11	
	SSA 270M	Tigo Energy	270	34.2	9.22	
	SSA 275M	Tigo Energy	275	34.2	9.32	
	SSA 280M	Tigo Energy	280	34.2	9.4	
	SSA 285M	Tigo Energy	285	34.2	9.47	
	SSA 290M	Tigo Energy	290	34.2	9.54	
	SSG 310M	Tigo Energy	310	40.4	8.99	
	SSG 315M	Tigo Energy	315	40.4	9.05	
	SSG 320M	Tigo Energy	320	40.4	9.15	
	SSG 325M	Tigo Energy	325	40.4	9.25	
	SSG 330M	Tigo Energy	330	40.4	9.32	
	SSG 335M	Tigo Energy	335	40.4	9.37	
	SSG 340M	Tigo Energy	340	40.4	9.45	
	SSA 245P	Tigo Energy	245	32.8	8.65	
	SSA250P	Tigo Energy	250	32.8	8.76	
	SSA255P	Tigo Energy	255	32.8	8.88	
	SSA260P	Tigo Energy	260	32.8	9.01	
	SSA265P	Tigo Energy	265	32.8	9.12	
	SSA270P	Tigo Energy	270	32.8	9.24	
	SSG 295P	Tigo Energy	295	40.1	8.58	
	SSG 300P	Tigo Energy	300	40.1	8.68	
	SSG 305P	Tigo Energy	305	40.1	8.78	
	SSG 310P	Tigo Energy	310	40.1	8.86	
	SSG 315P	Tigo Energy	315	40.1	8.94	
	SSG 315P	Tigo Energy	320	40.1	9.06	
Sunerg Solar	XM60/156 -260I+ VTINT	Tigo Energy	260	37.62	8.77	
www.sunergsolar.com	XM60/156 -265I+ VTINT	Tigo Energy	265	37.86	8.82	

	MODULE EFFICIENCY (%)	MODULES PER CONTAINER	CONTAINER SIZE	DEGREES C	YEARS	LB
	14.14	700	FEU	(NOCT) 47	25 (80%)	39.7
	14.45	700	FEU	(NOCT) 47	25 (80%)	39.7
	14.75	700	FEU	(NOCT) 47	25 (80%)	39.7
	15.06	700	FEU	(NOCT) 47	25 (80%)	39.7
	15.37	700	FEU	(NOCT) 47	25 (80%)	39.7
	95	17	1710 x 1100 x 1060mm	25	30	47
	15.9%	900	52	.-40/85	25	19
	16.2%	900	52	.-40/85	25	19
	16.5%	900	52	.-40/85	25	19
	16.8%	900	52	.-40/85	25	19
	17.1%	900	52	.-40/85	25	19
	17.4%	900	52	.-40/85	25	19
	17.8%	900	52	.-40/85	25	19
	15.9%	660	52	.-40/85	25	23
	16.2%	660	52	.-40/85	25	23
	16.4%	660	52	.-40/85	25	23
	16.7%	660	52	.-40/85	25	23
	16.9%	660	52	.-40/85	25	23
	17.2%	660	52	.-40/85	25	23
	17.4%	660	52	.-40/85	25	23
	15.0%	900	52	.-40/85	25	19
	15.3%	900	52	.-40/85	25	19
	15.6%	900	52	.-40/85	25	19
	15.9%	900	52	.-40/85	25	19
	16.2%	900	52	.-40/85	25	19
	16.5%	900	52	.-40/85	25	19
	15.1%	660	52	.-40/85	25	23
	15.4%	660	52	.-40/85	25	23
	15.6%	660	52	.-40/85	25	23
	15.9%	660	52	.-40/85	25	23
	16.2%	660	52	.-40/85	25	23
	16.4%	660	53	.-40/86	25	23
	15.96	540	40"	46±2 °C	10	49
	16.27	540	40"	46±2 °C	10	49

U.S. Solar Panel Models

Integrated Solar Modules

MODULE MANUFACTURER	MODEL/PRODUCT NAME	MICROINVERTER/ OPTIMIZER MANUFACTURER	NOMINAL OUTPUT (WP)	NOMINAL VOLTAGE (V)	NOMINAL CURRENT (A)	
Sunerg Solar *(continued)*	XM60/156 -270I+ VTINT	Tigo Energy	270	38.16	8.89	
www.sunergsolar.com	XM60/156 -275I+ VTINT	Tigo Energy	275	38.24	8.89	
	XM60/156-250I+35INT	Tigo Energy	250	37.32	8.8	
	XM60/156-255I+35INT	Tigo Energy	255	37.44	8.85	
	XM60/156-260I+35INT	Tigo Energy	260	37.56	8.9	
	XM60/156-265I+35INT	Tigo Energy	265	37.8	9	
	XM60/156-270I+35INT	Tigo Energy	270	37.92	9.05	
	XM60/156-275I+35INT	Tigo Energy	275	38.04	9.1	
	XP60/156-240I+35INT	Tigo Energy	240	37.78	8.52	
	XP60/156-245I+35INT	Tigo Energy	245	36.9	8.56	
	XP60/156-250I+35INT	Tigo Energy	250	37.2	8.64	
	XP60/156-255I+35INT	Tigo Energy	255	37.44	8.7	
	XP60/156-260I+35INT	Tigo Energy	260	37.8	8.76	
	XM60/156-280I35INT	Tigo Energy	280	39.06	9.28	
	XM60/156-285I35INT	Tigo Energy	285	39.3	9.34	
	XM60/156-290I35INT	Tigo Energy	290	39.6	9.43	
	XM60/156-295I35INT	Tigo Energy	295	39.84	9.49	
	XM60/156-300I35INT	Tigo Energy	300	39.90	9.51	
Trina Solar	PA/D05.002	Tigo Energy	245			
www.trinasolar.com	PA/D05.002	Tigo Energy	250			
	PA/D05.002	Tigo Energy	255			
	PA/D05.002	Tigo Energy	260			
	PA/D05.082	Tigo Energy	245			
	PA/D05.082	Tigo Energy	250			
	PA/D05.082	Tigo Energy	255			
	PA/D05.082	Tigo Energy	260			
	PD14.002	Tigo Energy	295			
	PD14.002	Tigo Energy	300			
	PD14.002	Tigo Energy	305			
	PD14.002	Tigo Energy	310			
Upsolar	UP-M250PT	Tigo Energy	250	32.4	8.5	
www.upsolar.com	UP-M255PT	Tigo Energy	255	32.6	8.55	
	UP-M260PT	Tigo Energy	260	32.9	8.6	
	UP-M260MT	Tigo Energy	260	32.2	8.96	
	UP-M265MT	Tigo Energy	265	32.4	9.04	
	UP-M270MT	Tigo Energy	270	32.6	9.12	
	UP-M300PT	Tigo Energy	300	38.1	8.66	
	UP-M305PT	Tigo Energy	305	38.3	8.74	
	UP-M310PT	Tigo Energy	310	38.5	8.82	

	MODULE EFFICIENCY (%)	MODULES PER CONTAINER	CONTAINER SIZE	DEGREES C	YEARS	LB
	16.57	540	40"	46±2 °C	10	49
	16.88	540	40"	46±2 °C	10	49
	15.35	540	40"	46±2 °C	10	40
	15.65	540	40"	46±2 °C	10	40
	15.96	540	40"	46±2 °C	10	40
	16.27	540	40"	46±2 °C	10	40
	16.57	540	40"	46±2 °C	10	40
	16.88	540	40"	46±2 °C	10	40
	14.73	540	40"	46±2 °C	10	40
	15.04	540	40"	46±2 °C	10	40
	15.35	540	40"	46±2 °C	10	40
	15.65	540	40"	46±2 °C	10	40
	15.96	540	40"	46±2 °C	10	40
	17.19	540	40"	46±2 °C	10	40
	17.5	540	40"	46±2 °C	10	40
	17.81	540	40"	46±2 °C	10	40
	18.12	540	40"	46±2 °C	10	40
	18.42	540	40"	46±2 °C	10	40
	15.0	840	40 feet	-0.41	25 years	41.9
	15.3	840	40 feet	-0.41	25 years	41.9
	15.6	840	40 feet	-0.41	25 years	41.9
	15.9	840	40 feet	-0.41	25 years	41.9
	15.0	840	40 feet	-0.41	25 years	41.9
	15.3	840	40 feet	-0.41	25 years	41.9
	15.6	840	40 feet	-0.41	25 years	41.9
	15.9	840	40 feet	-0.41	25 years	41.9
	15.2	840	40 feet	-0.41	25 years	61.7
	15.5	840	40 feet	-0.41	25 years	61.7
	15.7	840	40 feet	-0.41	25 years	61.7
	16.0	840	40 feet	-0.41	25 years	61.7
	15.4%	728	40"	45	25 Years	41.9
	15.7%	728	40"	45	25 Years	41.9
	16.0%	728	40"	45	25 Years	41.9
	16.0%	728	40"	45	25 Years	41.9
	16.3%	728	40"	45	25 Years	41.9
	16.6%	728	40"	45	25 Years	41.9
	15.5%	462	40"	45	25 Years	59.5
	15.7%	462	40"	45	25 Years	59.5
	16.0%	462	40"	45	25 Years	59.5

U.S. Solar Panel Models

Integrated Solar Modules

MODULE MANUFACTURER	MODEL/PRODUCT NAME	MICROINVERTER/ OPTIMIZER MANUFACTURER	NOMINAL OUTPUT (WP)	NOMINAL VOLTAGE (V)	NOMINAL CURRENT (A)	
Upsolar *(continued)*	UP-M250PS	SolarEdge	250	38	8.5	
www.upsolar.com	UP-M255PS	SolarEdge	255	38.2	8.55	
	UP-M260PS	SolarEdge	260	38.4	8.6	
	UP-M260MS	SolarEdge	260	38.3	8.96	
	UP-M265MS	SolarEdge	265	38.6	9.04	
	UP-M270MS	SolarEdge	270	38.9	9.12	
	UP-M300PS	SolarEdge	300	45.6	8.66	
	UP-M305PS	SolarEdge	305	45.8	8.74	
	UP-M310PS	SolarEdge	310	46	8.82	
Yingli	Yingli Smart Power Plus	Tigo Energy	250	32.5	9.5	
www.yinglisolar.com						

	MODULE EFFICIENCY (%)	MODULES PER CONTAINER	CONTAINER SIZE	DEGREES C	YEARS	LB
	15.4%	728	40"	45	25 Years	41.9
	15.7%	728	40"	45	25 Years	41.9
	16.0%	728	40"	45	25 Years	41.9
	16.0%	728	40"	45	25 Years	41.9
	16.3%	728	40"	45	25 Years	41.9
	16.6%	728	40"	45	25 Years	41.9
	15.5%	462	40"	45	25 Years	59.5
	15.7%	462	40"	45	25 Years	59.5
	16.0%	462	40"	45	25 Years	59.5
	15.3	728	40 foot	-125	25	40.8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U.S. Inverter Models

Central Inverters

		Input Characteristics, Central Inverters, DC					Output Characteristics (AC)		
Manufacturer	Model	PV Array Power Range (kWp)	Voltage Range MPPT	Max Voltage DC	Max Current (A)	Number Of DC Inputs	Rated Power (kW)	Max Current (A@V)	
ABB (Power-One)	ULTRA-750-TL-OUTD	1014	585 to 850	1000	1400	10	780	655	
www.abb.com/solarinverters	ULTRA-1100-TL-OUTD	1521	585 to 850	1000	2100	15	1170	982.5	
	ULTRA-1500-TL-OUTD	2028	585 to 850	1000	2800	20	1560	1310	
Advanced Energy	AE 100TX		295 to 595	600	356		100	320@208, 139@480, 111@600	
www.advanced-energy.com	AE 250NX		330 to 550	600	375		250	334@480	
	AE 250TX		295 to 595	600	890		250	304@480, 243@600	
	AE 260TX		295 to 595	600	925		260	“316@480	
	AE 333NX		330 to 550	600	500		333	445@480	
	AE 500NX/ AE 500NX-HE		330 to 550	600	750		500	667@480	
	AE 500NX-1kV		600 to 1000	1000	850		500	700@420	
	AE 500TX		310 to 595	600	1600		500	608@480, 486@600	
	AE 1000NX		550 to 1000	1000	956	Up to 10 pairs	1000	800@800	
AEG Power Solutions	Protect PV.500	500 to 580	500 to 820	1000	1060	8	510	1040@283	
www.aegps.com	Protect PV.630	630 to 945	550 to 820	1000	1170	8	630	1054@345	
	MPV.150.01	150 to 187	300 to 600	600	530	4	150	182	
	MPV.135.01	135 to 169	300 to 600	600	477	4	135	163	
	MPV.120.01	120 to 150	300 to 600	600	424	4	120	145	
	MPV.105.01	105 tp 131	300 to 600	600	371	4	105	127	
	MPV.090.01	90 to 113	300 to 600	600	318	4	90	109	
	MPV.075.01	75 to 94	300 to 600	600	265	4	75	91	
	MPV.060.01	60 to 75	300 to 600	600	212	4	60	72	
	MPV.045.01	45 to 56	300 to 600	600	159	4	45	54	
	MPV.030.01	30 to 38	300 to 600	600	106	4	30	36	
	MPV.015.01	15 to 19	300 to 600	600	53	4	15	18	
AETI	ISIS-1000-410-60	1870 Max	610 to 1100	1100	1700	14	1000	1410	
www.aeti.com	ISIS-1500-410-60	2805 Max	610 to 1100	1100	2550	20	1500	2115	
	ISIS-2000-410-60	3740 Max	610 to 1100	1100	3400	40	2000	2820	
Bonfiglioli	RPS TL-UL 0917	Multi-MPPT	525 to 850	1000	1750	10	917	1600	
www.bonfiglioliusa.com	RPS TL-UL 1001	Multi-MPPT	525 to 850	1000	1900	12	1000	1750	
	RPS TL-UL 1100	Multi-MPPT	525 to 850	1000	2100	12	1100	1920	
	RPS TL-UL 1283	Multi-MPPT	525 to 850	1000	2450	14	1283	2240	

Editor's Note:
Manufacturers were contacted to obtain accurate information for this section. In the event that data was not received through a company representative, information was run from the previous year or obtained through product brochures, data sheets and websites. If further information becomes available we will update online in our ***Inverter Specification Tool*** *available at www.solarpowerworldonline.com, and note for the 2016 print edition.*

Output Characteristics (AC)		Efficiency		General Information					
Rated Voltages (V)	Frequency (Hz)	Peak %	CEC wtd %	Consumption Day (W)	Consumption Night (W)	Operating Temperature Range (°C)	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)
690	50/60	98.7	98	<90	<90	-20 to 60	5	5	<2000
690	50/60	98.7	98	<135	<135	-20 to 60	5	5	<2500
690	50/60	98.7	98	<180	<180	-20 to 60	5	5	<3500
208, 480, 600	60	208: 96.4 480: 97.1 600: 96.4	208: 95.5 480: 96.0 600: 96.0	<42		-40 to 60	10	20	1361
480	60	98.1	97.5		<100	-20 to 50	5	20	927.5
480, 600	60	480: 97.7 600: 97.7	480: 96.5 600: 96.5	<33		-30 to 50	10	20	2268
480	60	97.7	97	<33		-30 to 50	10	20	2268
480	60	98.3	97.5		<100	-20 to 50	5	20	927.5
480	60	98.6 NX/98.7 NX-HE	97.5 NX/ 98 NX-HE		<100	-20 to 50	5	20	1705.5
420	60	98.2	97.5		<100	-20 to 50	5	20	1633
480,600	60	480: 97.8, 600: 97.6	97	<80		-30 to 55	10	20	3968
800	60	98.1	98		<200	-20 to 50	5	20	2472
283V	50/60	98.4	98		100	-20 to 50	5	5	1650
345V	50/60	98.4	98.2		100	-20 to 50	5	5	1650
480	60	97	96.5		60	-20 to 50	5	5	457.674328
480	60	97	96.5		60	-20 to 50	5	5	434.994728
480	60	97	96.5		60	-20 to 50	5	5	411.861536
480	60	97	96.5		60	-20 to 50	5	5	389.181936
480	60	97	96.5		60	-20 to 50	5	5	366.048744
480	60	97	96.5		60	-20 to 50	5	5	286.216552
480	60	97	96.5		60	-20 to 50	5	5	263.08336
480	60	97	96.5		60	-20 to 50	5	5	240.40376
480	60	97	96.5		60	-20 to 50	5	5	217.270568
480	60	97	96.5		60	-20 to 50	5	5	194.590968
410	60	98	96.5	300 to 3500	<300	-20 to 55	5	20	10251
410	60	98	96.5	300 to 3500	<300	-20 to 55	5	20	13063
410	60	98	96.5	300 to 3500	<300	-20 to 55	5	20	26126
330	60	98.6	98	100		-20 to 55	5	5	3000
330	60	98.6	98	120		-20 to 55	5	5	3550
330	60	98.6	98	120		-20 to 55	5	5	3550
330	60	98.6	98	140		-20 to 55	5	5	4100

U.S. Inverter Models

Central Inverters

		Input Characteristics, Central Inverters, DC					Output Characteristics (AC)		
Manufacturer	Model	PV Array Power Range (kWp)	Voltage Range MPPT	Max Voltage DC	Max Current (A)	Number Of DC Inputs	Rated Power (kW)	Max Current (A@V)	
Bonfiglioli *(continued)*	RPS TL-UL 0400	Multi-MPPT/Master Slave	550 to 850	1000	700	4 or 8	400	640	
www.bonfiglioliusa.com	RPS TL-UL 0500	Multi-MPPT/Master Slave	550 to 850	1000	875	6	500	800	
	RPS TL-UL 0367	Multi-MPPT/Master Slave	525 to 850	1000	700	4 or 8	367	640	
	RPS TL-UL 0501	Multi-MPPT/Master Slave	525 to 850	1000	950	6 or 12	500	875	
	RPS TL-UL 0550	Multi-MPPT/Master Slave	525 to 850	1000	1050	6 or 12	550	960	
	RPS TL-UL 0733	Multi-MPPT/Master Slave	525 to 850	1000	1400	8 or 16	733	1280	
	RPS TL-UL 0600	Multi-MPPT/Master Slave	550 to 850	1000	1050	6 or 12	600	960	
	RPS TL-UL 0750	Multi-MPPT/Master Slave	550 to 850	1000	1300	8 or 16	750	1200	
	RPS TL-UL 0800	Multi-MPPT/Master Slave	550 to 850	1000	1400	8 or 16	800	1280	
	RPS TL-UL 1000	Multi-MPPT	550 to 850	1000	1750	10	1000	1600	
	RPS TL-UL 1200	Multi-MPPT	550 to 850	1000	2100	12	1200	1920	
	RPS TL-UL 1400	Multi-MPPT	550 to 850	1000	2450	14	1400	2240	
Chint Power	CPS SC100KT-O/US-480	135	300 to 600	600	350	4	100	120	
www.chintpower.com	CPS SCA500KTL-H/US	650	450 to 850	1000	1200	8	500	1070	
Eaton	Power Xpert Solar 1500	1500	550 to 1000	1000	3100	Up to 24	1500kW / 1650kVA	3000	
www.eaton.com/powerxpertsolar	Power Xpert Solar 1670	1670	550 to 1000	1000	3100	Up to 24	1666kW / 1830kVA	3000	
Fronius USA	CL 33.3 Delta	28.3 to 39	230 to 500	600	154.0	1 pole each for DC + & DC, up to 3 lug-terminated wires	33.3	92.4@208, 80.1@240	
www.fronius-usa.com	36.0 WYE277	30.6 to 42.1	230 to 500	600	166.5	1 pole each for DC + & DC, up to 3 lug-terminated wires	36.0	43.3 @277	
	44.4 Delta	37.8 to 52	230 to 500	600	205.4	1 pole each for DC + & DC, up to 3 lug-terminated wires	44.4	123.2@208, 106.8@240	
	48.0 WYE277	40.8 to 56.2	230 to 500	600	222.0	1 pole each for DC + & DC, up to 3 lug-terminated wires	48.0	57.8@277	

Output Characteristics (AC)		Efficiency		General Information					
Rated Voltages (V)	Frequency (Hz)	Peak %	CEC wtd %	Consumption Day (W)	Consumption Night (W)	Operating Temperature Range (°C)	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)
360	60	98.6	98	40		-20 to 55	5	5	1300/1550
360	60	98.6	98	60		-20 to 55	5	5	1850/2150
330	60	98.6	98	40		-20 to 55	5	5	1300/1500
330	60	98.6	98	60		-20 to 55	5	5	1850/2150
330	60	98.6	98	60		-20 to 55	5	5	1850/2150
330	60	98.6	98	80		-20 to 55	5	5	2450/2700
360	60	98.6	98	60		-20 to 55	5	5	1850/2150
360	60	98.6	98	80		-20 to 55	5	5	2450/2700
360	60	98.6	98	80		-20 to 55	5	5	2450/2700
360	60	98.6	98	100		-20 to 55	5	5	3000
360	60	98.6	98	120		-20 to 55	5	5	3550
360	60	98.6	98	140		-20 to 55	5	5	4100
480	60	96.8	96	<50	<40	-20 to 60	5	20	900
315	60	98.5	98	<100	<40	-20 to 60	5	20	1600
320V	60	98.6%	98		332.5	-20 to 50	5	10	12500
357V	60	98.70%	98.5		334.42	-20 to 50	5	10	12500
208, 240	60	95.9	94.5, 95.0	65	<5	(-25°C - +50°C)	5	15	661
277	60	95.9	95.5	65	<5	(-25°C - +50°C)	5	15	661
208, 240	60	95.9	94.5, 95.0	65	<5	(-25°C - +50°C)	5	15	721
277	60	95.9	95.5	65	<5	(-25°C - +50°C)	5	15	721

U.S. Inverter Models

Central Inverters

		Input Characteristics, Central Inverters, DC					Output Characteristics (AC)		
Manufacturer	Model	PV Array Power Range (kWp)	Voltage Range MPPT	Max Voltage DC	Max Current (A)	Number Of DC Inputs	Rated Power (kW)	Max Current (A@V)	
Fronius USA *(continued)*	55.5 Delta	47.2 to 65	230 to 500	600	256.7	1 pole each for DC + & DC, up to 3 lug-terminated wires	55.5	154@208, 133.5@240	
www.fronius-usa.com	60.0 WYE277	51.0 to 70.2	230 to 500	600	277.5	1 pole each for DC + & DC, up to 3 lug-terminated wires	60.0	72.2	
Ideal Power Converters	IPV-30kW-480	25 to 36	+/-100 to +/-450	+/-600	50	2	30	37	
www.idealpower.com									
Ingeteam	IS 100 U 208/480	106.5 to 138.3	300 to 550	600	350	4	100	316 (480:137)	
www.ingeteam.com	IS 125 U 208/480	128.5 to 167.1 (480: 129.2 to 168)	330 to 820	1000	390	4	125	347 (480: 150)	
	IS 125TL U 208	127.1 to 167.7	330 to 820	1000	390	4	125	347	
	IS 165TL U 275	167.4 to 221	440 to 820	1000	390	4	165	346	
	IS 200TL U 330	202.7 to 267.8	525 to 820	1000	390	4	200	350	
	IS 220TL U 360	222.9 to 294.5	570 to 820	1000	390	4	220	353	
	IS 250TL U X208	254.7 to 334.4	350 to 820	1000	780	8	250	694	
	IS 375TL U X208	382.1 to 502.1	350 to 820	1000	1170	12	375	1041	
	IS 500TL U X208	509.5 to 669.5	350 to 850	1000	1560	16	500	1388	
	IS 500TL U X275	508.4 to 669.5	460 to 820	1000	1170	12	500	1050	
	IS 330TL U X275	335.5 to 441.9	460 to 820	1000	780	8	330	693	
	IS 660TL U X275	671.1 to 897.1	460 to 820	1000	1560	16	660	1386	
	IS 660TL U X360	670 to 884	606 to 820	1000	1170	12	660	1058	
	IS 400TL U X330	406.1 to 535.6	550 to 820	1000	780	8	400	700	
	IS 600TL U X330	609.2 to 803.4	550 to 820	1000	1170	12	600	1050	
	IS 800TL U X330	812 to 1071.2	550 to 820	1000	1560	16	800	1400	
	IS 440TL U X360	446.7 to 589.2	606 to 820	1000	780	8	440	706	

Output Characteristics (AC)		Efficiency		General Information					
Rated Voltages (V)	Frequency (Hz)	Peak %	CEC wtd %	Consumption Day (W)	Consumption Night (W)	Operating Temperature Range (°C)	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)
208, 240	60	95.9	94.5, 95.0	65	<5	(-25°C - +50°C)	5	15	783
277	60	95.9	95.5	65	<5	(-25°C - +50°C)	5	15	783
480	60	96.7	96.5	10	10	-24 to 45	10	10	43
3x208 (480: 3x480)	60	95.3 (480: 95.2)	94.5	30	1	-15 to 55	10	20	2561
208 (480: 480)	60	98.4 (480: 97.3)	96.5	30	1	-20 to 65	10	20	2645
208 V IT System	60	98.4	97.5	30	1	-20 to 65	10	20	1435
275 V IT System	60	98.6	98	30	1	-20 to 65	10	20	1435
330 V IT System	60	98.7	98.5	30	1	-20 to 65	10	20	1435
360 V IT System	60	98.7	98.5	30	1	-20 to 65	10	20	1435
208 V IT System	60	98.1	97.5	60	60	-20 to 65	10	20	3307
208 V IT System	60	98.1	97.5	90	90	-20 to 65	10	20	4520
208 V IT System	60	98.1	97.5	120	120	-20 to 65	10	20	5950
275 V IT System	60	98.3	98	90	90	-20 to 65	10	20	4520
275 V IT System	60	98.3	98	60	60	-20 to 65	10	20	3307
275 V IT System	60	98.3	98	120	120	-20 to 65	10	20	5950
360 V IT System	60	98.5	98.5	90	90	-20 to 65	10	20	4520
330 V IT System	60	98.5	98	60	60	-20 to 65	10	20	3307
330 V IT System	60	98.5	98	90	90	-20 to 65	10	20	4520
330 V IT System	60	98.5	98	120	120	-20 to 65	10	20	5950
360 V IT System	60	98.5	98.5	60	60	-20 to 65	10	20	3307

U.S. Inverter Models

Central Inverters

		Input Characteristics, Central Inverters, DC					Output Characteristics (AC)		
Manufacturer	Model	PV Array Power Range (kWp)	Voltage Range MPPT	Max Voltage DC	Max Current (A)	Number Of DC Inputs	Rated Power (kW)	Max Current (A@V)	
Ingeteam *(continued)*	IS 880TL U X360	892.6 to 1178.3	606 to 820	1000	1560	16	880	1411	
www.ingeteam.com	IS 500TL U X400	446.7 to 589.2	578 to 820	1000	900	8	510	736	
	IS 750TL U X400	670 to 884	578 to 820	1000	1350	12	765	1104	
	IS 1000TL U X400	892.6 to 1,178.3	578 to 820	1000	1800	16	1020	1472	
	IS 1000TL U B400	1,021 to 1,327.3	578 to 820	1000	1800	12	1005	1450	
	IS 250T U X480	257.3 to 334.4	350 to 820	1000	780	8	250	301	
	IS 375T U X480	385.9 to 502.1	350 to 820	1000	1170	12	375	451	
	IS 500T U X480	514.6 to 669.5	350 to 820	1000	1560	16	500	601	
Nextronex	Ray Max 150	150 kW thru 2000 kW	300 V to 850 V DC	1000	3000	Up to 24	150 kW thru 1800 kW	2880 A @390 V	
nextronex.com									
Parker Hannifin	890GT-S-1250		440-1000	1000	3100	12-16	1250	2750	
www.parker.com/gridtie	890GT-S-1500		500-1000	1000	3100	12-16	1500	2750	
	890GT-S-1600		545-1000	1000	3100	12-16	1600	2750	
	890GT-S-1700		575-1000	1000	3100	12-16	1700	2750	
	890GT-S-1750		585-1000	1000	3100	12-16	1750	2750	
	890GT-S-1950		640-1000	1000	3100	12-16	1950	2750	
Power Electronics	FREESUN HEC-UL FS0160CU	190	330 to 600	600	500	8	160 kW	488,4	
www.power-electronics.com	FREESUN HEC-UL FS0240CU	290	330 to 600	600	750	12	240 kW	732,6	
	FREESUN HEC-UL FS0320CU	380	330 to 600	600	1000	16	320 kW	976,8	
	FREESUN HEC-UL FS0400CU	480	330 to 600	600	1250	20	400 kW	1221	
	FREESUN HEC-UL FS0480CU	580	330 to 600	600	1500	24	480 kW	1465,2	
	FREESUN HEC-UL FS0560CU	670	330 to 600	600	1750	28	560 kW	1709,4	
	FREESUN HEC-UL FS0640CU	770	330 to 600	600	2000	32	640 kW	1953,6	
	FREESUN HEC-UL FS0250CU	300	500 to 820	1000	500	8	250 kW	481,8	
	FREESUN HEC-UL FS0380CU	450	500 to 820	1000	750	12	380 kW	721,6	
	FREESUN HEC-UL FS0501CU	600	500 to 820	1000	1000	16	500 kW	962,5	

Output Characteristics (AC)		Efficiency		General Information					
Rated Voltages (V)	Frequency (Hz)	Peak %	CEC wtd %	Consumption Day (W)	Consumption Night (W)	Operating Temperature Range (°C)	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)
360 V IT System	60	98.6	98.5	120	120	-20 to 65	10	20	5950
400 V IT System	60	98.5	98.5	60	60	-20 to 65	10	20	3307
400 V IT System	60	98.5	98.5	90	90	-20 to 65	10	20	4520
400 V IT System	60	98.6	98.5	120	120	-20 to 65	10	20	5950
400 V IT System	60	98.9	98.8	60	60	-20 to 65	10	20	4850
480	60	97.2	96.5	60	60	-20 to 65	10	20	2645+3307
480	60	97.2	96.5	90	90	-20 to 65	10	20	3527+4520
480	60	97.2	96.5	120	120	-20 to 65	10	20	4410+5950
390 V to 430 V 3 Phase	50 or 60 Hz	98%	97%	400 W minimum	None	full power to 45 C	10	20	950 lb minimum
270	50/60	98.1	97.6		<150	-20 (-40 opt) to 55	5	Upgradable	8820
315	50/60	98.4	98		<150	-20 (-40 opt) to 55	5	Upgradable	8820
342	50/60	98.5	98.1		<150	-20 (-40 opt) to 55	5	Upgradable	8820
360	50/60	98.6	98.2		<150	-20 (-40 opt) to 55	5	Upgradable	8820
370	50/60	98.6	98.3		<150	-20 (-40 opt) to 55	5	Upgradable	8820
415	50/60	98.7	98.4		<150	-20 (-40 opt) to 55	5	Upgradable	8820
208	60	98.6	97.5	920	<80	-20 to 50	5	25	3800
208	60	98.6	97.5	1380	<120	-20 to 50	5	25	6130
208	60	98.6	97.5	1840	<160	-20 to 50	5	25	6130
208	60	98.6	97.5	2300	<200	-20 to 50	5	25	8500
208	60	98.6	97.5	2760	<240	-20 to 50	5	25	8500
208	60	98.6	97.5	3220	<280	-20 to 50	5	25	10800
208	60	98.6	97.5	3680	<320	-20 to 50	5	25	10800
330	60	98.6	98	920	<80	-20 to 50	5	25	3800
330	60	98.6	98	1380	<120	-20 to 50	5	25	6130
330	60	98.6	98	1840	<160	-20 to 50	5	25	6130

U.S. Inverter Models

Central Inverters

		Input Characteristics, Central Inverters, DC					Output Characteristics (AC)		
Manufacturer	Model	PV Array Power Range (kWp)	Voltage Range MPPT	Max Voltage DC	Max Current (A)	Number Of DC Inputs	Rated Power (kW)	Max Current (A@V)	
Power Electronics *(continued)*	FREESUN HEC-UL FS0630CU	750	500 to 820	1000	1250	20	630 kW	1203,4	
www.power-electronics.com	FREESUN HEC-UL FS0750CU	900	500 to 820	1000	1500	24	750 kW	1444,3	
	FREESUN HEC-UL FS0880CU	1050	500 to 820	1000	1750	28	880 kW	1685,2	
	FREESUN HEC-UL FS1001CU	1200	500 to 820	1000	2000	32	1000 kW	1925	
	FREESUN HEC-UL FS0280CU	330	540 to 820	1000	500	8	280 kW	488,4	
	FREESUN HEC-UL FS0420CU	500	540 to 820	1000	750	12	420 kW	733,7	
	FREESUN HEC-UL FS0560CU	670	540 to 820	1000	1000	16	560 kW	977,9	
	FREESUN HEC-UL FS0701CU	830	540 to 820	1000	1250	20	700 kW	1222,1	
	FREESUN HEC-UL FS0830CU	1000	540 to 820	1000	1500	24	830 kW	1466,3	
	FREESUN HEC-UL FS0970CU	1170	540 to 820	1000	1750	28	970 kW	1710,5	
	FREESUN HEC-UL FS1110CU	1330	540 to 820	1000	2000	32	1110 kW	1955,8	
	FREESUN HEC-UL FS0300CU	360	585 to 820	1000	500	8	300 kW	488,4	
	FREESUN HEC-UL FS0450CU	540	585 to 820	1000	750	12	450 kW	732,6	
	FREESUN HEC-UL FS0600CU	720	585 to 820	1000	1000	16	600 kW	976,8	
	FREESUN HEC-UL FS0751CU	900	585 to 820	1000	1250	20	751 kW	1221	
	FREESUN HEC-UL FS0900CU	1080	585 to 820	1000	1500	24	900 kW	1465,2	
	FREESUN HEC-UL FS1050CU	1260	585 to 820	1000	1750	28	1050 kW	1709,4	
	FREESUN HEC-UL FS1200CU	1440	585 to 820	1000	2000	32	1200 kW	1953,6	
	FREESUN HEC-UL FS1250CU	1440	585 to 820	1000	2000	32	1250 kW	1953,6	
	FREESUN HEK-FS1200PU	1440	520 to 820	1000	2000	8	1200	1776	
	FREESUN HEK-2(FS0751PU)	1800	520 to 820	1000	2500	16	1500	2x1110	
	FREESUN HEK-2(FS0830PU)	1992	520 to 820	1000	3000	16	1660	2x1333	
	FREESUN HEK-2(FS1000PU)	2400	520 to 820	1000	4000	16	2000	2x1750	
	FREESUN HEK-2(FS1200PU)	2880	520 to 820	1000	4000	16	2400	2x1776	
	FREESUN HEK-2(FS1250PU)	2500	520 to 820	1000	4000	16	2500	2x1850	

Output Characteristics (AC)		Efficiency		General Information					
	Rated Voltages (V)	Frequency (Hz)	Peak %	CEC wtd %	Consumption Day (W)	Consumption Night (W)	Operating Temperature Range (°C)	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)
	330	60	98.6	98	2300	<200	-20 to 50	5	25	8500
	330	60	98.6	98	2760	<240	-20 to 50	5	25	8500
	330	60	98.6	98	3220	<280	-20 to 50	5	25	10800
	330	60	98.6	98	3680	<320	-20 to 50	5	25	10800
	360	60	98.6	98	920	<80	-20 to 50	5	25	3800
	360	60	98.6	98	1380	<120	-20 to 50	5	25	6130
	360	60	98.6	98	1840	<160	-20 to 50	5	25	6130
	360	60	98.6	98	2300	<200	-20 to 50	5	25	8500
	360	60	98.6	98	2760	<240	-20 to 50	5	25	8500
	360	60	98.6	98	3220	<280	-20 to 50	5	25	10800
	360	60	98.6	98	3680	<320	-20 to 50	5	25	10800
	390	60	98.6	98	920	<80	-20 to 50	5	25	3800
	390	60	98.6	98	1380	<120	-20 to 50	5	25	6130
	390	60	98.6	98	1840	<160	-20 to 50	5	25	6130
	390	60	98.6	98	2300	<200	-20 to 50	5	25	8500
	390	60	98.6	98	2760	<240	-20 to 50	5	25	8500
	390	60	98.6	98	3220	<280	-20 to 50	5	25	10800
	390	60	98.6	98	3680	<320	-20 to 50	5	25	10800
	390	60	98.6	98	3680	<320	-20 to 50	5	25	10800
	390	60					-20 to 50	5	25	30000
	390	60					-20 to 50	5	25	45000-51500
	360	60					-20 to 50	5	25	45000-51500
	330	60					-20 to 50	5	25	45000-51500
	390	60					-20 to 50	5	25	45000-51500
	390	60					-20 to 50	5	25	45000-51500

U.S. Inverter Models

Central Inverters

		Input Characteristics, Central Inverters, DC					Output Characteristics (AC)		
Manufacturer	Model	PV Array Power Range (kWp)	Voltage Range MPPT	Max Voltage DC	Max Current (A)	Number Of DC Inputs	Rated Power (kW)	Max Current (A@V)	
Santerno	TG100 208/480/600 NA		315 to 600	600	381	up to 4 per pole (fuse protected)	100	315/137/109	
www.santerno.com	TG125 208/480/600 NA		315 to 600	600	432	up to 4 per pole (fuse protected)	125	347/151/121	
	TG760 600V TL NA - 215		330 to 600	600	2000	10 + 10 (fuse protected)	500	1343	
	TG760 1000V TL NA - 320/340/360/380		495, 820/ 525, 820/550, 820/580, 820	1000	2000	10 + 10 (fuse protected)	711/756/ 800/844	1283	
Satcon	PowerGate Plus PVS-30			600	104	6	30		
www.satcon.com	PowerGate Plus PVS-50			600	172	6	50		
	PowerGate Plus PVS-50S			600	198	6	50		
	PowerGate Plus PVS-75			600	248	6	75		
	PowerGate Plus PVS-100			600	331	6	100		
	PowerGate Plus PVS-110S			600	440	9	110		
	PowerGate Plus PVS-135			600	454	9	135		
	PowerGate Plus PVS-210			600	830	15	210		
	PowerGate Plus PVS-250			600	814	15	250		
	PowerGate Plus PVS-375			600	1277	24	375		
	PowerGate Plus PVS-500			600	1628	30	500		
	PowerGate Plus PVS-1000			900	2442	40	1000		
	PowerGate Plus_CE PVS-100CE			900	248	4	100		
	PowerGate Plus_CE PVS-250CE			900	620	12	250		
	PowerGate Plus_CE PVS-500CE			900	1228	20	500		
	PowerGate Plus_CE PVS-625CE			900	1250	20	625		
	PowerGate Plus_CE PVS-1000CE			900	2442	40	1000		
	Equinox EQX-625			1000	1240	24	625		
	Equinox EQX-500CE			900	1228	20	500		
	Equinox EQX-625CE			1000	1240	24	625		

Output Characteristics (AC)		Efficiency		General Information					
Rated Voltages (V)	Frequency (Hz)	Peak %	CEC wtd %	Consumption Day (W)	Consumption Night (W)	Operating Temperature Range (°C)	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)
208/480/600	60	96.6	96	100	<20	-25 to 62	5	5	1400
208/480/600	60	96.9	96	100	<20	-25 to 62	5	5	1450
215	60	98.2	97.5	2165	<45	-25 to 62	5	5	2150
320/340/360/380	60	98.6	98	2165	<45	-25 to 62	5	5	2150
	60	96	95			-20 to 50	5	5	1204
	60	96	95			-20 to 50	5	5	1733
	60	96	96			-20 to 50	5	5	1732
	60	96.7	96			-20 to 50	5	5	2150
	60	96.3	96			-20 to 50	5	5	2350
	60	96.3	95.5			-20 to 50	5	5	2684
	60	96.7	96			-20 to 50	5	5	2684
	60	96.2	95.5			-20 to 50	5	5	5300
	60	96.6	96			-20 to 50	5	5	5300
	60	96.3	95.5			-20 to 50	5	5	5811
	60	97.5	97			-20 to 50	5	5	5900/10150
	60	97.8	96			-20 to 50	5	5	12000
	50	96.7	96			-20 to 50	5	5	2497
	50	97.8	97.2			-20 to 50	5	5	3511
	50	96.9	97			-20 to 50	5	5	6182
	50	97.6	97.4			-20 to 50	5	5	6182
	50	98.1	97			-20 to 50	5	5	11975
	60	98.5	98			-20 to 50	5	5	6950
	50	98.5	97.5			-20 to 50	5	5	6182
	50	98.5	97.8			-20 to 50	5	5	6934

U.S. Inverter Models

Central Inverters

		Input Characteristics, Central Inverters, DC					Output Characteristics (AC)		
Manufacturer	Model	PV Array Power Range (kWp)	Voltage Range MPPT	Max Voltage DC	Max Current (A)	Number Of DC Inputs	Rated Power (kW)	Max Current (A@V)	
Schneider Electric	GT 250 480/600		300 to 480 , 310 to 480	600	867	1	250 kW	301/241	
www.SEsolar.com	GT 500 MVX		310 to 480	600	1720	1	500 kW	1400	
	GT 500 480/600		310 to 480	600	1720	1	500 kW	610/490	
	Conext Core XC 540/630/680		440 to 800, 510 to 800, 550 to 800	1000	1280	1	540/630/680	1040	
	Conext Core XC 540/630/680 NA		440 to 800, 510 to 800, 550 to 800	1000	1280	1	540/630/680	1040	
SMA America	Sunny Central 500 CP-US 600/1000	n/a	330 to 480/430 to 820	600/1000	1600/1250	1 (Busbar) / 6 to 9 Fused	500 @ 50°C 520 @ 40°C 550 @ 25°C	1588/1176	
www.sma-america.com	Sunny Central 630CP-US	n/a	500 to 820	1000	1350	1 (Busbar) / 6 to 9 Fused	630 @ 50°C 655 @ 40°C 693 @ 25°C	1283	
	Sunny Central 720CP-US	n/a	525 to 820	1000	1600	1 (Busbar) / 6 to 9 Fused	720 @ 50°C 749 @ 40°C 792 @ 25°C	1411	
	Sunny Central 750CP-US	n/a	545 to 820	1000	1600	1 (Busbar) / 6 to 9 Fused	750 @ 50°C 780 @ 40°C 825 @ 25°C	1411	
	Sunny Central 800CP-US/XT	n/a	570 to 820 (XT: 641 to 850/ (583-850@50 C))	1000	1600 (XT: 1400)	1 (Busbar) / 6 to 9 Fused (XT: also 32) optiprotect	800 @ 50°C 832 @ 40°C 880 @ 25°C	1411	
	Sunny Central 850CP-US/XT	n/a	570 to 820 (XT: 681 to 850/ (620-850@50 C))	1000	1600	1 (Busbar) / 6 to 9 Fused	850 @ 50°C , 884 @ 40°C (non XT only), 935 @ 25°C	1411	
	Sunny Central 900CP-US/XT	n/a	600 to 820 (XT: 722 to 850/ (656-850@50 C))	1000	1600 (XT: 1400)	1 (Busbar) / 6 to 9 Fused (XT: also 32) optiprotect	900 @ 50°C , 936 @ 40°C (non XT only), 990 @ 25°C	1411	
	Sunny Central 500CP XT	n/a	449 to 850 (436-850@50 C)	1000	1250	1 (Busbar) / 6 to 9 Fused/ or 32 (Optipro-tect)	500 @ 50°C 550 @ 25°C	1176	
	Sunny Central 630CP XT	n/a	529 to 850 (505-850@50 C)	1000	1350	1 (Busbar) / 6 to 9 Fused/ or 32 (Optiprotect)	630 @ 50°C 700 @ 25°C	1283	
	Sunny Central 720CP XT	n/a	577 to 850 (525-850@50 C)	1000	1400	1 (Busbar) / 6 to 9 Fused/ or 32 (Optiprotect)	720 @ 50°C 792 @ 25°C	1411	

Output Characteristics (AC)		Efficiency		General Information					
Rated Voltages (V)	Frequency (Hz)	Peak %	CEC wtd %	Consumption Day (W)	Consumption Night (W)	Operating Temperature Range (°C)	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)
480/600	60	96.8	96		<35	-15 to 50/ -35 to 45	5	5	2018
208	60	98	97		<161	-20 to 50	5	5	1587
480/600	60	96.9	96		<336	-20 to 50	5	5	1225 (inverter); 1878 (trans-former)
300/350/380	50/60	98.5/98.7/98.9	98.5/98.5/98.7		<100	-10 to 45, derating to 50	5	5	1590
300/350/380	60	98.2/98.5/98.6	97.5/98/98		<210	-35 to 50, derating to 55	5	5	1940 (w/o DC recom-biner) 2240 (with DC recom-biner)
200/270	50, 60	98.1/98.5	97.5/98	<1800	<150	-25 to 50	5	25	1870
315	50, 60	98.5	98	<1800	<150	-25 to 50	5	25	1870
324	50, 60	98.6	98	<1800	<150	-25 to 50	5	25	1870
342	50, 60	98.6	98	<1800	<150	-25 to 50	5	25	1870
360	50, 60	98.7	98.5	<1800	<150	-25 to 50	5	25	1870
360 (XT: 386)	50, 60	98.7 (XT: 98.6)	98.5	<1800 (XT: <1900)	<150 (XT: <100)	-25 to 50 (XT: '-25 to 62)	5	25	1870 (XT: 1900)
405	50, 60	98.7 (XT: 98.6)	98.5	<1800 (XT: <1900)	<150	-25 to 50	5	25	1870 (XT: 1900)
270	50, 60	98.6	98.5	<1900	<100	-25 to 62	5	25	1900
315	50, 60	98.7	98.5	<1900	<100	-25 to 62	5	25	1900
324	50, 60	98.6	98.5	<1900	<100	-25 to 62	5	25	1900

U.S. Inverter Models

Central Inverters

		Input Characteristics, Central Inverters, DC					Output Characteristics (AC)		
Manufacturer	**Model**	**PV Array Power Range (kWp)**	**Voltage Range MPPT**	**Max Voltage DC**	**Max Current (A)**	**Number Of DC Inputs**	**Rated Power (kW)**	**Max Current (A@V)**	
SMA America *(continued)*	Sunny Central 760CP XT	n/a	609 to 850 (554-850@50 C)	1000	1400	1 (Busbar) / 6 to 9 Fused/ or 32 (Optipro-tect)	760 @ 50°C 825 @ 25°C	1411	
www.sma-america.com	Sunny Central 500-US / HE	n/a	330 to 600	600	1600	6 to 9	500	600 (HE: 1470)	
	Sunny Central 250-US	n/a	330 to 600	600	800	4 to 6	250 kVA	300	
	Sunny Central 2200-US	2000-3200 kWp	570-1000 V	1000 V	4110	32	2200 @ 25C	3300	
	Sunny Central 2500	2250-3600 kWp	840-1500 V	1500 V	3000	24	2475 @ 25C	2645	
Solectria Renewables	PVI 50KW	65	300 to 500 / Low Voltage Option - 285-500	600	176 / Low Voltage Op-tion - 185	2 to 8 posi-tions	50	139 @ 208 / 120 @ 240 / 60 @ 480 / 48 @ 600	
www.solectria.com	PVI 60KW	78	300 to 500 / Low Voltage Option - 285-500	600	211 / Low Voltage Op-tion - 222	2 to 8 posi-tions	60	167 @ 208 / 144 @ 240 / 72 @ 480 / 58 @ 600	
	PVI 75KW / PVI 75KW-PE	97.5	300 to 500 / Low Voltage Option - 285-500	600	264 / Low Voltage Op-tion - 278	2 to 8 posi-tions	75	208 @ 208 / 180 @ 240 / 90 @ 480 / 72 @ 600	
	PVI 85KW /PVI 85KW-PE	11/17/14	300 to 500 / Low Voltage Option - 285-500	600	299 / Low Voltage Op-tion - 314	2 to 8 posi-tions	85	236 @ 208 / 205 @ 240 / 102 @ 480 / 82 @ 480	
	PVI 100KW / PVI 100KW-PE	130	300 to 500 / Low Voltage Option - 285-500	600	351 / Low Voltage Op-tion - 370	2 to 8 posi-tions	100	278 @ 208 / 240 @ 240 / 120 @ 480 / 96 @ 600	
	SGI 225	292.5	300 to 500	600	768	6, 12 or 24 positions	225	271 @ 480 / 217 @ 600	
	SGI 250	325	300 to 500	600	853	6, 12 or 24 positions	250	301 @ 480 / 240 @ 600	
	SGI 266	345.8	300 to 500	600	908	6, 12 or 24 positions	266	320 @ 480 / 256 @ 600	
	SGI 300	390	300 to 500	600	1026	6, 12 or 24 positions	300	360 @ 480 / 289 @ 600	
	SGI 500/ SGI 500PE	650	300 to 500	600	1721 / PE: 1712	8, 16 or 32 positions	500	602 @ 480 / 480 @ 600	
	SGI 500XT	650	300 to 500	600	1750	8, 16 or 32 positions	500	1387	
	SGI 500XTM	700	545 to 820	1000	945	up to 16 positions	500	760	
	SGI 750XTM	1050	545 to 820	1000	1420	up to 16 positions	750	1140	

Output Characteristics (AC)		Efficiency		General Information					
Rated Voltages (V)	Frequency (Hz)	Peak %	CEC wtd %	Consumption Day (W)	Consumption Night (W)	Operating Temperature Range (°C)	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)
342	50, 60	98.6	98.5	<1900	<100	-25 to 62	5	25	1900
480 (HE: 200)	60	97.4 (HE: 98.6)	97 (HE: 98)	<1500 (HE: <1600)	< 80 (HE: <110)	-25 to 60	5	25	<3250 (HE: <1800)
480	60	97.5	97	<800	<69	-25 to 50	5	25	<1900
385	60/50 Hz	98.3	98.1 (un-rounded)	<5000W	<300W	-25 to 60 C	5	20	8800
540	60/50 Hz	98.4	98.2 (un-rounded)	<5000W	<300W	-25 to 60 C	5	20	8800
208, 240, 480 or 600	60	208 - 96.7 / 240 - 97.7 / 480 - 96.5 / 600 - 96.5	208 - 96.0 / 240 - 97.0 / 480 - 96.0		< 3	-40 to 55	5	20	1450
208, 240, 480 or 600	60	208 - 96.7 / 240 - 97.8 / 480 - 96.5 / 600 - 96.5	208 - 96.0 / 240 - 97.0 / 480 - 96.0		< 3	-40 to 55	5	20	1450
208, 240, 480 or 600	60	208 - 97.3 / 240 - 97.1 / 480 - 97.2 / 600 - 97.2; PE: 208 - 97.8 / 480 - 97.7	208 - 97.0 / 240 - 96.0 / 480 - 97.0; PE: 208 - 97.5 / 480 - 97.5		< 3	-40 to 55	5	20	1875; PE - 2070
208, 240, 480 or 600	60	208 - 96.6 / 240 - 96.7 / 480 - 96.9 / 600 - 96.9; PE: 208 - 97.4 / 480 - 97.3	208 - 96.0 / 240 - 96.0 / 480 - 96.5; PE: 208 - 97.0		< 3	-40 to 55	5	20	1875; PE - 2070
208, 240, 480 or 600	60	208 - 96.5 / 240 - 96.9 / 480 - 96.9 / 600 - 96.9; PE: 208 - 97.3 / 480 - 97.2	208 - 96.0 / 240 - 96.0 / 480 - 96.5; PE: 208 - 97.0		< 3	-40 to 55	5	20	1875; PE - 2070
208, 240, 480 or 600	60	98.0	97.5		28	-40 to 50	5	20	5170
208, 240, 480 or 600	60	98.0	97.5		28	-40 to 50	5	20	5650
208, 240, 480 or 600	60	98.0	97.5		28	-40 to 50	5	20	5650
208, 240, 480 or 600	60	98.0	97.5		28	-40 to 50	5	20	5650
208, 240, 480 or 600	60	97.9 / PE: 98.3	97.0 / PE: 97.5		32	-40 to 50	5	20	6980 / PE: 7107
208	60	98.1	98.0		41	-40 to 50	5	20	3410
380	60	98.2	98.0		110	-40 to 50	5	20	3187
380	60	98.2	98.0		150	-40 to 50	5	20	3600

U.S. Inverter Models

Central Inverters

		Input Characteristics, Central Inverters, DC					Output Characteristics (AC)		
Manufacturer	Model	PV Array Power Range (kWp)	Voltage Range MPPT	Max Voltage DC	Max Current (A)	Number Of DC Inputs	Rated Power (kW)	Max Current (A@V)	
Sungrow North America	SG100KU	140	300 to 600	600	340	4	100	140	
www.sungrow.ca	SG250KU	350	320 to 600	600	820	2	250	330	
	SG500LV	600	320 to 600	600	1600	12	500	1443	
	SG750LV	1050	500 to 820	1000	1600	12	750	1512	
	SG800LV	1120	545 to 820	1000	1600	12	800	1512	
	SG1000MX	1400	550 to 850	1000	1875	12	1000	2016	
TMEIC	PVL-L0500U-S	569	320 to 550	600	1600	Customizable	500	1325	
www.tmeic.com	PVL-L0500E-S	600	450 to 950	1000	1155	Customizable	500	962	
	PVL-L0630E-S	771	550 to 950	1000	1403	Customizable	630	1148	
	PVL-L0630U-S	643	550 to 950	1000	1202	Customizable	630	1148	
	PVL-L1833GRQ	1710	605 to 950	1000	2878	Customizable	1667	2826	

String Inverters

		Input Characteristics, String Inverters, DC						Ou	
Manufacturer	Model	PV Array Power Range (kWp)	Voltage Range MPPT	Max Voltage DC	Max Current (A)	Number Of DC Inputs	MPPT	Rated Power (kW)	Max Current (A@V)
ABB (Power-One)	UNO-2.0-I-OUTD-US	2.6	90 to 470	520	12.5	2	1	2	10
www.abb.com/solarinverters	UNO-2.5-I-OUTD-US	3.25	90 to 470	520	12.8	2	1	2.5	12
	PVI-3.0-OUTD-(S)-US-(A)	3.9	90 to 580	600	10/MPPT	4	2	3	12.0 to 14.5
	PVI-3.6-OUTD-(S)-US-(A)	4.68	90 to 580	600	16/MPPT	4	2	3.6	16.0 to 17.2
	PVI-3.8-OUTD-(S)-US-(A)	4.94	90 to 580	600	16/MPPT	4	2	3.8	16
	PVI-4.2-OUTD-(S)-US-(A)	5.46	90 to 580	600	16/MPPT	4	2	4.2	20
	PVI-5000-OUTD-US-(A)	6.5	90 to 580	600	22/MPPT	4	2	5	20 to 27
	PVI-6000-OUTD-US-(A)	7.8	90 to 580	600	22/MPPT	4	2	6	24 to 30
	PVI 10.0-I-OUTD-S1/S2-US		220 to 470	520	24/MPPT	6	2	10	30 or 14
	PVI-12.0-I-OUTD-S1/S2-US		250 to 470	520	25/MPPT	6	2	12	16
	TRIO-20.0-TL-OUTD-XX-US-480	24	200 to 950	1000	25/MPPT	2 or 4	2	20	27
	TRIO-27.6-TL-OUTD-XX-US-480	32	200 to 950	1000	30.9/MPPT	2 or 4	2	27.6	36
	UNO-7.6-TL-OUTD-S-US-A	9.88	90 to 580	600	24/MPPT	4 or 6 (opt.)	2	7.6	36.5, 32, 27.5
	UNO-8.6-TL-OUTD-S-US-A	11.18	90 to 580	600	24/MPPT	4 or 6 (opt.)	2	8.6	36, 31

Output Characteristics (AC)		Efficiency		General Information					
Rated Voltages (V)	Frequency (Hz)	Peak %	CEC wtd %	Consumption Day (W)	Consumption Night (W)	Operating Temperature Range (°C)	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)
422 to 526	59.3 to 60.5	97.2	96.5	<30	<30	-25 to 55	5	20	1050
420 to 530	59.3 to 60.5	97.3	96.5	<50	<50	-25 to 55	5	20	2300
176 to 220	59.3 to 60.5	98.3	98	<100	<100	-25 to 55	5	20	2400
277 to 347	57 to 62	98.7	98.5	<100	<100	-25 to 60	5	20	2700
300 to 377	57 to 62	98.7	98.5	<100	<100	-25 to 60	5	20	2700
316-396	47 to 63	98.7	98.5	<100	<20	-25 to 60	5	20	2700
210	60	97.5	97.1EU	500	75	-20 to 50	5	20	1300 / 2866
300	60	98.5	98.3EU	500	75	-20 to 50	5	20	1300 / 2866
380	60	98.6	98.3EU	500	75	-20 to 50	5	20	1300 / 2866
380	60	98.6	98.3EU	500	75	-20 to 50	5	20	1300 / 2866
418	60	99.01	98.5	100	100	-20 to 50	5	20	6000 / 13220

utput Characteristics (AC)		Efficiency		General Information					
Rated Voltages (V)	Frequency (Hz)	Peak %	CEC wtd %	Consumption Day (W)	Consumption Night (W)	Operating Temperature Range (°C)	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)
208, 240, 277	60	96.6	95.5	<8.0	<0.6	-25 to 60	10	20	42.5
208, 240, 277	60	96.6	95.5 to 96	<8.0	<0.6	-25 to 60	10	20	42.5
208, 240, 277	60	96.9	96	<8.0	<0.6	-25 to 60	10	20	47.3
208, 240, 277	60	97	96	<8.0	<0.6	-25 to 60	10	20	47.3
208, 240, 277	60	97	96	<8.0	<0.6	-25 to 60	10	20	47.3
208, 240, 277	60	97	96	<8.0	<0.6	-25 to 60	10	20	47.3
208, 240, 277	60	97.1	96 to 96.5	<8.0	<0.6	-25 to 60	10	20	59.5
208, 240, 277	60	97.1	96 to 96.5	<8.0	<0.6	-25 to 60	10	20	59.5
208, 480, 600 (CAN)	60	96.5 to 97.3	96 to 97	<8.0	0	-25 to 60	10	20	48.5 or 51.7
480, 600 (CAN)	60	97.3	97	<8.0	0	-25 to 60	10	20	48.5 or 51.7
480	60	98.2	97.5	<8.0	0	-30 to 60	10	20	71
480	60	98.2	97.5	<8.0	0	-30 to 60	10	20	76
208, 240, 277	60	97.5	96.5	<8.0	<0.6	-25 to 60	10	20	81.5
240, 277	60	97.5	96.5	<8.0	<0.6	-25 to 60	10	20	81.5

U.S. Inverter Models

String Inverters

		Input Characteristics, String Inverters, DC						Output Characteristics (AC)		
Manufacturer	Model	PV Array Power Range (kWp)	Voltage Range MPPT	Max Voltage DC	Max Current (A)	Number Of DC Inputs	MPPT	Rated Power (kW)	Max Current (A@V)	
Advanced Energy	AE_3TL-12_6	21	+/-125-450	2 x 500	2 x 27.5	10	1	12	14.5	
www.advanced-energy.com	AE_3TL-16_6	28	+/-125-450	2 x 500	2 x 33	10	1	16	19.3	
	AE_3TL-20_6	35	+/-125-445	2 x 500	2 x 39	10	1	20	24.1	
	AE_3TL-24_6	42	+/-125-445	2 x 500	2 x 44	10	1	24	28.9	
	AE_3TL-12_10	21	+/-250-900	1000	2 x 27.5	6	1	12	14.5	
	AE_3TL-16_10	28	+/-250-900	1000	2 x 33	6	1	16	19.3	
	AE_3TL-20_10	35	+/-250-890	1000	2 x 39	6	1	20	24.1	
	AE_3TL-23_10	42	+/-250-890	1000	2 x 44	6	1	24	28.9	
	AE_3TL-12_10-08	21	+/-250-900	1000	2 x 27.5	6	1	12	14.5	
	AE_3TL-16_10-08	28	+/-250-900	1000	2 x 33	6	1	16	19.3	
	AE_3TL-20_10-08	35	+/-250-890	1000	2 x 39	6	1	20	24.1	
	AE_3TL-24_10-08	42	+/-250-890	1000	2 x 44	6	1	24	28.9	
Chint Power	CPS SC20KTL-O/US-480 (3-phase)	27	300 to 550	600	70	8	2	20	27.3	
www.chintpower.com	CPS SCA 14KTL-DO/US-208 (3-phase)	19	180 to 580	600	50	8	2	14	39	
	CPS SCA23K-TL-DO/US-480 (3-phase)	31	480 to 800	1000	50	8	2	23	32	
	CPS SCA28K-TL-DO/US-480 (3-phase)	38	500 to 800	1000	58	8	2	28	39	
	CPS SCA3K-TL-O/US (1-phase)	4	150 to 550	550	16	4	2	3 at 240 ; 3 at 208	13.5 at 240	
	CPS SCA4K-TL-O/US (1-phase)	5.2	150 to 550	550	21	4	2	4 at 240 ; 4 at 208	18 at 240	
	CPS SCA5K-TL-O/US (1-phase)	6.5	150 to 550	550	26	4	2	5 at 240 ; 4.6 at 208	22 at 240	
	CPS SCA6K-TL-O/US (1-phase)	7.8	150 to 550	550	32	4	2	6 at 240 ; 5.5 at 208	27.5 at 240	
	CPS SCE4K-TL-O/US (1-phase)	4.8	225 to 500	600	19	4	1	4 at 240 and 277 ; 3.8 at 208	18.3 at 208	
	CPS SCE5KTL-O/US (1-phase)	6	200 to 500	600	26	4	1	5 at 240 and 277 ; 4.6 at 208	22.1 at 208	
	CPS SCE6KTL-O/US (1-phase)	7.2	200 to 500	600	32	4	1	6 at 240 and 277 and 208	28.9 at 208	
	CPS SCE7KTL-O/US (1-phase)	8.4	200 to 500	600	37	4	1	7 at 240 and 277 and 208	33.7 at 208	

Output Characteristics (AC)			Efficiency		General Information					
	Rated Voltages (V)	Frequency (Hz)	Peak %	CEC wtd %	Consumption Day (W)	Consumption Night (W)	Operating Temperature Range (°C)	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)
	480	60	98.2	97.8	24	0.5	-25 to 55	5	20	108
	480	60	98.2	97.8	24	0.5	-25 to 55	5	20	108
	480	60	98.2	97.8	24	0.5	-25 to 55	5	20	108
	480	60	98.2	98	24	0.5	-25 to 55	5	20	108
	480	60	98.2	97.8	24	0.5	-25 to 55	5	20	108
	480	60	98.2	97.8	24	0.5	-25 to 55	5	20	108
	480	60	98.2	97.8	24	0.5	-25 to 55	5	20	108
	480	60	98.2	98	24	0.5	-25 to 55	5	20	108
	480	60	98.2	97.8	24	0.5	-25 to 55	5	20	108
	480	60	98.2	97.8	24	0.5	-25 to 55	5	20	108
	480	60	98.2	97.8	24	0.5	-25 to 55	5	20	108
	480	60	98.2	98	24	0.5	-25 to 55	5	20	108
	480	60	97.4	97	<20	<2	-25 to 60	5	20	63
	208	60	96.7	96	<20	<2	-25 to 60	5	20	64
	480	60	98.4	98	<20	<2	-25 to 60	5	20	55
	480	60	98.4	98	<20	<2	-25 to 60	5	20	55
	208, 240	60	97.6	96.5	<8	<1	-25 to 60	10	10	36.5
	208, 240	60	97.7	97	<8	<1	-25 to 60	10	10	36.5
	208, 240	60	97.8	97	<8	<1	-25 to 60	10	10	36.5
	208, 240	60	97.5	96.5	<8	<1	-25 to 60	10	10	36.5
	208, 240, 277	60	97.5	97	<7	<0.2	-25 to 50	10	10	39
	208, 240, 277	60	97.5	97	<7	<0.2	-25 to 50	10	10	41
	208, 240, 277	60	97.5	97	<7	<0.2	-25 to 50	10	10	46
	208, 240, 277	60	97.5	97	<7	<2	-25 to 50	10	10	46

U.S. Inverter Models

String Inverters

		Input Characteristics, String Inverters, DC						Output Characteristics (AC)		
Manufacturer	Model	PV Array Power Range (kWp)	Voltage Range MPPT	Max Voltage DC	Max Current (A)	Number Of DC Inputs	MPPT	Rated Power (kW)	Max Current (A@V)	
Delta	Solivia 3.0 TL	3.60	200-500V	600V	18	2	1	3.0	15.0@208/240	
www.deltaenergy systems.com	Solivia 3.8 TL	4.56	200-500V	600V	20	2	1	3.8	16.0@208/240	
	Solivia 5.2 TL	6.24	200-500V	600V	15 per MPP tracker	4	2	5.2	27.5@208/240	
	Solivia 6.6 TL	7.92	200-500V	600V	18 per MPP tracker	4	2	6.6	32.0@208/240	
	Solivia 7.6 TL	9.12	200-500V	600V	20 per MPP tracker	4	2	7.6	32.0@208/240	
Fronius USA	IG Plus Advanced 3.0-1 UNI	2.50 to 3.45	230 to 500	600	14.0	6	1	3.0	14.4, 12.5, 10.8	
www.fronius-usa.com	IG Plus Advanced 3.8 - 1 UNI	3.20 to 4.40	230 to 500	600	17.8	6	1	3.8	18.3, 15.8. 13.7	
	IG Plus Advanced 5.0 - 1 UNI	4.25 to 5.75	230 to 500	600	23.4	6	1	5.0	24.0, 20.8, 18.1	
	IG Plus Advanced 6.0 - 1 UNI	5.10 to 6.90	230 to 500	600	28.1	6	1	6.0	28.8, 25.0, 21.7	
	IG Plus Advanced 7.5 - 1 UNI	6.35 to 8.60	230 to 500	600	35.1	6	1	7.5	36.1, 31.3, 27.1	
	IG Plus Advanced 10.0 - 1 UNI	8.50 to 11.50	230 to 500	600	46.7	6	1	9.995	48.1, 41.7, 36.1	
	IG Plus Advanced 10.0 - 3 DELTA	8.50 to 11.50	230 to 500	600	46.7	6	1	9.995	27.7, 24.0, n/a	
	IG Plus Advanced 11.4 - 1 UNI	9.70 to 13.10	230 to 500	600	53.3	6	1	11.4	54.8, 47.5, 41.2	
	IG Plus Advanced 11.4 - 3 DELTA	9.70 to 13.10	230 to 500	600	53.3	6	1	11.4	31.6, 27.4, n/a	
	IG Plus Advanced 12.0 - 3 WYE277	10.20 to 13.80	230 to 500	600	56.1	6	1	12.0	n/a, n/a, 14.4	
	IG 2000	1.50 to 2.40	150 to 450	500	13.6	3	1	2.00	8.33	
	IG 3000	2.10 to 3.30	150 to 450	500	18.0	3	1	2.70	11.3	
	IG 2500 LV	1.80 to 2.70	150 to 450	500	16.9	3	1	2.35	11.3	
	IG 4000	3.00 to 4.80	150 to 450	500	26.1	3	1	4.00	16.7	
	IG 5100	4.10 to 6.10	150 to 450	500	33.2	3	1	5.10	21.3	
	IG 4500 LV	3.50 to 5.30	150 to 450	500	29.3	3	1	4.50	21.6	
	Galvo 1.5-1	1.20 to 2.40	120 to 335	420	16.7	6	1	1.5	8.2, 7.7, 7.1	
	Galvo 2.0-1	1.60 to 3.20	120 to 335	420	22.4	6	1	2.0	9.1, 9.1, 9.1	

Output Characteristics (AC)			Efficiency		General Information					
	Rated Voltages (V)	Frequency (Hz)	Peak %	CEC wtd %	Consumption Day (W)	Consumption Night (W)	Operating Temperature Range (°C)	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)
	208/240	60	98	97.5	<4.5W	<1.2W	-25~70	10	20	43
	208/240	60	98	97.5	<4.5W	<1.2W	-25~70	10	20	43
	208/240	60	98	97.5	<5W	<1.5W	-25~70	10	20	65
	208/240	60	98	97.5	<5W	<1.5W	-25~70	10	20	65
	208/240	60	98	97.5	<5W	<1.5W	-25~70	10	20	65
	208, 240, 277	60	96.2	95.0, 95.5, 95.5	8	<1.5	(-40°C - +55°C)	10	20	55
	208, 240, 277	60	96.2	95.0, 95.5, 95.5	8	<1.5	(-40°C - +55°C)	10	20	55
	208, 240, 277	60	96.2	95.5, 95.5, 96.0	15	<1.5	(-40°C - +55°C)	10	20	81
	208, 240, 277	60	96.2	95.5, 96.0, 96.0	15	<1.5	(-40°C - +55°C)	10	20	81
	208, 240, 277	60	96.2	95.0, 95.5, 96.0	15	<1.5	(-40°C - +55°C)	10	20	81
	208, 240, 277	60	96.2	95.0, 95.5, 96.0	22	<1.5	(-40°C - +55°C)	10	20	110
	208, 240	60	96.2	95.5, 95.5, n/a	20	<1.5	(-40°C - +55°C)	10	20	110
	208, 240, 277	60	96.2	95.5, 96.0, 96.0	22	<1.5	(-40°C - +55°C)	10	20	110
	208, 240	60	96.2	95.0, 96.0, n/a	22	<1.5	(-40°C - +55°C)	10	20	110
	277	60	96.2	n/a, n/a, 96.0	20	<1.5	(-40°C - +55°C)	10	20	110
	240	60	95.2	93.5	7	<0.15	(-20°C - +50°C)	10	20	26
	240	60	95.2	94	7	<0.15	(-20°C - +50°C)	10	20	26
	208	60	94.4	93	7	<0.15	(-20°C - +50°C)	10	20	26
	240	60	95.2	94	12	<0.15	(-20°C - +50°C)	10	20	41.8
	240	60	95.2	94.5	12	<0.15	(-20°C - +50°C)	10	20	41.8
	208	60	94.4	93.5	12	<0.15	(-20°C - +50°C)	10	20	41.8
	208, 220, 240	60	95.8	94.0, 94.0, 94.5	8	<1	(-40°C - +50°C)	10	20	36.05
	208, 220, 241	60	95.8	94.5, 94.5, 94.5	8	<1	(-40°C - +50°C)	10	20	36.05

U.S. Inverter Models

String Inverters

		Input Characteristics, String Inverters, DC						Output Characteristics (AC)		
Manufacturer	Model	PV Array Power Range (kWp)	Voltage Range MPPT	Max Voltage DC	Max Current (A)	Number Of DC Inputs	MPPT	Rated Power (kW)	Max Current (A@V)	
Fronius USA *(continued)*	Galvo 2.5-1	2.00 to 3.80	165 to 440	550	20.1	6	1	2.5	13.7, 12.9, 11.8	
www.fronius-usa.com	Galvo 3.1-1	2.50 to 4.50	165 to 440	550	25.0	6	1	3.1	14.1, 14.1, 14.1	
	Symo 10.0-3 208/240	8.00 to 13.00	200 to 600	600	25.0/16.5	6	2	10.0	n/a	
	Symo 10.0-3 480	8.00 to 13.00	200 to 1000	1000	25.0/16.5	6	2	10.0	n/a, n/a	
	Symo 12.0-3 480	9.60 to 16.60	200 to 600	600	25.0/16.5	6	2	12.0	n/a	
	Symo 12.5-3 480	6.90 to 16.25	200 to 1000	1000	25.0/16.5	6	2	12.5	n/a, n/a	
	Symo 15.0-3 208/240	12.00 to 19.50	200 to 1000	1000	33.0/25.0	6	1	15.0	n/a	
	Symo 15.0-3 480	12.00 to 19.50	200 to 1000	1000	33.0/25.0	6	2	15.0	n/a, n/a	
	Symo 17.5-3 480	14.00 to 22.75	200 to 1000	1000	33.0/25.0	6	2	17.5	n/a, n/a	
	Symo 20.0-3 480	16.00 to 26.00	200 to 1000	1000	33.0/25.0	6	2	20.0	n/a, n/a	
	Symo 24.0-3 480	19.20 to 31.20	200 to 1000	1000	33.0/25.0	6	2	24.0	n/a, n/a	
Ginlong (Ningbo) Technologies	Solis-1K-2G-US	1.2	70 to 400	500	10	1	1	1	5.2	
www.ginlong-usa.com	Solis-1.5K-2G-US	1.8	100 to 400	500	10	1	1	1.5	8.1	
	Solis-2K-2G-US	2.3	100 to 400	500	10	1	1	2	10.5	
	Solis-2.5K-2.5G-US	3	100 to 500	600	10+10	2	2	2.5	13.3	
	Solis-3K-3G-US	3.5	100 to 500	600	10+10	2	2	3	15.7	
	Solis-3.6K-2G-US	4.2	100 to 500	600	10+10	2	2	3.6	16	
	Solis-4K-3G-US	4.6	100 to 500	600	15+15	2	2	4	21	
	Solis-4.6K-2G-US	5.3	100 to 500	600	15+15	2	2	4.6	23.8	
	Solis-5K-2G-US	5.3	100 to 500	600	15+15	2	2	5	23.8	
	Solis-6K-US	6.9	250 to 800	1000	15+15	2	2	6	10.5	
	Solis-10K-US	11.5	300 to 800	1000	15+15	2	2	10	16	
	Solis-15K-US	15.8	300 to 800	1000	18+18	2	2	15	24	
	GCI-1K-2G-H-US	1.2	70 to 400(PV) 30 to 400(Wind)	500	10	1	1	1	5.2	

Output Characteristics (AC)			Efficiency		General Information					
	Rated Voltages (V)	Frequency (Hz)	Peak %	CEC wtd %	Consumption Day (W)	Consumption Night (W)	Operating Temperature Range (°C)	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)
	208, 220, 242	60	96.0	95.0, 95.0, 95.0	8	<1	(-40°C - +50°C)	10	20	36.93
	208, 220, 243	60	96.0	95.0, 95.5, 95.5	8	<1	(-40°C - +50°C)	10	20	36.93
	208, 220/240	60	97.0	96.5, 96.5, n/a		<1	(-40°C - +60°C)	10	20	91.6
	480	60	98.1	n/a, n/a, 97.0		<1	(-40°C - +60°C)	10	20	91.6
	208, 220/240	60	97.0	96.5, 96.5, n/a		<1	(-40°C - +60°C)	10	20	76.7
	480	60	98.1	n/a, n/a, 97.0		<1	(-40°C - +60°C)	10	20	76.7
	208	60	98.0	97.5, 97.5, n/a		<1	(-40°C - +60°C)	10	20	
	480	60	98.0	n/a, n/a, 97.0		<1	(-40°C - +60°C)	10	20	95.7
	480	60	98.0	n/a, n/a, 97.0		<1	(-40°C - +60°C)	10	20	95.7
	480	60	98.0	n/a, n/a, 97.0		<1	(-40°C - +60°C)	10	20	95.0
	480	60	98.0	n/a, n/a, 97.5		<1	(-40°C - +60°C)	10	20	95.0
	208/240	60	96.5	95.7	<6	<1	-25 to 60	5	10	11
	208/240	60	96.5	95.8	<6	<1	-25 to 60	5	10	11
	208/240	60	96.6	95.8	<6	<1	-25 to 60	5	10	11
	208/240	60	96.8	96.1	<6	<1	-25 to 60	5	10	14.5
	208/240	60	97.2	96.3	<6	<1	-25 to 60	5	10	14.5
	208/240	60	97.4	96.5	<6	<1	-25 to 60	5	10	14.5
	208/240	60	97.5	96.6	<6	<1	-25 to 60	5	10	15.5
	208/240	60	97.6	96.8	<6	<1	-25 to 60	5	10	15.5
	208/240	60	97.6	96.8	<6	<1	-25 to 60	5	10	15.5
	480~ 3phase	60	98.2	97	<6	<1	-25 to 60	5	10	27
	480~ 3phase	60	98.2	97.3	<6	<1	-25 to 60	5	10	27
	480~ 3phase	60	98.2	97.2	<6	<1	-25 to 60	5	10	30
	208/240	60	96.5	95.7	<6	<1	-25 to 60	5	10	11

U.S. Inverter Models

String Inverters

		Input Characteristics, String Inverters, DC						Output Characteristics (AC)		
Manufacturer	Model	PV Array Power Range (kWp)	Voltage Range MPPT	Max Voltage DC	Max Current (A)	Number Of DC Inputs	MPPT	Rated Power (kW)	Max Current (A@V)	
Ginlong (Ningbo) Technologies *(continued)*	GCI-1.5K-2G-H-US	1.8	100 to 400(PV) 30 to 400(Wind)	500	10	1	1	1.5	8.1	
www.ginlong-usa.com	GCI-2K-2G-H-US	2.3	100 to 400(PV) 30 to 400(Wind)	500	10	1	1	2	10.5	
	GCI-2.5K-2G-H-US	3	100 to 500(PV) 30 to 540(Wind)	600	10+10	2	2	2.5	13.3	
	GCI-3K-2G-H-US	3.5	100 to 500(PV) 30 to 540(Wind)	600	10+10	2	2	3	15.7	
	GCI-3.6K-2G-H-US	4.2	100 to 500(PV) 30 to 540(Wind)	600	10+10	2	2	3.6	16	
	GCI-4K-2G-H-US	4.6	100 to 500(PV) 30 to 540(Wind)	600	15+15	2	2	4	21	
	GCI-4.6K-2G-H-US	5.3	100 to 500(PV) 30 to 540(Wind)	600	15+15	2	2	4.6	23.8	
	GCI-5K-2G-H-US	5.3	100 to 500(PV) 30 to 540(Wind)	600	15+15	2	2	5	23.8	
Ingeteam	IS 3.6TL U	3.8 to 4.7	125 to 450	550	22	4	1	3.6	17.5	
www.ingeteam.com	IS 5TL U	5.3 to 6.5	125 to 450	550	30	4	1	5	25	
	IS 6TL U	6.3 to 7.4	125 to 450	550	32	4	1	6	26.2	
	IS 7.5TL U	7.9 to 9.3	125 to 450	550	35	4	1	7.5	36.1	
	IS 8.6TL U	9.1 to 11	125 to 450	550	35	4	1	8.6	36.1	
	IS 10TL U	10.5 to 13.7	125 to 450	550	35	4	1	10	36.1	
	IS 2.8TL U M	2.8 to 3.6	90 to 750	850	22	2	2	2.8	16	
	IS 3.3TL U M	3.4 to 4.3	90 to 750	850	22	2	2	3.3	16	
	IS 5TL U M	5.1 to 6.5	90 to 750	850	22	2	2	5	26.2	
	IS 6TL U M	6.1 to 7.8	90 to 750	850	22	2	2	6	26.2	
	IS 2.8HF U	2.9 to 3.6	125 to 500	550	17	1	1	2.8	13.5	
	IS 3.3HF U	3.4 to 4.3	125 to 500	550	22	1	1	3.3	16	

Output Characteristics (AC)			Efficiency		General Information					
	Rated Voltages (V)	Frequency (Hz)	Peak %	CEC wtd %	Consumption Day (W)	Consumption Night (W)	Operating Temperature Range (°C)	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)
	208/240	60	96.5	95.8	<6	<1	-25 to 60	5	10	11
	208/240	60	96.6	95.8	<6	<1	-25 to 60	5	10	11
	208/240	60	96.8	96.1	<6	<1	-25 to 60	5	10	14.5
	208/240	60	97.2	96.3	<6	<1	-25 to 60	5	10	14.5
	208/240	60	97.4	96.5	<6	<1	-25 to 60	5	10	14.5
	208/240	60	97.5	96.6	<6	<1	-25 to 60	5	10	15.5
	208/240	60	97.6	96.8	<6	<1	-25 to 60	5	10	15.5
	208/240	60	97.6	96.8	<6	<1	-25 to 60	5	10	15.5
	208, 240, 277	60	98	96.5	<10	<0.5	-20 to 70	10	20	44.1
	208, 240, 277	60	97.2	96	<10	<0.5	-20 to 70	10	20	61.73
	240, 277	60	97.7	97.5	<10	<0.5	-20 to 70	10	20	61.73
	208, 240, 277	60	97.8	97	<10	<0.5	-20 to 70	10	20	66.14
	240, 277	60	97.8	97	<10	<0.5	-20 to 70	10	20	66.14
	277	60	97.8	97.5	<10	<0.5	-20 to 70	10	20	66.14
	208, 240	60	98.4	97.5	<10	<0.5	-25 to 65	10	20	44.1
	208, 240	60	98.4	97.5	<10	<0.5	-25 to 65	10	20	44.1
	208, 240	60	98.4	97.5	<10	<0.5	-25 to 65	10	20	46.3
	240	60	98.4	97.5	<10	<0.5	-25 to 65	10	20	46.3
	208, 240, 277	60	96.3	95.5	<10	<0.5	-25 to 65	10	20	55.12
	208, 240, 277	60	96.3	95.5	<10	<0.5	-25 to 65	10	20	55.12

U.S. Inverter Models

String Inverters

		Input Characteristics, String Inverters, DC						Output Characteristics (AC)		
Manufacturer	Model	PV Array Power Range (kWp)	Voltage Range MPPT	Max Voltage DC	Max Current (A)	Number Of DC Inputs	MPPT	Rated Power (kW)	Max Current (A@V)	
Ingeteam *(continued)*	IS 5HF U	5.2 to 6.5	125 to 500	550	33	1	1	5	26.2	
www.ingeteam.com	IS 6HF U	6.3 to 7.8	125 to 500	550	33	1	1	6	26.2	
	IS 18TL U M480	18.6 to 24.1	200 to 820	1000	50	2	2	18	22	
	IS 24TL U M480	24.7 to 32.2	200 to 820	1000	54	2	2	24	29	
	IS 660TL U X360	670 to 884	606 to 820	1000	1170	12	3	660	1058	
	IS 400TL U X330	406.1 to 535.6	550 to 820	1000	780	8	2	400	700	
	IS 600TL U X330	609.2 to 803.4	550 to 820	1000	1170	12	3	600	1050	
	IS 800TL U X330	812 to 1071.2	550 to 820	1000	1560	16	4	800	1400	
	IS 440TL U X360	446.7 to 589.2	606 to 820	1000	780	8	2	440	706	
	IS 880TL U X360	892.6 to 1178.3	606 to 820	1000	1560	16	4	880	1411	
	IS 250T U X480	257.3 to 334.4	350 to 820	1000	780	8	2	250	301	
	IS 375T U X480	385.9 to 502.1	350 to 820	1000	1170	12	3	375	451	
	IS 500T U X480	514.6 to 669.5	350 to 820	1000	1560	16	4	500	601	
KACO new energy	2.0 TL1 M1 WM OD US33, US3C, & US3D	2.1 to 2.6	190 V to 510 V	600	1 x 11.0 A	2	1	2	8.3	
kaco-newenergy.com	2.0 TL1 M1 WM OD US38 & US39	2.1 to 2.6	190 V to 510 V	600	1 x 11.0 A	2	1	2	8.3	
	3.0 TL1 M1 WM OD US33, US3C, & US3D	3.1 to 3.9	140 V to 510 V	600	2 x 11.0 A	4	2	3	12.5	
	3.0 TL1 M1 WM OD US38 & US39	3.1 to 3.9	140 V to 510 V	600	2 x 11.0 A	4	2	3	12.5	
	4.0 TL1 M1 WM OD US33, US3C, & US3D	4.1 to 5.2	185 V to 510 V	600	2 x 11.0 A	4	2	4	16.7	
	4.0 TL1 M1 WM OD US38 & US39	4.1 to 5.2	185 V to 510 V	600	2 x 11.0 A	4	2	4	16.7	
	5.0 TL1 M1 WM OD US33, US3C, & US3D	5.1 to 6.5	215 V to 510 V	600	2 x 11.0 A	4	2	5.0 @ 240V, 4.8 @ 220V, 4.6 @ 208V	20.8	
	5.0 TL1 M1 WM OD US38 & US39	5.1 to 6.5	215 V to 510 V	600	2 x 11.0 A	4	2	5.0 @ 240V, 4.8 @ 220V, 4.6 @ 208V	20.8	

Output Characteristics (AC)			Efficiency		General Information					
	Rated Voltages (V)	Frequency (Hz)	Peak %	CEC wtd %	Consumption Day (W)	Consumption Night (W)	Operating Temperature Range (°C)	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)
	208, 240, 277	60	96.3	95.5	<10	<0.5	-25 to 65	10	20	55.12
	240, 277	60	96.3	95.5	<10	<0.5	-25 to 65	10	20	55.12
	480	60	98.5	98	<10	<0.5	-20 to 65	10	20	132.2
	480	60	98.5	98	<10	<0.5	-20 to 65	10	20	132.2
	360 V IT System	60	98.5	98.5	90	90	-20 to 65	5	20	4520
	330 V IT System	60	98.5	98	60	60	-20 to 65	5	20	3307
	330 V IT System	60	98.5	98	90	90	-20 to 65	5	20	4520
	330 V IT System	60	98.5	98	120	120	-20 to 65	5	20	5950
	360 V IT System	60	98.5	98.5	60	60	-20 to 65	5	20	3307
	360 V IT System	60	98.6	98.5	120	120	-20 to 65	5	20	5950
	480	60	97.2	96.5	60	60	-20 to 65	5	20	2645+3307
	480	60	97.2	96.5	90	90	-20 to 65	5	20	3527+4520
	480	60	97.2	96.5	120	120	-20 to 65	5	20	4410+5950
	240, 220, 208	60 Hz (59.3 to 60.5)	~97%	Pending		3 W	-25 to 60			45
	240, 220, 208	60 Hz (59.3 to 60.5)	~97%	Pending		3 W	-25 to 60			33
	240, 220, 208	60 Hz (59.3 to 60.5)	~97%	Pending		3 W	-25 to 60			52
	240, 220, 208	60 Hz (59.3 to 60.5)	~97%	Pending		3 W	-25 to 60			40
	240, 220, 208	60 Hz (59.3 to 60.5)	~97%	Pending		3 W	-25 to 60			52
	240, 220, 208	60 Hz (59.3 to 60.5)	~97%	Pending		3 W	-25 to 60			40
	240, 220, 208	60 Hz (59.3 to 60.5)	~97%	Pending		3 W	-25 to 60			52
	240, 220, 208	60 Hz (59.3 to 60.5)	~97%	Pending		3 W	-25 to 60			40

U.S. Inverter Models

String Inverters

		Input Characteristics, String Inverters, DC						Output Characteristics (AC)		
Manufacturer	Model	PV Array Power Range (kWp)	Voltage Range MPPT	Max Voltage DC	Max Current (A)	Number Of DC Inputs	MPPT	Rated Power (kW)	Max Current (A@V)	
KACO new energy *(continued)*	10.0 TL3 M2 WM OD USK3, USKA, & USKE	10.1 to 13.0	280 V to 550 V	600	2 x 18.6 A	4	2	10	12	
kaco-newenergy.com	10.0 TL3 M2 OD WM USK8 & USK9	10.1 to 13.0	280 V to 550 V	600	2 x 18.6 A	4	2	10	12	
	10.0 TL3 M2 OD WM CAP3, CAPA, & CAPE	10.1 to 13.0	280 V to 550 V	600	2 x 18.6 A	4	2	10	9.6	
	10.0 TL3 M2 OD WM CAP8 & CAP9	10.1 to 13.0	280 V to 550 V	600	2 x 18.6 A	4	2	10	9.6	
	32.0 TL3 M1 GM OD USK0	38.4 to 43.2	310 to 550	600	165	1	1	32	38.4	
	32.0 TL3 M3 GM OD USK0	38.4 to 43.2	310 to 550	600	55	3	3	32	38.4	
	40.0 TL3 M1 GM OD USK0	48.0 to 54.0	390 to 850	1000	165	1	1	40	48.1	
	40.0 TL3 M3 GM OD USK0	48.0 to 54.0	390 to 850	1000	55	3	3	40	48.1	
	50.0 TL3 M1 GM OD USK0	60.0 to 67.5	480 to 850	1000	165	1	1	50	60.1	
Schneider Electric	Conext CL1800NA		300 to 800	1000	32.0A/ MPPT	4 strings / MPPT	2	18kW	25A	
www.SEsolar.com	Conext CL2500NA		500 to 800	1000	26.5A/ MPPT	4 strings / MPPT	2	25kW	33A	
	Conext CL20000E		350 to 800	1000	31.0A/ MPPT	4 strings / MPPT	2	20kW	32A	
	Conext CL2500E		430 to 800	1000	31.0A/ MPPT	4 strings / MPPT	2	25kW	40A	
	Conext TL 8000E		416 to 850	1000	10/MPPT	4	2	8	13	
	Conext TL 10000E		350 to 850	1000	20x1, 10x1	4	2	10	17	
	Conext TL 15000E		350 to 850	1000	23/MPPT	4	2	15	24	
	Conext TL 20000E		350 to 850	1000	30/MPPT	4	2	20	32	
	Conext RL 3000E	3.15	160 to 500	550	10 (per channel)	2	2	3	13.9	
	Conext RL 4000E	4.2	180 to 500	550	12 (per channel)	4	2	4	18.2	
	Conext RL 5000E	5.25	180 to 500	550	18 (per channel)	4	2	5	23.2	

Output Characteristics (AC)			Efficiency		General Information					
	Rated Voltages (V)	Frequency (Hz)	Peak %	CEC wtd %	Consumption Day (W)	Consumption Night (W)	Operating Temperature Range (°C)	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)
	480	60 Hz (59.3 to 60.5)	>98%	97.5		< 1.5 W	-25 to 60			100
	480	60 Hz (59.3 to 60.5)	>98%	97.5		< 1.5 W	-25 to 60			88
	600	60 Hz (59.3 to 60.5)	>98%	97.5		< 1.5 W	-25 to 60			100
	600	60 Hz (59.3 to 60.5)	>98%	97.5		< 1.5 W	-25 to 60			88
	480	60 Hz (59.3 to 60.5)	>98%	97		< 1.5 W	-25 to 60	5	5	381
	480	60 Hz (59.3 to 60.5)	>98%	97		< 1.5 W	-25 to 60			381
	480	60 Hz (59.3 to 60.5)	>98%	97.5		< 1.5 W	-25 to 60	5	5	381
	480	60 Hz (59.3 to 60.5)	>98%	97.5		< 1.5 W	-25 to 60			381
	480	60 Hz (59.3 to 60.5)	>98%	97.5		< 1.5 W	-25 to 60	5	5	381
	277/480	60 +/- 3	98.0%	97.5%		<2.5	-25 t0 60	10	extendeds to 20	112(in-verter), 42(wiring box)
	277/480	60 +/- 3	98.4%	98.0%		<2.5	-25 t0 60	10	extendeds to 20	112(in-verter), 42(wiring box)
	230/400	50 +/- 3, 60 +/- 3	98.4%	98.0% Euro		<2.5	-25 t0 60	5	extendeds to 20	112(in-verter), 42(wiring box)
	230/400	50 +/- 3, 60 +/- 3	98.4%	98.0% Euro		<2.5	-25 t0 60	5	extendeds to 20	112(invert-er), 42(wir-ing box)
	230/400	50 +/- 3	98.1	97.5 Euro		<2	-20 to 60	5	10	38
	230/400	50 +/- 3	98.1	97.5 Euro		<2	-20 to 60	5	10	41
	230/400	50 +/- 3	98	97.3 Euro		<2	-20 to 60	5	10	67.2
	230/400	50 +/- 3	98	97.5 Euro		<2	-20 to 60	5	10	67.2
	230	45 to 55	97.5	97 Euro	<10	<1	-20 to 65	5	10	20
	230	45 to 55	97.5	97 Euro	<10	<1	-20 to 65	5	10	21
	230	45 to 55	97.5	97 Euro	<10	<1	-20 to 65	5	10	22 to 24

U.S. Inverter Models

String Inverters

		Input Characteristics, String Inverters, DC						Output Characteristics (AC)		
Manufacturer	Model	PV Array Power Range (kWp)	Voltage Range MPPT	Max Voltage DC	Max Current (A)	Number Of DC Inputs	MPPT	Rated Power (kW)	Max Current (A@V)	
SMA America	Sunny Boy 8000TL-US-12 208V/240V	see max Voltage and Current	300 to 480 / 345 to 480	600	27.9 / 24.1	1	1	8000 W	38.5 / 33.4	
www.sma-america.com	Sunny Boy 9000TL-US-12 208V/240V	see max Voltage and Current	300 to 480 / 345 to 480	600	31 / 27.1	1	1	9000 W	43.3 / 37.5	
	Sunny Boy 10000TL-US-12 208V/ 240V	see max Voltage and Current	300 to 480 / 345 to 480	600	35 / 30.2	1	1	10000 W	48.1 / 41.7	
	Sunny Boy 11000TL-US-12 240V	see max Voltage and Current	345 to 480	600	33.3	1	1	11000 W	45.8	
	Sunny Boy 5000-US-12 (208 / 240 / 277)	see max Voltage and Current	250 to 480	600	21	4	1	5000 W	24 / 21 / 18	
	Sunny Boy 6000-US-12 (208 / 240 / 277)	see max Voltage and Current	250 to 480	600	25	4	1	6000 W	29 / 25 / 22	
	Sunny Boy 7000-US-12 (208 / 240 / 277)	see max Voltage and Current	250 to 480	600	30	4	1	7000 W	34 / 29 / 25	
	Sunny Boy 8000-US-12 (240 / 277)	see max Voltage and Current	300 to 480	600	30	4	1	7680 W / 8000 W	32 / 29	
	Sunny Boy 3000-US (208 / 240)	see max Voltage and Current	175 to 400 / 200 to 400	500	17	4	1	3000 W	15 / 13	
	Sunny Boy 3800-US	see max Voltage and Current	250 to 480	600	18	4	1	3800 W	16	
	Sunny Boy 4000-US (208, 240)	see max Voltage and Current	220 to 480 / 250 to 480	600	18	4	1	3500 W / 4000 W	17	
	Sunny Boy 2000HF-US (208 / 240)	see max Voltage and Current	175 to 480	600	15	2	1	2100 W	9.6 / 8.3	
	Sunny Boy 2500HF-US (208, 240)	see max Voltage and Current	220 to 480	600	15	2	1	2600 W	12.0 / 10.4	
	Sunny Boy 3000HF-US (208, 240)	see max Voltage and Current	220 to 480	600	15	2	1	3150 W	14.4 / 12.5	
	Sunny Tripower 12000TL-US-10	see max Voltage and Current	300 to 800/150 to 1000	1000	66	1 per MPPT channel/8	2	12000 W	14.5	
	Sunny Tripower 15000TL-US-10	see max Voltage and Current	300 to 800/150 to 1000	1000	66	1 per MPPT channel/8	2	15000 W	18.1	
	Sunny Tripower 20000TL-US-10	see max Voltage and Current	380 to 800/150 to 1000	1000	66	1 per MPPT channel/8	2	20000 W	24.1	
	Sunny Tripower 24000TL-US-10	see max Voltage and Current	450 to 800/150 to 1000	1000	66	1 per MPPT channel/8	2	24000 W	29	
	MLX 60	78000 W	685 to 800	1000	110	1	1	60000 W	87	

Output Characteristics (AC)			Efficiency		General Information					
	Rated Voltages (V)	Frequency (Hz)	Peak %	CEC wtd %	Consumption Day (W)	Consumption Night (W)	Operating Temperature Range (°C)	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)
	208 / 240	60	98.6 / 98.6	98		0.15	-40 to 60	10	20	78
	208 / 240	60	98.6 / 98.7	98		0.15	-40 to 60	10	20	78
	208 / 240	60	98.6 / 98.7	97.5 / 98		0.15	-40 to 60	10	20	78
	240	60	98.7	98		0.15	-40 to 60	10	20	78
	208 / 240 / 277	60	96.7 / 96.8 / 96.8	95.5		0.1	-40 to 45	10	20	141
	208 / 240 / 277	60	96.9 / 96.8 / 97	95.5 / 95.5 / 96		0.1	-40 to 45	10	20	141
	208 / 240 / 277	60	97.1 / 96.9 / 97	95.5 / 96 / 96		0.1	-40 to 45	10	20	141
	240 / 277	60	96.3 / 96.5	96		0.1	-40 to 45	10	20	145
	208 / 240	60	96 / 96.5	95 / 95.5		0.1	-25 to 45	10	20	84
	240	60	96.8	96		0.1	-25 to 45	10	20	84
	208 / 240	60	96.5 / 96.8	95.5 / 96		0.1	-25 to 45	10	20	84
	208 / 240	60	97.3	97		0.8	-25 to 45	10	20	51
	208 / 240	60	96.9	96.5		0.8	-25 to 45	10	20	51
	208 / 240	60	96.6	96.5		0.8	-25 to 45	10	20	51
	277 / 480	60	98.2	97.5		1	-25 to 60	10	15/20	121 lb (55kg)
	277 / 480	60	98.2	97.5		1	-25 to 60	10	15/20	121 lb (55kg)
	277 / 480	60	98.5	97.5		1	-25 to 60	10	15/20	121 lb (55kg)
	277 / 480	60	98.5	98		1	-25 to 60	10	15/20	121 lb (55kg)
	400 / 480	60	98.8	98.5		1	-40 to 80	5	20	165

U.S. Inverter Models

String Inverters

		Input Characteristics, String Inverters, DC						Output Characteristics (AC)		
Manufacturer	Model	PV Array Power Range (kWp)	Voltage Range MPPT	Max Voltage DC	Max Current (A)	Number Of DC Inputs	MPPT	Rated Power (kW)	Max Current (A@V)	
SolarEdge	SE3000A-US	Recommended Max. 3.75	N/A; Fixed voltage	500	9.5	2	N/A; SE optimizers perform module-level MPPT	3.0	12.5	
www.solaredge.com	SE3800A-US	Recommended Max. 4.75	N/A; Fixed voltage	500	13.0	2	N/A; SE optimizers perform module-level MPPT	3.8	16.0	
	SE5000A-US	Recommended Max. 6.25	N/A; Fixed voltage	500	16.5 @ 208V / 15.5 @ 240V	2	N/A; SE optimizers perform module-level MPPT	5.0	24 @ 208V / 21 @ 240V	
	SE6000A-US	Recommended Max. 7.5	N/A; Fixed voltage	500	18.0	2	N/A; SE optimizers perform module-level MPPT	6.0	25.0	
	SE7600A-US	Recommended Max. 9.5	N/A; Fixed voltage	500	23.0	2	N/A; SE optimizers perform module-level MPPT	7.6	32.0	
	SE10000A-US	Recommended Max. 12.4	N/A; Fixed voltage	500	33.0 @ 208V / 30.5 @ 240V	2	N/A; SE optimizers perform module-level MPPT	10.0	48 @ 208V / 42 @ 240V	
	SE11400A-US	Recommended Max. 14.25	N/A; Fixed voltage	500	34.5	2	N/A; SE optimizers perform module-level MPPT	11.4	47.5	
	SE9kUS	Recommended Max. 11.25	N/A; Fixed voltage	250 DC to Gnd	26.5	2	N/A; SE optimizers perform module-level MPPT	9	25	

Output Characteristics (AC)		Efficiency		General Information					
	Rated Voltages (V)	Frequency (Hz)	Peak %	CEC wtd %	Consumption Day (W)	Consumption Night (W)	Operating Temperature Range (°C)	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)
	240	59.3 to 60.5	97.7	97.5		< 2.5	-25 to 60	12	25	51.2
	240	59.3 to 60.5	98.2	98		< 2.5	-25 to 60	12	25	51.2
	208 & 240	59.3 to 60.5	98.3	97.5 @ 208V / 98 @ 240V		< 2.5	-25 to 60	12	25	54.7
	240	59.3 to 60.5	98.3	97.5		< 2.5	-25 to 60	12	25	54.7
	240	59.3 to 60.5	98	97.5		< 4	-25 to 60	12	25	88.4
	208 & 240	59.3 to 60.5	98	97 @ 208V / 97.5 @ 240V		< 4	-25 to 60	12	25	88.4
	240	59.3 to 60.5	98	97.5		< 4	-25 to 60	12	25	88.4
	208 L-L	59.3 to 60.5	97.1	96.5		< 3	-25 to 60	12	25	79.7

U.S. Inverter Models

String Inverters

		Input Characteristics, String Inverters, DC						Output Characteristics (AC)		
Manufacturer	Model	PV Array Power Range (kWp)	Voltage Range MPPT	Max Voltage DC	Max Current (A)	Number Of DC Inputs	MPPT	Rated Power (kW)	Max Current (A@V)	
SolarEdge *(continued)*	SE10kUS	Recommended Max. 12.5	N/A; Fixed voltage	490 DC to Gnd	13.5	2	N/A; SE optimizers perform module-level MPPT	10	12	
www.solaredge.com	SE20kUS	Recommended Max. 25	N/A; Fixed voltage	490 DC to Gnd	26.5	2	N/A; SE optimizers perform module-level MPPT	20	24	
Solectria Renewables	PVI 1800	125 to 350	125 to 350	400	11	1	yes	1.8	208 - 8.7 / 240 - 7.5	
www.solectria.com	PVI 2500	125 to 350	125 to 350	400	15	1	yes	2.5	208 - 12 / 240 - 10.4	
	PVI 3800TL	120 to 550	200 to 500	600	20 A	2	yes	3.8	208 - 15.8 / 240 - 15.8	
	PVI 5200TL	120 to 550	200 to 500	600	15 A per MPPT (30 A)	2	yes	5.2	208 - 25 / 240 - 21.6	
	PVI 6600TL	120 to 550	200 to 500	600	18 A per MPPT (36 A)	2	yes	6.6	208 - 31.7 / 240 - 27.5	
	PVI 7600TL	120 to 550	200 to 500	600	20 A per MPPT (40 A)	2	yes	7.6	208 - 31.7 / 240 - 31.7	
	PVI 14TL	180 to 580	300 to 540	600	25 A per MPPT (50 A)	8 (4 per MPPT)	yes	14	39	
	PVI 20TL	260 to 580	300 to 550	600	35 A per MPPT (70 A)	8 (4 per MPPT)	yes	20	24	
	PVI 23TL	300 to 900	480 to 800	1000	25 A per MPPT (50 A)	8 (4 per MPPT)	yes	23	27.7	
	PVI 28TL	300 to 900	500 to 800	1000	29 A per MPPT (58 A)	8 (4 per MPPT)	yes	28	33.7	
Sungrow North America	SG30KU	42	280 to 950	1000	66	10	2	30	40	
www.sungrow.ca	SG36KU	50.4	280 to 950	1000	66	10	2	36	48	
	SG50KU	70	300 to 950	1000	104	16	4	50	80	
	SG60KU	84	570 to 950	1000	120	12	1	60	96	

Output Characteristics (AC)			Efficiency		General Information					
	Rated Voltages (V)	Frequency (Hz)	Peak %	CEC wtd %	Consumption Day (W)	Consumption Night (W)	Operating Temperature Range (°C)	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)
	480 L-L	59.3 to 60.5	98.2	98		< 3	-25 to 60	12	25	79.7
	480 L-L	59.3 to 60.5	98.1	98		< 3	-25 to 60	12	25	79.7
	208 or 240	60	93.8	208 - 92.5 / 240 - 92.5		208 - 0.26 / 240 - 0.10	-25 to +55	5	10	34.1
	208 or 240	60	93.8	208 - 92.0 / 240 - 93.0		208 - 0.14 / 240 - 0.32	-25 to +55	5	10	36.3
	208 or 240	60	98.3	97.5		< 1	-25 to +50	10	20	43
	208 or 240	60	98.3	97.5		< 1	-25 to +50	10	20	65
	208 or 240	60	98.3	97.5		< 1	-25 to +50	10	20	65
	208 or 240	60	98.3	97.5		< 1	-25 to +50	10	20	65
	208	60	96.9	96.0		< 3	-25 to +60	10	20	141
	480	60	97.4	97.0		< 3	-25 to +60	10	20	132
	480	60	98.6	98.0		< 3	-25 to +60	10	20	122
	480	60	98.5	98.0		< 3	-25 to +60	10	20	122
	422 to 528	57 to 63	98.5	98	<1	<1	-25 to 60	10	20	143
	422 to 528	57 to 63	98.5	98	<1	<1	-25 to 60	10	20	143
	422 to 528	55 to 65	98.9	98.5	<1	<1	-25 to 60	10	20	154
	310 to 480	55 to 65	99	98.7	<1	<1	-25 to 60	10	20	121

U.S. Inverter Models

Off-Grid Inverters

Manufacturer	Model	Input Voltage (V) DC	Input Current (Charger) AC (A)	Rated Power (25 °C)	Output Current (Charger 25°C)	Output Voltage (+/- 5%)	Output Frequency (+/- 0.1 Hz)	Charger Efficiency	Search Mode	
Darfon	HBF2000	75	25	1.6 kW	30	230	50/60	98%	N/A	
www.darfon.com	HBF3000	75	25	2.4 kW	30	230	50/60	98%	N/A	
	HBF5000	145	60	4 kW	30	230	50/60	97%	N/A	
Magnum Energy	RD2212	9-16 VDC	15	2200 W	110 ADC	120 VAC	60 Hz	85%	5 W	
www.magnumenergy.com	RD1824	18-32 VDC	15	1800 W	50 ADC	120 VAC	60 Hz	85%	5 W	
	RD2824	18-32 VDC	21	2800 W	80 ADC	120 VAC	60 Hz	85%	5 W	
	RD3934	18-32 VDC	29	3900 W	105 ADC	120 VAC	60 Hz	92%	5 W	
	MS2000	9-17 VDC	15	2000 W	100 ADC	120 VAC	60 Hz	85%	5 W	
	MS2012	9-17 VDC	15	2000 W	100 ADC	120 VAC	60 Hz	85%	7 W	
	MS2024	18-34 VDC	7.9	2000 W	60 ADC	120 VAC	60 Hz	85%	7 W	
	MS2812	9-17 VDC	18	2800 W	125 ADC	120 VAC	60 Hz	85%	7 W	
	MS4024	18-34 VDC	29	4000 W	105 ADC	120 VAC	60 Hz	85%	7 W	
	MM612AE	9-16 VDC	4	600 W	30 ADC	120 VAC	60 Hz	85%	3 W	
	MM1512AE	9-16 VDC	9	1500 W	70 ADC	120 VAC	60 Hz	88%	6 W	
	MM1524AE	18-32 VDC	9	1500 W	35 ADC	120 VAC	60 Hz	88%	4 W	
	MS4024PAE	18.0-34.0 VDC	15 AAC per leg	4000 W	105 ADC	120/240 VAC split phase	60 Hz	85%	<6 W	
	MS4448PAE	36.0-64.0 VDC	17.5 AAC per leg	4400 W	60 ADC	120/240 VAC split phase	60 Hz	85%	<6 W	
	MSH4024RE	18.0-34.0 VDC	AC 1&2 Input 29	4000 W	110 ADC	AC 1&2 Out 120 VAC	60 Hz	85%	<7 W	
OutBack Power	FX2012T-Sealed	12VDC	60 amps AC	0°C to 50°C	17 amps AC	2%	60Hz	90%	6 W	
www.outbackpower.com	FX2524T-Sealed	24VDC	60 amps AC	0°C to 50°C	20.8 amps AC	2%	60Hz	92%	6 W	
	FX3048T-Sealed	48VDC	60 amps AC	0°C to 50°C	25 amps AC	2%	60Hz	93%	6 W	
	VFX2812-Vented	12VDC	60 amps AC	0°C to 50°C	23.3 amps AC	2%	60Hz	90%	6 W	

	No Load	Operating Temperature °C	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)	1 msec (A) AC	100 msec (A) AC	5 sec (real W)	Power Factor	# AC Inputs
	N/A	0 to 55	2	2	17.6	14A (peak power)	14A (peak power)	2.4kW (peak power)	N/A	1
	N/A	0 to 55	2	2	17.6	21A (peak power)	21A (peak power)	3.6kW (peak power)	N/A	1
	N/A	0 to 55	2	2	17.6	35A (peak power)	35A (peak power)	6kW (peak power)	N/A	1
	20 W	-20°C to +60°C	2	2	37 lb	60	37	3700	>0.95	
	12 W	-20°C to +60°C	2	2	35 lb	70	40	4000	>0.95	
	19 W	-20°C to +60°C	2	2	42 lb	100	60	6000	>0.95	
	25 W	-20°C to +60°C	2	2	53 lb	150	90	8000	>0.95	
	25 W	-20°C to +60°C	3	5 when installed on MMP or MP system	40 lb	50	33	3300	>0.95	
	25 W	-20°C to +60°C	3	5 when installed on MMP or MP system	42 lb	50	33	3300	>0.95	
	25 W	-20°C to +60°C	3	5 when installed on MMP or MP system	41 lb	75	37	2850	>0.95	
	30 W	-20°C to +60°C	3	5 when installed on MMP or MP system	55 lb	70	40	3900	>0.95	
	25 W	-20°C to +60°C	3	5 when installed on MMP or MP system	55 lb	120	72	5800	>0.95	
	10 W	-20°C to +60°C	2	2	16 lb	27	11	1100	>0.95	
	18 W	-20°C to +60°C	2	2	22 lb	42	23	2100	>0.95	
	9 W	-20°C to +60°C	2	2	22 lb	45	24	2650	>0.95	
	27 W	-20°C to +60°C	3	5 when installed on MMP or MP system	55 lb	Line-Neutral: 120, Line-Line: 70	Line-Neutral: 72, Line-Line: 40	5800	>0.95	
	25 W	-20°C to +60°C	3	5 when installed on MMP or MP system	55 lb	Line-Neutral: 120, Line-Line: 70	Line-Neutral: 72, Line-Line: 40	8500	>0.95	
	25 W	-20°C to +60°C	3	5 when installed on MMP or MP system	58 lb	120	82	5800	>0.95	
	20W	-40 to 60 C	5 yrs	10 optional	62 lbs	56 amps AC	40 amps AC	4000VA	-1 to 1	1
	23W	-40 to 60 C	5 yrs	10 optional	62 lbs	70 amps AC	50 amps AC	4800VA	-1 to 1	1
	23W	-40 to 60 C	5 yrs	10 optional	62 lbs	70 amps AC	50 amps AC	4800VA	-1 to 1	1
	20W	-40 to 60 C	5 yrs	10 optional	61 lbs	56 amps AC	40 amps AC	4000VA	-1 to 1	1

U.S. Inverter Models

Off-Grid Inverters

Manufacturer	Model	Input Voltage (V) DC	Input Current (Charger) AC (A)	Rated Power (25 °C)	Output Current (Charger 25°C)	Output Voltage (+/- 5%)	Output Frequency (+/- 0.1 Hz)	Charger Efficiency	Search Mode	
OutBack Power *(continued)*	VFX3524-Vented	24VDC	60 amps AC	0°C to 50°C	29.2 amps AC	2%	60Hz	92%	6 W	
www.outbackpower.com	VFX3648-Vented	48VDC	60 amps AC	0°C to 50°C	30 amps AC	2%	60Hz	93%	6 W	
	GS8048, Radian	48VDC	50 amps AC	0°C to 50°C	33.3 amps at 240VAC	2%	60Hz	93%	10W	
	GS8048A, Radian	48VDC	50 amps AC	0°C to 50°C	33.3 amps at 240VAC	2%	60Hz	93%	10W	
	GS4048A, Radian	48VDC	50 amps AC	0°C to 50°C	33.3 amps at 240VAC	2%	60Hz	93%	10W	
Princeton Power Systems	Grid Tied Inverter (2 Port) - GTIB-30	(Battery) 280-600 standard, (PV) 280-580	(Grid) 208 VAC +10%, -12%, 3-phase 3/4 wire 480 VAC +10%, -12%, 3-phase 3/4 wire	32kW						
www.princetonpower.com	Grid Tied Inverter (2 Port) — GTIB-100	(Battery) 330-600, (PV) 330-580	(Grid) 480 VAC +10%, -12%, 3-phase 3/4 wire w/ transformer	100kW						
	Battery Integrated Inverter (3 Port) — BIGI-250	"(Battery) 415-600, (PV) 415-600	(Grid) 480 VAC +10%, -12%, 3-phase 3/4 wire	250 kW						
	Demand Response Inverter (4 Port) — DRI-10	(Battery) 250-600, (PV) 280-580	(Grid) 240 VAC +10%, -12% split phase 208 VAC +10%, -12% 2 phase	10 kW						
	Demand Response Inverter (4 Port) — DRI-100	(Battery) 280-600 standard / 36-600 vdc optional, (PV) 280-580	(Grid) 480 VAC +10%, -12%, 3-phase, 3-wire	100kW						
Schneider Electric	Conext SW 2524 E	20 - 34 Vdc	10.6 A	2500 W	65 A	230 Vac (nominal)	50 / 60 Hz Selectable	90.0%	Yes	
www.SEsolar.com	Conext SW 4024 E	20 - 34 Vdc	14.0 A	3400 W	90 A	230 Vac (nominal)	50 / 60 Hz Selectable	90.0%	Yes	
	Conext SW 4048 E	40 - 68 Vdc	14.0 A	3400 W	45 A	230 Vac (nominal)	50 / 60 Hz Selectable	90.0%	Yes	
	Conext SW 2524 NA	20 - 34 Vdc	9.0 A	2400 W	65 A	120 / 240 Vac	50 / 60 Hz Selectable	90.0%	Yes	

	No Load	Operating Temperature °C	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)	1 msec (A) AC	100 msec (A) AC	5 sec (real W)	Power Factor	# AC Inputs
	23W	-40 to 60 C	5 yrs	10 optional	61 lbs	70 amps AC	50 amps AC	5000VA	-1 to 1	1
	23W	-40 to 60 C	5 yrs	10 optional	61 lbs	70 amps AC	50 amps AC	5000VA	-1 to 1	1
	30W	-20 to 50 C	5 yrs	10 optional	125 lbs	100 amps AC at 240VAC 200 amps AC at 120VAC	70.7 amps AC at 240VAC	12kVA	-1 to 1	2
	34W	-20 to 50 C	5 yrs	10 optional	125 lbs	100 amps AC at 240VAC 200 amps AC at 120VAC	70.7 amps AC at 240VAC	12kVA	-1 to 1	2
	34W	-20 to 50 C	5 yrs	10 optional	82 lbs	100 amps AC at 240VAC 200 amps AC at 120VAC	70.7 amps AC at 240VAC	12kVA	-1 to 1	2
		0° to 50°C w/derating above 40°C			650 lbs				Greater than 0.95	
		0 to 50°C			1020 lbs				Greater than 0.95	
		0 to 30°C							0 to 1 leading and lagging (adjustable	
		0 to 40°C			500 lbs				0 - 1.00 leading or lagging (adjustable)	
		0 to 50°C			3,600 lbs				0- 1.00 leading or lagging (adjustable)	
		Minus 20°C to 60°C	2	5	49			5000 W	>0.98	1
		Minus 20°C to 60°C	2	5	62			7000 W	>0.98	1
		Minus 20°C to 60°C	2	5	62			7000 W	>0.98	1
		Minus 20°C to 60°C	2	5	49			4000 W	>0.98	1

U.S. Inverter Models

Off-Grid Inverters

Manufacturer	Model	Input Voltage (V) DC	Input Current (Charger) AC (A)	Rated Power (25 °C)	Output Current (Charger 25°C)	Output Voltage (+/- 5%)	Output Frequency (+/- 0.1 Hz)	Charger Efficiency	Search Mode	
Schneider Electric *(continued)*	Conext SW 4024 NA	20 - 34 Vdc	13.0 A	3400 W	90 A	120 / 240 Vac	50 / 60 Hz Selectable	90.0%	Yes	
www.SEsolar.com	Conext SW 4048 NA	40 - 68 Vdc	13.0 A	3400 W	45 A	120 / 240 Vac	50 / 60 Hz Selectable	90.0%	Yes	
	Conext XW+ 7048 E	40 to 64 V (48 V Nominal)	230 V	5500 W	110 A	230 Vac	50 / 60 Hz Selectable	95.8%	Yes	
	Conext XW+ 8548 E	40 to 64 V (48 V Nominal)	230 V	6800 W	140 A	230 Vac	50 / 60 Hz Selectable	95.8%	Yes	
	Conext XW+ 5548 NA	42 to 60 V (48 V Nominal)	3 - 60 A (60 A Default)	5500 W	110 A	L-N : 120V L-L : 240V	50 / 60 Hz Selectable	95.7%	Yes	
	Conext XW+ 6848 NA	42 to 60 V (48 V Nominal)	3 - 60 A (60 A Default)	6800 W	140 A	L-N : 120V L-L : 240V	50 / 60 Hz Selectable	95.7%	Yes	
SMA America	Sunny Island 4548-US	48	56	4500	180	120	60	96%		
www.sma-america.com	Sunny Island 6048-US	48	56	5750	180	120	60	96%		

Microinverters

		Microinverter Input Characteristics							Output Characteristics (AC)		
Manufacturer	Model	Nominal PV Power (W)	Max PV Power (W)	Max PV Voltage (V)	Operating range (V)	MPPT Range (V)	Min, Max Start-Up (V)	Max PV Current (A)	Max PV Source Short Circuit Current (A)	Max Power (W)	
ABB (Power-One)	Micro-0.25-I-OUTD-US	250	300	65	12 to 60	25 to 60	25	10.5A	12.5A	260	
www.abb.com/solarinverters	Micro-0.3-I-OUTD-US	300	360	65	12 to 60	30 to 60	25	10.5A	12.5A	310	
	Micro-0.3HV-I-Outd-US	300	360	79	19 to 75	30 to 75	25	10.5A	12.5A	310	
APS America	YC500A	180 to 310	310W (STC)	55	16 to 45	22 to 45	22, 55	12A x 2		500	
apsamerica.com	YC1000-3	180 to 310	310W (STC)	55	16 to 45	16 to 45	22, 55	14.8A x 4		900	
	OG500A	180 to 310	310W (STC)	55	21 to 29.6	n/a	21 to 29.6	12A x 2		500	
Darfon	MIG240	240	260	60	22 to 45	24 to 40	24	10	12	245	
www.darfon.com	MIG300	300	300	60	22 to 45	24 to 40	24	10	12	260	
Enecsys	240-60-MP	250	270 (STC)	44	20 to 44	24 to 35	22, 42.5	10.4	16	240	
www.enecsys.com	260-60-MP	275	295 (STC)	44	20 to 44	24 to 35	22, 42.5	11.2	16	260	

	No Load	Operating Temperature °C	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)	1 msec (A) AC	100 msec (A) AC	5 sec (real W)	Power Factor	# AC Inputs
		Minus 20°C to 60°C	2	5	62			7000 W	>0.98	1
		Minus 20°C to 60°C	2	5	62			7000 W	>0.98	1
		Minus 25°C to 70°C	2	5	118				0.98	2
		Minus 25°C to 70°C	2	5	121.7				0.98	2
		Minus 25°C to 70°C	2	5	118				0.98	2
		Minus 25°C to 70°C	2	5	121.7				0.98	2
	25W	negitive 13 F to 140 F	5	5	139					1
	25W	negitive 13 F to 140 F	5	5	139					1

	Output Characteristics (AC)					Efficiency		General Information			
	Nominal V, or Range	Nominal Current (A)	Nominal freq. range (Hz)	Max units per xA string	Max Fault Current (A)	Maximum %, CEC (%)	Night Consumption (mW)	Operating Temperature Range (°C)	Weight (lb)	Min Warranty (Yrs)	Max Warranty (Yrs)
	208, 240	1.2, 1.04	57-60.5Hz	13, 15	14.3A, 12.4A	96.5, 96	<50mW	-40 to 75	3.5	10	10
	208, 240	1.44, 1.25	57-60.5Hz	11, 12	14.3A, 12.4A	96.5, 96	<50mW	-40 to 75	3.5	10	10
	208, 240	1.44, 1.25	57-60.5Hz	11, 12	14.3A, 12.4A	96.5, 96	<50mW	-40 to 75	3.5	10	10
	181V-298V	181 to 298	59.3- 60.5	2.4 (208) 2.08 (240)	59.3 to 60.5	95.5%, 94.5%	120mW	16 to 45	2.5	25	25
	181V-310V (3ph)	181 to 310 (3ph)	59.3- 60.5	1.44 x3(208) 1.08 x 3 (480)	59.3 to 60.5	95%, 94%	300mW	16 to 45	4	10	10
	116.4-123.6	116.4 to 123.6	59.3- 60.5	4.17 (120) 2.17 (240)	59.3 to 60.5	92%,90%	0	21 to 29.6	2.4	10	10
	240	0.917	60	25 units per 30A string	2	95.7%, 95%	51	20 to 85	5.5	25	25
	250	1.04	60	24 units per 30A string	2	95.8%,95%	89	20 to 60	5.5	25	25
	240	1	60	16/20A	9.3A AC 3ms	96.5, 96	<30mW	-40°C to 85°C	3.6	25	25
	240	1.08	60	14/20A	9.3A AC 3ms	96.5, 96	<30mW	-40°C to 85°C	3.6	25	25

U.S. Inverter Models

Microinverters

		Microinverter Input Characteristics							Output Characteristics (AC)		
Manufacturer	Model	Nominal PV Power (W)	Max PV Power (W)	Max PV Voltage (V)	Operating range (V)	MPPT Range (V)	Min, Max Start-Up (V)	Max PV Current (A)	Max PV Source Short Circuit Current (A)	Max Power (W)	
Enecsys *(continued)*	280-60-MP	295	315 (STC)	44	20 to 44	24 to 35	22, 42.5	12.3	16	280	
www.enecsys.com	300-60-MP	315	335 (STC)	44	20 to 44	24 to 35	22, 42.5	13.1	16	300	
	250NL	265	290 (STC)	44	20 to 44	24 to 35	22, 42.5	10.4	16	250	
Enphase Energy	M215	190 to 270		48	16 to 48	27-39	22, 48	10	15	215	
enphase.com	M250	210 to 300		48	16 to 48	27-39	22, 48	10	15	250	
SMA America	Sunny Boy 240-US	250	60 Cell	45	23 to 45	23 to 32	23, 40	8.5 A	12 A	240 W	
www.sma-america.com											

Power Optimizers

		Input Characteristcs, DC, Power Optimizers						Output Characteristics (DC)		
Manufacturer	Model	PV Array Power Range (kWp)	Voltage Range MMP	Max Vdc	Max current (A)	Number of dc Inputs	MPPT	Rated Power (kW)	Max Current (A)	
SolarEdge	P300	300	8 to 48V	48V	10.0	1	1	na	15A DC	
www.solaredge.com	P400	400	8 to 80V	80V	10.0	1	1	na	15A DC	
	P405	405	12.5 to 105V	125V	10.0	1	1	na	15A DC	
	P600	600	12.5 to 80V	96V	10.0	1	1	na	15A DC	
	P700	700	12.5 to 105V	105V	10.0	1	1	na	15A DC	
Tigo Energy	Tigo Energy 2ES-50 (Retrofit)	N/A	16 to 48	52	10	2	2	0.6 (at DC output)	10 (at DC output)	
www.tigoenergy.com	Tigo Energy 2ES-75 (Retrofit)	N/A	30 to 65	75	7.5	2	2	0.7 (at DC output)	10 (at DC output)	

	Output Characteristics (AC)					Efficiency		General Information			
	Nominal V, or Range	Nominal Current (A)	Nominal freq. range (Hz)	Max units per xA string	Max Fault Current (A)	Maximum %, CEC (%)	Night Consumption (mW)	Operating Temperature Range (°C)	Weight (lb)	Min Warranty (Yrs)	Max Warranty (Yrs)
	240	1.17	60	13/20A	9.3A AC 3ms	96.5, 96	<30mW	-40°C to 85°C	3.6	25	25
	240	1.25	60	12/20A	9.3A AC 3ms	96.5, 96	<30mW	-40°C to 85°C	3.6	25	25
	240	1.04	60	15/20A	9.3A AC 3ms	96, 95.5	<30mW	-40°C to 85°C	2.6	25	25
	208Vac (183-229) 240Vac (211-264)	208 (1.1 A), 240 (0.9 A)	57-62.5	1 @ 208, .9 @ 240	59.3 to 60.5	96.5	65mW	(-40) to 65	1.6	25	25
	208Vac (183-229) 240Vac (211-264)	208 (1.15 A), 240 (1.0 A)	57-62.5	1.15 @ 208, 1 @ 240	59.3 to 60.5	96.5	65mW	(-40) to 85	2	25	25
	211 to 264 V	1 A	59.3 to 60.5	1 Series, 12 Parallel	Peak 51.2A, RMS 36.2A Duration 1.4 ms	96%, 96%	< 300	−40°C to +45°C	1.65	10	+5 or +10 yr extension to max 20 yr

	Output Characteristics (DC)		Efficiency		General Information					
	Rated Voltages	Frequency (Hz)	Maximum %	CEC wtd %	Consumption (W) day/ night		Operating °C range	Min Warranty (Yrs)	Max Warranty (Yrs)	Weight (lb)
	60V DC	na	99.5	98.8	na	na	-40 to +85	25	25	2.05
	60V DC	na	99.5	98.8	na	na	-40 to +85	25	25	2.05
	85V DC	na	99.5	98.8	na	na	-40 to +85	25	25	2.05
	85V DC	na	99.5	98.6	na	na	-40 to +85	25	25	2.05
	85V DC	na	99.5	98.6	na	na	-40 to +85	25	25	2.05
	52 (at DC output)	N/A	99.8	99.6	<1	0	-30 to 70	25	25	1
	75 (at DC output)	N/A	99.8	99.6	<1	0	-30 to 70	25	25	1

U.S. Racking & Mounting Models

Flat-Roof Mounting

COMPANY	MODEL	MATERIALS	ATTACHED OPTION?	TILT ANGLES (DEGREES)	CERTIFICATIONS	GROUNDING	PANEL COMPATIBILITY	WARRANTY
Aerocompact	S	Aluminum	Yes	5, 10, 15	Windtunnel, Ca. approved, ETTL to UL 2703	Integrated	60 and 72 cell	25 years
www.aerocompact.com	EW+	Aluminum	Yes	10	Windtunnel, Ca. approved, ETTL to UL 2703	Integrated	60 and 72 cell	25 years
Crider Solar	10	Aluminum	Multiple	Up to 25		Included	All	10 years
www.crideramericas.com	20	Steel / Aluminum	Multiple	Up to 25		Included	All	10 years
	30	Steel Aluminum	Multiple	Up to 25		Included	All	10 years
DPW Solar	POWER XPRESS	Steel	Yes	5 or 10	UL467	Integrated	All major brands	10 years
www.dpwsolar.com	POWER-FAB CRS-G2	Aluminum	Yes	5 or 10	UL467	Integrated	All major brands	10 years
	Ballasted Power Rail	Aluminum	Yes	0	UL467	Washers	All major brands	10 years
	Ballasted Roof Mount	Aluminum	No	20 to 45	UL467	Washers	All major brands	10 years
Dual Rack	Dual Jack tilt kit	Asphalt comp. shingle	6005-T5	Variable	PE certified, UL 2703 pending	Self rounding / UL 2703 grounding mid clamps for modules / UL 2703 grounding lay in lug for rail	Any module frame	10 years limited
fortuneenergy.net	Flash L-tilt kit	Asphalt comp. shingle	6005-T6	Variable	PE certified, UL 2703 pending	Self rounding / UL 2703 grounding mid clamps for modules / UL 2703 grounding lay in lug for rail	Any module frame	10 years limited
DynoRaxx *dynoraxx.com*	Evolution FR	Fiberglass with UV Protection		10	PE Certified / ASCE 7-05 & 7-10 compliant / IBC compliant / Wind tunnel tested	DynoBond for modules only / Racking does not need to be grounded	All 60, 72, and 96 cell modules	10 years
Ecolibrium Solar *ecolibriumsolar.com*	EcoFoot2+	White ASA UL-listed Resin	Preassembled universal clamp	5, 10	Class-A Fire Safety - California / Subject UL2703 Bonding / Grounding / Wind Tunnel and CFD Tested / SEAOC Seismic Compliant	Integrated grounding without need for grounding washers	All	25 years

Editor's Note:
Manufacturers were contacted to obtain accurate information for this section. In the event that data was not received through a company representative, information was obtained through product brochures, data sheets and websites. If further information becomes available we will update online in our ***Racking Specification Tool*** *available at www.solarpowerworldonline.com, and note for the 2016 print edition.*

Flat-Roof Mounting

COMPANY	MODEL	MATERIALS	ATTACHED OPTION?	TILT ANGLES (DEGREES)	CERTIFICATIONS	GROUNDING	PANEL COMPATIBILITY	WARRANTY
Enable Energy	Avanza - rail-free	Aluminum and steel	Penetration	Adjustable	UL	Yes	All major brands	10 years
enable-energy.com	Solante - rail system	Aluminum and steel	Penetration	Adjustable	UL	Yes	All major brands	10 years
GameChange Racking	GC Roof System	Aluminum and steel	Available in attached or floating system	5, 10, 15 and 20	CPP, ETL/UL 467 and 2703	ETL/UL 467 tested grounding strip	All panels	20 years
gamechangeracking.com								
HatiCon Solar	alTite	Aluminum	Yes	Up to 45	No	Yes	Landscape and portrait	10 year standard (Extended available)
haticonsolar.com	alLite	Aluminum	Yes	5, 10 and 15	No	Yes	Landscape and portrait	10 year standard (Extended available)
IronRidge	Ballasted Roof Mount System	Galvanized and stainless steel	Ballasted; seismic anchors available	10	Wind Tunnel Tested; PE Certified	WEEB	Most 60- and 72-modules	20 years
www.ironridge.com	Roof Mount System (w/ Tilt Legs)	6000-series aluminum	Tilt stand-offs	0 to 45	UL 2703; PE Certified	Integrated	Most 60- and 72-modules	20 years
KB Racking	EkonoRack 2.0	Aluminum	Yes	5, 10, 12, 15	ETL Certified	Once per array	Framed PV modules	10 year standard (Extended available)
kbracking.com	AeroRack	Aluminum	Yes	5, 10, 15, 20, 25	Wind Tunnel Tested	Once per array	Framed PV modules	10 year standard (Extended available)
Mounting Systems	Lambda	Aluminum and stainless steel	Yes	Up to 30			Framed and unframed	10 years
usa.mounting-systems.info	Lambda Light EW+	Aluminum and stainless steel	Yes	10 or 15	UL 2703 (pending);UL 1703 Revised (pending); IBC 2012; ASCE 7-05/7-10	Fully integrated bonding	Framed and unframed	10 years
	Lambda Light S+	Aluminum and stainless steel	Yes	11 or 15	UL 2703 (pending);UL 1703 Revised (pending); IBC 2012; ASCE 7-05/7-10	Fully integrated bonding	Framed and unframed	10 years

U.S. Racking & Mounting Models

Flat-Roof Mounting

COMPANY	MODEL	MATERIALS	ATTACHED OPTION?	TILT ANGLES (DEGREES)	CERTIFICATIONS	GROUNDING	PANEL COMPATIBILITY	WARRANTY
Orion Solar Racking	Ballasted System	5052-H32 aluminum	Ballasted (seismic available); TPO roofing attachment	5, 10, 15	UL 2703	Integrated	Most 60 and 72 cell modules	15 years
www.orionsolarracking.com	Adjustable Tilt System	6061-T6 aluminum	Tilt, stand offs; TPO roofing option	Up to 60	UL 2703: PE	Integrated	Most 60 and 72 cell modules	15 years
PanelClaw	Polar Bear III, ballasted flat roof mounting system	Aluminum and G90 steel	Yes	10	System level fire classified with a Class A rating for type 1 and type 2 modules	ETL classified under UL 2703	All leading brands	25 years
www.panelclaw.com	Polar Bear East-West, ballasted flat roof mounting system	Aluminum and G90 steel	Yes	10	n/a	UL 2703 certified for electric bonding and grounding	All leading brands	10 years
Patriot Solar Group *patriotsolargroup.com*	Spider ST-Ballasted Roof Mount	Plastic HDPE	Standoff, guywire, etc.	5.4, 7	50 PSF snow load; 150 MPH wind load	Integrated	All commercially available	25 years
Polar Racking	PR2 Ballasted Flat Roof System	Aluminum with stainless steel fasteners	Inverter Stands, Anchoring for Seismic zones and under capacity roof tops	5, 10, 15, 20, 25, 30	Bonding & Grounding -TUV SUD America, Mechanical Load tested and Wind tunnel tested	Fully integrated	All standard 60 and 72 cell modules	10 years
www.polarracking.com	PRB Ballasted Flat Roof System	Aluminum with stainless steel fasteners	Wind Deflectors, Ballast Tray extensions	7, 12	UL 2703, Class A/B Fire Rating and Wind tunnel Test	Fully integrated	All standard 60 and 72 cell modules	10 years
RBI Solar *www.rbisolar.com*	RM-B	Aluminum	n/a	5 to 15	ETL Classified to UL2703	WEEB, Bonding Washers	All commercially available	20 years
Renusol America	Renusol CS60	HMWPE	yes	10, 15	UL2703 Bonding	Dynobond	Framed 60-cell	25 years
www.renusolamerica.com	Renusol EW	Aluminum and stainless steel	Yes	10	Wind Tunnel, UL467 Bonding, UL1703 Fire	WEEB / Integrated	Framed 60 and 72 cell	25 years
Schletter	FixEZ	Aluminum	Yes	3 to 15 degrees	ETL, ISO 9001-2008, ASCE, IBC	Yes	All	20-year Limited Warranty
www.schletter.us	AluGrid	Aluminum	Yes	10 or 15 degrees	ETL, ISO 9001-2008, ASCE, IBC	Yes	All	20-year Limited Warranty

Flat-Roof Mounting

COMPANY	MODEL	MATERIALS	ATTACHED OPTION?	TILT ANGLES (DEGREES)	CERTIFICATIONS	GROUNDING	PANEL COMPATIBILITY	WARRANTY
Schletter *(continued)*	Windsafe	Aluminum	Yes	0 to 90 degrees	ETL, ISO 9001-2008, ASCE, IBC	Yes	All	20-year Limited Warranty
www.schletter.us	IsoTop	Aluminum	Yes	0 to 90 degrees	ETL, ISO 9001-2008, ASCE, IBC	Yes	All	20-year Limited Warranty
SnapNrack Solar Mounting Solutions	550	Anodized aluminum clamp and tilt legs with stainless steel hardware	Yes	10	50-state Structural Engineering	WEEB	60 and 72 cell modules	10 years
www.snapnrack.com	500	Anodized aluminum clamp with stainless steel hardware	Yes	Flush to roof	50-state Structural Engineering	WEEB	60 and 72 cell modules	10 years
	450	Anodized aluminum rail and tilt legs, galvanized steel wind screens with stainless steel hardware	Yes	5, 12, 20		WEEB	Modules approved for short-side mounting	10 years
	100 UL	Anodized aluminum and stainless steel hardware	Yes	0 to 45	UL 2703 Listed for Electrical Bonding and Fire; 50-state Structural Engineering	Integrated	60 and 72 cell modules	10 years
Solar SpeedRack	SpeedTrack	Steel and aluminum	Membrane anchoring or ballast	15, 30	PE Certification	3rd party	Prism Solar panels only	10 years
www.solarspeedrack.com								
SolarDock	SolarDock 2	Aluminum with stainless steel hardware	No	Up to 35	TUV Rheinland PTL UL2703	Patented grounding clip, integrated panel and system grounding	All modules with frames	25 years
www.solardock.com								
Sollega	FastRack FR510	Ultramid nylon (33% glass)	Yes	5, 10	UL 2703 Grounding	Integrated	All framed and some frameless	25 years
www.sollega.com								
Spider-Rax	Tarantula	Aluminum 6063-T6 and stainless steel	Yes	5 to 35	UL 2703	Integrated	All framed modules	20 years
spiderrax.com								
SunLink	Precision-Modular RMS	Aluminum (5052-H32; 6005A-T61), TPV, stainless steel, galvanized steel	Ballasted, connected or hybrid	10	ETL listed to 2703; Certified class A system fire classification rating with type 1 modules	Fully integrated grounding	All major 60- and 72-cell brands	15 years
sunlink.com								

U.S. Racking & Mounting Models

Flat-Roof Mounting

COMPANY	MODEL	MATERIALS	ATTACHED OPTION?	TILT ANGLES (DEGREES)	CERTIFICATIONS	GROUNDING	PANEL COMPATIBILITY	WARRANTY
SunLink *sunlink.com*	Precision RMS	Aluminum (5052-H32; 6005A-T61), recycled rubber, stainless steel	Ballasted, connected or hybrid	5, 10, 15, 20, 25, 30	ETL listed to 2703	Fully integrated grounding	All major brands	15 years
SunModo *sunmodo.com*	EZ SunBeam Flat Roof System	Aluminum	Universal	Adjustable for any tilt	UL	Integrated grounding	All major brands	10-year limited
S:FLEX	LEICHT mount FLEX	Aluminum, stainless steel hardware	Yes	0 to 35	Conforms to IBC, wind-tunnel tested up to 150 mph wind speeds, various stamped PE certification letters, MCS Certificate by BBA, EG Certificate by TÜV-Rheinland, UL 2703 in progress	Integrated grounding	Any framed and frameless modules	10 years. Extension available.
www.sflex.com	LEICHT mount EU South	Aluminum, stainless steel hardware	Yes	5 , 10 and 15	ETL Listed to UL 2703, up to 150 mph wind speeds	Integrated grounding	Any framed modules	25 years
	LEICHT mount EU East-West	Aluminum, stainless steel hardware		10	ETL Listed to UL 2703, up to 150 mph wind speeds	Integrated grounding	Any framed modules	25 years
	Tilt Leg / Triangles	Aluminum, stainless steel hardware	Yes	Up to 45	Conforms to IBC, various stamped PE certification letters, MCS Certificate by BBA, EG Certificate by TÜV-Rheinland, UL 2703 in progress	Integrated grounding	Any framed and frameless modules	10 years. Extension available.
	Elevated Rooftop Array (SLA)	Aluminum, stainless steel hardware	Yes	Up to 45	Conforms to IBC, various stamped PE certification letters, MCS Certificate by BBA, EG Certificate by TÜV-Rheinland, UL 2703 in progress	Integrated grounding	Any framed and frameless modules	10 years. Extension available.
Unirac *unirac.com*	RM - ROOF MOUNT	Aluminum	Yes	10 nominal	UL 2703 bonding and grounding and fire certification	Integrated bonding	All major brands	20-year manufacturing warranty
Zilla *www.zillarac.com*	Cobra	Aluminum, stainless hardware, galvanized ballast pans	Yes	10 and custom	n/a	Weebs included with hardware	All Standard Framed Modules w/ Mounting Holes	10 Year

Sloped-Roof Mounting

COMPANY	MODEL	APPLICABLE ROOF TYPES	MATERIALS	APPLICABLE TO NEW AND/ OR EXISTING ROOFS?	FLASHING INCLUDED?	HARDWARE INCLUDED?	NO. OF ROOF ATTACHMENTS	RAIL COMPATIBILITY	CERTIFICATIONS
DPW Solar *www.dpwsolar.com*	Power Rail	All	Aluminum	Both	Yes	Yes	56	Power Rail	UL467
Dual Rack	Dual Jack kit	Asphalt comp. shingle	6005-T5	Both	Yes	Yes	One	Dual rail and most available racking on the market	PE certified; UL2703 pending
fortuneenergy.net	Flash L-kit	Asphalt comp. shingle	6005-T6	Both	Yes	Yes	One	Dual rail and most available racking on the market	PE certified; UL2703 pending
	S-tile roof hook	S-tile	Stainless steel 1.4301	Both	No	Yes	Two	Dual rail and most available racking on the market	PE certified; UL2703 pending
	Flat tile roof hook	Flat tile	Stainless steel 1.4301	Both	No	Yes	Two	Dual rail and most available racking on the market	PE certified; UL2703 pending
DynoRaxx *www.dynoraxx.com*	Evolution PR 2.0	Asphalt	6061 Aluminum	Both	Yes	Yes	2	All 60, 72, and 96 cell modules	
EcoFasten Solar	Green Fasten GF1	Composition Shingle	.032 gauge aluminum, 304 18.8 stainless steel, EPDM rubber	Both	Yes	Yes	1	Compression bracket options that offer compatibility with all major racking manufacturers	IAPMO
www.ecofastensolar.com	Green Fasten GF2	Composition Shingle	.032 gauge aluminum, 304 18.8 stainless steel, EPDM rubber	Both	Yes	Yes	2	Compression bracket options that offer compatibility with all major racking manufacturers	
	QuikFoot	Composition Shingle, Slate	6000 series aluminum, 18.8 stainless steel,.032 gauge aluminum	Both	Yes	Yes	2	Compression bracket options that offer compatibility with all major racking manufacturers	
	CorruSlide	Corrugated Metal	6000 series aluminum, 18.8 stainless steel	Both	N/A	Yes	5	Compression bracket options that offer compatibility with all major racking manufacturers	

U.S. Racking & Mounting Models

Sloped-Roof Mounting

COMPANY	MODEL	APPLICABLE ROOF TYPES	MATERIALS	APPLICABLE TO NEW AND/ OR EXISTING ROOFS?	FLASHING INCLUDED?	HARDWARE INCLUDED?	NO. OF ROOF ATTACHMENTS	RAIL COMPATIBILITY	CERTIFICATIONS
EcoFasten Solar *(continued)*	Simple Seal System	Metal Ribbed, Metal with Exposed Fasteners	EPDM Rubber	Both	N/A	Yes	1 or 2, depending on bracket option	Compression bracket options that offer compatibility with all major racking manufacturers	
www.ecofastensolar.com	SIM-Support	Corrugated Metal	6000 series aluminum, 18.8 stainless steel, EPDM rubber	Both	N/A	Yes	2	Compression bracket options that offer compatibility with all major racking manufacturers	
	ASG-U Clamps	Metal Standing Seam	6000 series aluminum, 304 stainless steel 18.8 alloy	Both	N/A	Yes	2	Compression bracket options that offer compatibility with all major racking manufacturers	
	Tile Flashing System - Flat	Flat Tile	6000 series aluminum, 18.8 stainless steel, .032 gauge pre-finished 3105 aluminum, 6061 T-6 aluminum, EPDM rubber	Both	Yes	Yes	2	Compression bracket options that offer compatibility with all major racking manufacturers	
	Tile Flashing System - W	W Tile	6000 series aluminum, 18.8 stainless steel, .032 gauge pre-finished 3105 aluminum, 6061 T-6 aluminum, EPDM rubber	Both	Yes	Yes	2	Compression bracket options that offer compatibility with all major racking manufacturers	
	Tile Flashing System - S	S Tile	6000 series aluminum, 18.8 stainless steel, 0.32 gauge pre-finished 3105 aluminum, 6061 T-6 aluminum, EPDM rubber	Both	Yes	Yes	2	Compression bracket options that offer compatibility with all major racking manufacturers	

Sloped-Roof Mounting

COMPANY	MODEL	APPLICABLE ROOF TYPES	MATERIALS	APPLICABLE TO NEW AND/ OR EXISTING ROOFS?	FLASHING INCLUDED?	HARDWARE INCLUDED?	NO. OF ROOF ATTACHMENTS	RAIL COMPATIBILITY	CERTIFICATIONS
EcoFasten Solar *(continued)*	Eco-44R-NDD	SIPs Panels, Wood Decking, Wood Blocking	6000 series aluminum, 304 stainless steel, .032 gauge aluminum	Both	Yes	Yes	8	Compression bracket options that offer compatibility with all major racking manufacturers	
www.ecofastensolar.com									
Enable Energy	Avanza - rail less	Sloped and flat roof	Aluminum and steel	Both	Yes	Yes	Varies	n/a	UL
enable-energy.com	Solante - rail system	Sloped and flat roof	Aluminum and steel	Both	Yes	Yes	Varies	n/a	UL
HatiCon Solar	alHome	Tile, asphalt shingle, metal roof	Aluminum	Both	No	Yes	Dependent on roof type and zones	Yes	No
www.haticonsolar.com									
IronRidge	Roof Mount System	All roof types	6000-series aluminum and stainless steel	Both	Yes	Yes	N/A	IronRidge	UL 2703, Integrated Grounding, Class A Fire Rating, PE Certified
www.ironridge.com									
Magerack	Magerack Solar Mounting System 101 Series	Asphalt, Shake, Tile, Stone-Coated Steel Roof	Anodized aluminum alloy 6061-T6 and stainless steel 304	Both	Yes	Yes	N/A	Magerack	UL 2703 Listed and P.E. Engineering Report
www.magerack.com	L-foot with Flashing	Asphalt, Shake	Anodized aluminum alloy 6061-T6 and stainless steel 304	Both	Yes	Yes	2 or 4	All racking systems with side-mounted rails	Testing and P.E. Engineering Reports
	Tile Hook with Flashing	Tile	Stainless steel 304	Both	Yes	Yes	2 or 4	All racking systems with side-mounted rails	Testing and P.E. Engineering Reports
	Tile Hook for Stone-Coated Steel Roof	Stone-Coated Steel Roof	Stainless steel 304	Both	No	Yes	2 or 4	All racking systems with side-mounted rails	Testing and P.E. Engineering Reports
Mounting Systems	Alpha+	Flat tile, curved tile, corrugated, composition shingles, shake shingles, slate, flat metal, standing seam	Aluminum and stainless steel	Both	No	Yes	Various roof hooks, L-feet, hanger bolts, clamps		UL Subj 2703 (ETL listing pending), UL 1703 Revised (ETL listing pending), ETL listing to UL 467, IBC 2012, ASCE 7-05/7-10
usa.mounting-systems.info									

U.S. Racking & Mounting Models

Sloped-Roof Mounting

COMPANY	MODEL	APPLICABLE ROOF TYPES	MATERIALS	APPLICABLE TO NEW AND/ OR EXISTING ROOFS?	FLASHING INCLUDED?	HARDWARE INCLUDED?	NO. OF ROOF ATTACHMENTS	RAIL COMPATIBILITY	CERTIFICATIONS
Mounting Systems *(continued)* *usa.mounting-systems.info*	Tau+	Trapezoidal metal sheet	Aluminum and stainless steel	Both	N/A	Yes	Two		ETL listing to UL Subj 2703 (pending), ETL listed to UL 467, IBC 2012, ASCE 7-05/7-10
Orion Solar Racking *www.orionsolarracking.com*	Venus System	Comp shingle, spanish, flat	Rails are 6005, clamps are stainless steel	Both	Yes	Yes		Most 60 and 72 cell modules	UL 2703, PE certified
Polar Racking *www.polarracking.com*	PRR Flush Mount Racking System	Flush mounted shingle, metal, tile roofs, awning, BIPV and facade mounts	6000 Series aluminum components, 300 Series stainless steel hardware	Both	No, but sold as accessories	Yes		Compatible of mounting all framed modules ranging from 35 mm - 50 mm	UL 2703, Class A & Class B fire rating & Mechanical load tested
PV Racking *www.pvracking.us*	Clamp-free pitched roof mount	Any pitched roof	Aluminum, stainless steel hardware	Both	Upon request	Yes	Varies	Compatible with most flashing on the market	N/A
Quick Mount PV	Quick Rack	Composition/ Asphalt Shingle Roofs	Aluminum, stainless steel hardware, EPDM rubber	Both	Yes	Yes	1	Rail-free	UL System Fire Class Rating A, Type 1 Modules; UL 2703
www.quickmountpv.com	Classic Comp Series	Composition/ Asphalt Shingle Roofs	Aluminum, stainless steel hardware, EPDM rubber	Both	Yes	Yes	1	All major commercially available brands	ICC-ES certified
	E-Mount Series	Composition/ Asphalt Shingle Roofs	Aluminum, stainless steel hardware, EPDM rubber	Both	Yes	Yes	1	All major commercially available brands	
	Quick Hook Series	Curved and Flat Tile Roofs	Aluminum, stainless steel hardware, EPDM rubber	Both	Yes	Yes	2	All major commercially available brands	

Sloped-Roof Mounting

COMPANY	MODEL	APPLICABLE ROOF TYPES	MATERIALS	APPLICABLE TO NEW AND/ OR EXISTING ROOFS?	FLASHING INCLUDED?	HARDWARE INCLUDED?	NO. OF ROOF ATTACHMENTS	RAIL COMPATIBILITY	CERTIFICATIONS
Quick Mount PV *(continued)*	QBase Unvivesal Tile Mount	Curved and Flat Tile Roofs	Aluminum, stainless steel hardware, EPDM rubber	Both	Yes (double flashed)	Yes	2 or 4	All major commercially available brands	
www.quickmountpv.com	QBase Standard Flat Tile Mount	Flat Tile Roofs	Aluminum, stainless steel hardware, EPDM rubber	Both	Yes (double flashed)	Yes	2 or 4	All major commercially available brands	
	QBase Composition Mount	Composition / Asphalt Shingle Roofs	Aluminum, stainless steel hardware, EPDM rubber	Both	Yes	Yes	2 or 4	All major commercially available brands	
	QBase Low Slope Mount	Low slope roofs	Aluminum, stainless steel hardware, EPDM rubber	Both	No. For built-up asphalt roofs alum. flashing avails.	Yes	2 or 4	All major commercially available brands	
	Classic Shake Mount	Shake roofs	Aluminum, stainless steel hardware, EPDM rubber	Both	Yes	Yes	1	All major commercially available brands	ICC-ES certified
	QBase Shake & Slate Mount	Shake, Slate and Decra Metal Shingle roofs	Aluminum, stainless steel hardware, EPDM rubber	Both	Yes	Yes	2 or 4	All major commercially available brands	
	Specialty Flat Tile Mount	Flat Tile Roofs	Aluminum, stainless steel hardware, EPDM rubber	Both	Yes (double flashed)	Yes	2 or 4	All major commercially available brands	
	Classic Conduit Mount	Composition / Asphalt Shingle Roofs	Aluminum, stainless steel hardware, EPDM rubber	Both	Yes	Yes	1	All major commercially available brands	
	Classic Conduit Shake Mount	Shake roofs	Aluminum, stainless steel hardware, EPDM rubber	Both	Yes	Yes	1	All major commercially available brands	
	Conduit Penetration Flashing	Composition / Asphalt Shingle Roofs	Aluminum, stainless steel hardware, EPDM rubber	Both	Yes	Yes	N/A	All major commercially available brands	

U.S. Racking & Mounting Models

Sloped-Roof Mounting

COMPANY	MODEL	APPLICABLE ROOF TYPES	MATERIALS	APPLICABLE TO NEW AND/ OR EXISTING ROOFS?	FLASHING INCLUDED?	HARDWARE INCLUDED?	NO. OF ROOF ATTACHMENTS	RAIL COMPATIBILITY	CERTIFICATIONS
Renusol America	Renusol VS	All	Aluminum	Both	Yes	Yes	Depends on spans	60 and 72 cell modules	UL467 Bonding, UL1703 Fire
www.renusolamerica.com	Renusol MS	Trapezoidal	Aluminum	Both	Yes (integrated)	Yes	Shares - railless system	Frames 60 and 72 cell modules	UL467 Bonding, UL1703 Fire
Roof Tech	rt-[e] mount	Asphalt	Aluminum, stainless, butyl	Both	Yes, integrated	Yes, stainless	Multiple fasteners	Framed modules	UL2703, ASTM 2140, ICC, and IBC 2006,2009 2012
www.roof-tech.us	rt-[e] mount air	Asphalt	Aluminum, stainless, butyl	Both	Yes, integrated	Yes, stainless	Multiple fasteners	Framed modules	UL2703, ASTM 2140, ICC, and IBC 2006,2009 2012
	u set solar	Asphalt	Aluminum, stainless, butyl	Both	Yes, integrated	Yes, stainless	Multiple fasteners	See website	n/a
S-5!	S-5-PV Kit	Standing seam metal roofs and exposed fastened metal roofs		Both	Not needed	Yes	Varies by Project	PV Kit replaces need for racking	
www.s-5.com	S-5! Clamps	Standing seam metal roofs		Both	Not needed	Yes	Varies by Project	Most types	
	S-5! Brackets	Exposed fastened metal roofs		Both	Not needed	Varies	Varies by Project	Most types	
Schletter	FixZ Series	All	Aluminum	Both	Optional	Yes	Depending on spacing	All modules	ETL, ISO 9001-2008, ASCE, IBC
www.schletter.us	Windsafe	All	Aluminum	Both	Optional	Yes	Depending on spacing	All modules	ETL, ISO 9001-2008, ASCE, IBC
	Standard Flush Mount	All	Aluminum	Both	Optional	Yes	Depending on spacing	All modules	ETL, ISO 9001-2008, ASCE, IBC
	GridNorm	All	Aluminum	Both	Optional	Yes	Depending on spacing	All modules	ETL, ISO 9001-2008, ASCE, IBC
SnapNrack Solar Mounting Solutions	100 UL	Composition shingle, flat tile, S-tile, corrugated, metal panel, standing seam	Anodized aluminum and stainless steel hardware	Both	Composition roof - flashing included; concrete tile roof - flashing options available	All hardware included except for roof interface fastener	N/A	All standard 60 cell and 72 cell	UL 2703 listed for electrical bonding and fire; 50-state structural engineering
www.snapnrack.com									

Sloped-Roof Mounting

COMPANY	MODEL	APPLICABLE ROOF TYPES	MATERIALS	APPLICABLE TO NEW AND/ OR EXISTING ROOFS?	FLASHING INCLUDED?	HARDWARE INCLUDED?	NO. OF ROOF ATTACHMENTS	RAIL COMPATIBILITY	CERTIFICATIONS
Solar SpeedRack	Solar Speed Mount	All	Aluminum	Both	N/A	Yes	N/A	See website	UL 467 / UL2703 / PE
www.solarspeedrack.com	Solar SpeedRail	All	Aluminum	Both	N/A	Yes	N/A	See website	PE
solarroofhook.com	Adjustable 90° All Tile Hook for Side Mount Rails (Part# STRHA DJ9038)	Curved (Spanish) Tile Roofs and Flat Tile Roofs; with or without batons	304 Stainless Steel Hook; 302 Stainless Steel Screws	Both	Flashing Available	Hooks and Mounting Screws	2 or 4	Compatible with IronRidge, DPW Solar, Snap n Rack, Zillarac and more	Test results available
www.solarroofhook.com	90° Flat Tile Hook for Side Mount Rails (Part# FTRH 9038)	Flat Tile Roofs	304 Stainless Steel Hook; 302 Stainless Steel Screws	Both	No	Hooks and Mounting Screws	2 or 4	Compatible with IronRidge, DPW Solar, Snap n Rack, Zillarac and more	Test results available
	180° Flat Tile Hook for Bottom Mount Rails (Part# FTRH 18038)	Flat Tile Roofs	304 Stainless Steel Hook; 302 Stainless Steel Screws	Both	No	Hooks and Mounting Screws	2 or 4	Compatible with IronRidge, DPW Solar, Snap n Rack, Zillarac and more	Test results available
	90° Spanish Tile Hook for Side Mount Rails (Part# STRH90)	Curved (Spanish) Tile Roofs	304 Stainless Steel Hook; 302 Stainless Steel Screws	Both	Flashing Available	Hooks and Mounting Screws	2 or 4	Compatible with IronRidge, DPW Solar, Snap n Rack, Zillarac and more	Test results available
	180° Spanish Tile Hook for Bottom Mount Rails (Part# STRH180)	Curved (Spanish) Tile Roofs	304 Stainless Steel Hook; 302 Stainless Steel Screws	Both	Flashing Available	Hooks and Mounting Screws	2 or 4	Compatible with IronRidge, DPW Solar, Snap n Rack, Zillarac and more	Test results available
	Adjustable 180° Spanish Tile Hook for Bottom Mount Rails (Part# STRH ADJ)	Curved (Spanish) Tile Roofs	304 Stainless Steel Hook; 302 Stainless Steel Screws	Both	Flashing Available	Hooks and Mounting Screws	2 or 4	Compatible with IronRidge, DPW Solar, Snap n Rack, Zillarac and more	Test results available

Sloped-Roof Mounting

COMPANY	MODEL	APPLICABLE ROOF TYPES	MATERIALS	APPLICABLE TO NEW AND/ OR EXISTING ROOFS?	FLASHING INCLUDED?	HARDWARE INCLUDED?	NO. OF ROOF ATTACHMENTS	RAIL COMPATIBILITY	CERTIFICATIONS
solarroofhook.com *(continued)*	Adjustable 180° Spanish Tile Hook with 97mm Height Adjustment for Bottom Mount Rails (Part# STRHAD J18097)	Curved (Spanish) Tile Roofs	304 Stainless Steel Hook; 302 Stainless Steel Screws	Both	Flashing Available	Hooks and Mounting Screws	2 or 4	Compatible with IronRidge, DPW Solar, Snap n Rack, Zillarac and more	Test results available
www.solarroofhook.com	180° Stone Coat Steel Hook for Bottom Mount Rails (Part# SCSR H180)	Stone Coat Steel or Cal-Pac Roofs	304 Stainless Steel Hook; 302 Stainless Steel Screws	Both	Flashing Available	Hooks and Mounting Screws	2 or 4	Compatible with IronRidge, DPW Solar, Snap n Rack, Zillarac and more	Test results available
	Shorter 180° Stone Coat Steel Hook for Bottom Mount Rails (Part# SCSRH 180S)	Stone Coat Steel or Cal-Pac Roofs	304 Stainless Steel Hook; 302 Stainless Steel Screws	Both	Flashing Available	Hooks and Mounting Screws	2 or 4	Compatible with IronRidge, DPW Solar, Snap n Rack, Zillarac and more	Test results available
	90° Stone Coat Steel Hook for Side Mount Rails (Part# SCSR H90)	Stone Coat Steel or Cal-Pac Roofs	304 Stainless Steel Hook; 302 Stainless Steel Screws	Both	Flashing Available	Hooks and Mounting Screws	2 or 4	Compatible with IronRidge, DPW Solar, Snap n Rack, Zillarac and more	Test results available
	Adjustable 90° Stone Coat Steel Hook for Side Mount Rails (Part# SCA90)	Stone Coat Steel or Cal-Pac Roofs	304 Stainless Steel Hook; 302 Stainless Steel Screws	Both	Flashing Available	Hooks and Mounting Screws	2 or 4	Compatible with IronRidge, DPW Solar, Snap n Rack, Zillarac and more	Test results available

Sloped-Roof Mounting

COMPANY	MODEL	APPLICABLE ROOF TYPES	MATERIALS	APPLICABLE TO NEW AND/ OR EXISTING ROOFS?	FLASHING INCLUDED?	HARDWARE INCLUDED?	NO. OF ROOF ATTACHMENTS	RAIL COMPATIBILITY	CERTIFICATIONS
solarroofhook.com *(continued)*	Adjustable 180° Stone Coat Steel Hook for Bottom Mount Rails (Part# SCA180)	Stone Coat Steel or Cal-Pac Roofs	304 Stainless Steel Hook; 302 Stainless Steel Screws	Both	Flashing Available	Hooks and Mounting Screws	2 or 4	Compatible with IronRidge, DPW Solar, Snap n Rack, Zillarac and more	Test results available
www.solarroofhook.com	Flashed L-Foot System (Part# 15987)	Asphalt (Composite) Shingle	Galvanized Aluminum Flashing and L-Foot; 302 Stainless Steel Screws	Both	Flashing Available	Flashing, L-Foot, Mounting Screws	1	Compatible with IronRidge, DPW Solar, Snap n Rack, Zillarac and more	Test results available
	QuickBOLT (Part# QBKIT3)	Asphalt (Composite) Shingle	Galvanized or Black Aluminum Flashing and L-Foot; 304 Stainless Steel Washer and Bolt	Both	Flashing Available	Flashing, L-Foot, Compression Washer, QuickBOLT, Serrated Hex Flange Nuts	1	Compatible with IronRidge, DPW Solar, Snap n Rack, Zillarac and more	Test results available
Spider-Rax	Black Widow	All Tile Types (metal, clay, flat and S-curve)	Aluminum 6063-T6 and Stainless Steel	Both	Optional	Yes, including mounting lugs	Average 2.2 per panel	All framed modules	UL 2703
www.spiderrax.com	Red Widow	Asphalt Shingle	Aluminum 6063-T6 and Stainless Steel	Both	Yes	Yes, including mounting lugs	Average 2.2 per panel	All framed modules	UL 2703
SunModo	EZ Roof Mounts	Composition Shingle	Aluminum	Both	Yes	Yes	4 (L foot version) 3 (standoff version	All Major Brands	IAMPO
www.sunmodo.com	EZ Metal Roof Mounts	Metal	Aluminum	Both	N/A	Yes	3 (L foot version) 2 (standoff version)	All Major Brands	
	EZ Helio Pitched Roof System	Shingle/ Metal	Aluminum	Both	Yes, if applicable	Yes		All Major Brands	UL

U.S. Racking & Mounting Models

Sloped-Roof Mounting

COMPANY	MODEL	APPLICABLE ROOF TYPES	MATERIALS	APPLICABLE TO NEW AND/ OR EXISTING ROOFS?	FLASHING INCLUDED?	HARDWARE INCLUDED?	NO. OF ROOF ATTACHMENTS	RAIL COMPATIBILITY	CERTIFICATIONS
S:FLEX	Flush Mount	All roof types including composite shingle, asphalt, roof Tiles, standing seam metal sheet, corrugated metal sheet	Aluminum, stainless steel hardware	Both	Optional	Yes	Optimized for any local wind, snow and seismic load requirements with 4 ft and 6 ft being most common	Any framed and frameless modules. Low profile racking option works on carport systems. Works with any flashing and standoff solution.	IBC, various stamped PE certification letters, MCS Certificate by BBA, EG Certificate by TÜV-Rheinland, UL 2703 in progress
www.sflex.com									
Unirac	SM - SOLAR MOUNT	Tile and Comp Shingle Roofs - Flush Mount or Tilt on Flat, Low and High Slope Roofs	Aluminum	Both	N/A	Yes	Varies	All Major Brands	UL 2703
unirac.com	SM - SUN FRAME	Tile and Comp Shingle Roofs - Flush Mount on Low and High Slope Roofs	Aluminum	Both	N/A	Yes	Varies	All Major Brands	N/A
Zilla	Rac Pac	Asphalt, Tile, Metal, Shake Shingle	Aluminum, Stainless Hardware	Both	No	Yes	Depends on Design	Compatible with Zilla flashing and mounting components as well as virtually all others	ETL to UL 467
www.zillarac.com	Phantom	Asphalt, Tile, Metal, Shake Shingle	Aluminum, Stainless Hardware	Both	Yes	Yes	Depends on Design	N/A	ETL to UL 467

Ground Mounts

COMPANY	MODEL	MATERIALS	TILT ANGLES	FOUNDATION OPTIONS	MODULE COMPATIBILITY	GROUNDING	MAXIMUM GRADE OF TERRAIN	CERTIFICATIONS	WARRANTY
AP Alternatives	Standard 60 Cell	Galvanized steel		Helical anchor	All major brands	Included with system			20 years
apalternatives.com	Standard 72 Cell	Galvanized steel		Helical anchor	All major brands	Included With system			20 years
	Standard Thin Film	Galvanized steel		Helical anchor	All major brands				20 years

Ground Mounts

COMPANY	MODEL	MATERIALS	TILT ANGLES	FOUNDATION OPTIONS	MODULE COMPATIBILITY	GROUNDING	MAXIMUM GRADE OF TERRAIN	CERTIFICATIONS	WARRANTY
Array Technologies	DuraRack fixed-tilt system	Galvanized high-strength steel and anodized aluminum	10 to 40	W6 I-beam standard	Most commercially available	Grounding supplied by ATI	5 to 10%	None	10 year limited
arraytechinc.com	DuraRack AT manually adjustable fixed-tilt system	Corrosion resistant high-strength steel and anodized aluminum	0 to 60 adjustable	4 x 4" ID SCH40 steel pipe / 1 x 5" ID SCH40 steel pipe	Most commercially available	Grounding supplied by ATI	1 to 2%	None	10 year limited
	DuraRack SP single-pole fixed-tilt system	Power coated high-strength steel and anodized aluminum, Galvanized steel optional	0, 15, 30, 45 or 60	1 x 8" ID SCH80 steel pipe	Most commercially available	Customer installed WEEB or Lugs	Unlimited	None	10 year limited
Baja Construction Co.	Baja Ground Mount	Galvanized steel	0 to 25	Embedded/ Driven	All commercially available	Integrated	2' depending on column type	UL467 Components	One-year workmanship
bajacarports.com									
Crider Solar	100	Steel	0 to 90	Multiple	All	Included	45 degrees		10 years
www.crideramericas.com	200	Steel, Aluminum	0 to 90	Multiple	All	Included	45 degrees		10 years
	300	Steel, Aluminum	0 to 90	Multiple	All	Included	45 degrees		10 years
DPW Solar	Power Peak	Steel, Aluminum	15 to 35	Driven pile	All major brands	Integrated	5%	UL467	20 years
www.dpwsolar.com	POWER-FAB TPM & UTPM	Steel, Aluminum	15 to 65	Concrete	All major brands	Washer	Unlimited		10 years
	POWER-FAB MPM G2	Steel, Aluminum	15 to 45	Concrete	All major brands	Washer	Unlimited	UL467	10 years
	POWER-FAB LGM	Steel, Aluminum	5 to 65	Concrete	All major brands	Washer	5%	UL467	10 years
GameChange Racking	GC Pour-in-Place Ballasted Ground System	Steel, aluminum	5 to 35	Ballasted	All panels	ETL/UL 467 tested grounding strip	30%	CPP, ETL/UL 467 and 2703	20 years
gamechangeracking.com	GC Max-Span Post System	Steel, aluminum	5 to 35	Post, helical pile, ground screw	All panels	ETL/UL 467 tested grounding strip	30%	CPP, ETL/UL 467 and 2703	20 years

U.S. Racking & Mounting Models

Ground Mounts

COMPANY	MODEL	MATERIALS	TILT ANGLES	FOUNDATION OPTIONS	MODULE COMPATIBILITY	GROUNDING	MAXIMUM GRADE OF TERRAIN	CERTIFICATIONS	WARRANTY
Grupo Clavijo *www.grupoclavijo.net*	Single Post structure / DoublePole structure	S355 JR / S275 JR steel / hot dipped galvanized steel	Depending on project	Micro piles, screw, concrete foundation, ballasted	All		E-W: up to 15% / N-S: up to 6%	TÜV NORD. Structural Safety Certificate; ISO 9001	10 years metal structure, 20 years for galvanizing
HatiCon Solar *www.haticonsolar.com*	alTerrain	Aluminum	0 to 35	Rammed sigma post, welded plate, concrete pour, ballast, helical pile	Landscape and portrait	Yes	35 degrees	No	10 year standard (Extended offered)
HST Solar	HRACK II	Galvanized Steel	0 to 40	Ballasted	All (Framed, Frameless)	Integrated	Up to 5 degrees	UL2703	20 years
hstsolar.com	HRACK P	Galvanized Steel	0 to 40	Pile driven	All (Framed, Frameless)	Integrated	All	UL2703	20 years
IronRidge *www.ironridge.com*	Ground Mount System	6000-series aluminum, stainless steel and Sched. 40 steel pipe	0 to 45	Concrete, driven pile, helical pile, ballasted	Most 60- and 72-cell modules	WEEB	Flexible	PE Certified	20 years
Mounting Systems	Sigma I+	Aluminum, stainless steel, galvanized steel	15,20,25 or 30	Driven pile	Framed and unframed	Fully integrated bonding	±10 degrees	UL Subj 2703 (pending); PE structural	10 years
usa.mounting-systems.info	Sigma I XL+	Aluminum, stainless steel, galvanized steel	20,25,30 or 35	Driven pile	Framed and unframed	Fully integrated bonding	Configuration dependent	UL Subj 2703 (pending); PE structural	10 years
	Sigma II+	Aluminum, stainless steel, galvanized steel	15,20,25 or 30	Driven pile, earth screw, ballast, caisson	Framed and unframed	Fully integrated bonding	Configuration dependent	UL Subj 2703 (pending); PE structural	10 years
Orion Solar Racking *orionsolarracking.com*	Jupiter Ground Mount	Rails, midclamps, endclamps, steel caps, angle steel, angle splice kit, U-bolts	30, 45, 60	Embedment, pile driven, helical piles	Any	Integrated	30 degrees	UL 2703, PE stamped	15 years

Ground Mounts

COMPANY	MODEL	MATERIALS	TILT ANGLES	FOUNDATION OPTIONS	MODULE COMPATIBILITY	GROUNDING	MAXIMUM GRADE OF TERRAIN	CERTIFICATIONS	WARRANTY
PanelClaw *panelclaw.com*	Panda Bear, ballasted ground mount system	Aluminum and G90 steel	10, 20 and 30 degrees	Ballasted	All leading module brands	UL 2703 certified for electric bonding and grounding	±10 degrees	n/a	10 years
Patriot Solar Group *patriotsolargroup.com*	Post Driven Ground Mount	Galvanized steel	10 to 40 degrees in 5-degree increments	Imbedded reinforced concrete, post driven, helical pile, etc.	All commercially available	Optional	15 degree NS; 3 degrees EW	80 PSF snow load; 150 MPH wind load	10 years against mechanical failure
Polar Racking *www.polarracking.com*	PRU Utility Scale Ground Mount	Galvanized steel (G90-G235)	5 to 45	Helical, rammed, micro-pile and grouted pile, groundscrew, pre-cast ballasted, pour-in place ballasted foundations	All	Integrated bonding and grounding through proprietary midclamps	10 degrees	CPP Wind Tunnel Tested; UL 2703 (pending)	20 years
PV Racking *www.pvracking.us*	Clamp-free ground mount	Aluminum, galvanized steel	Fixed at any angle 5 degrees or higher	Helical piers, driven piles, or concrete	Most panels	Lug and copper wire, recommend SGB4	n/a	n/a	15 years
RBI Solar	GM-I	Steel	5 to 45	Driven Post, concrete pier, precast or cast-in-place concrete ballast, helical/screw foundation, dual post, spread footing and epoxy coated posts	All commercially available panels	Third party and integrated solutions	12-15% with continuous rows; 30% with tables	ETL Classified to UL 2703	20 years
www.rbisolar.com	GM-T	Steel	5 to 45	Driven Post, concrete pier, precast or cast-in-place concrete ballast, helical/screw foundation, dual post, spread footing and epoxy coated posts	All commercially available panels	Third party and integrated solutions	12-15% with continuous rows; 30% with tables	ETL Classified to UL 2704	20 years

U.S. Racking & Mounting Models

Ground Mounts

COMPANY	MODEL	MATERIALS	TILT ANGLES	FOUNDATION OPTIONS	MODULE COMPATIBILITY	GROUNDING	MAXIMUM GRADE OF TERRAIN	CERTIFICATIONS	WARRANTY
Ready Rack Solar	Crystalline Series	Galvanized steel		Helical anchor or concrete in place	All major brands	Included with system			20 years
www.readyracksolar.com	Thin Film Series	Galvanized steel		Helical anchor or concrete in place	All major brands				20 years
Renusol America	Renusol GS	HMWPE	10 degrees	Not Applicable (Ballasted System)	Framed 60 and 72 cell	Dynobond	5 degrees	UL2703 Bonding, Wind Tunnel	25 years
www.renusolamerica.com	Renusol VS	Aluminum / steel	Variable	Poured in place posts	Framed 60 and 72 cell, and frameless	WEEB / Grounding integrated clamps	No limit	UL 467 Bonding	10 years
Schletter	FS System	Aluminum, galvanized steel posts	0 to 90 degrees	Rammed or embedded in concrete	All	Yes	7 degrees	ETL, ISO 9001-2008, ASCE, IBC	20-year limited warranty
www.schletter.us	FS Uno	Galvanized steel	0 to 90 degrees	Rammed or embedded in concrete	All	Yes	7 degrees	ETL, ISO 9001-2008, ASCE, IBC	5-year limited warranty
	FS Duo	Galvanized steel	0 to 90 degrees	Rammed or embedded in concrete	All	Yes	7 degrees	ETL, ISO 9001-2008, ASCE, IBC	5-year limited warranty
	PVMax	Aluminum	0 to 90 degrees	Ballast block, drilled shaft, ground screws	All	Yes	3 degrees	ETL, ISO 9001-2008, ASCE, IBC	20-year limited warranty
	PVMini	Aluminum	0 to 90 degrees	Ballast block, drilled shaft	All	Yes	3 degrees	ETL, ISO 9001-2008, ASCE, IBC	20-year limited warranty
Solar FlexRack	FlexRack Series G2	Pre-galvanized steel	Any	Round Post, W-Section, SmartPost, Helical Piers, Earth Screws, C-Channels	Any	ETL Certified	20% E/W	ETL, ISO 9001	20 years
solarflexrack.com	FlexRack Series G3	Pre-galvanized steel	Any	Round Post, W-Section, SmartPost, Helical Piers, Earth Screws, C-Channels	Any	ETL Certified	10% E/W	ETL, ISO 9001	20 years
	FlexRack Series B	Pre-galvanized steel	Any	Ballasted	Any	ETL Certified	Varies depending on array configuration	ETL, ISO 9001	20 years
Solar SpeedRack *www.solarspeedrack.com*	Solar Ground Mount	Steel, aluminum	20, 40, custom	Driven or cement	All PV panels with thickness of 30 to 50 mm	Integrated grounding	n/a	PE certification	10 years

Ground Mounts

COMPANY	MODEL	MATERIALS	TILT ANGLES	FOUNDATION OPTIONS	MODULE COMPATIBILITY	GROUNDING	MAXIMUM GRADE OF TERRAIN	CERTIFICATIONS	WARRANTY
SolarDock *www.solardock.com*	SolarDock 2	Aluminum with stainless steel hardware	Up to 35	Non-penetrating, ballasted	All modules with frames	Patented grounding clip, integrated panel and system grounding		TUV Rheinland PTL UL2703	25 years
SunLink *www.sunlink.com*	Large-Scale GMS	Galvanized steel components; stainless steel and galvanized steel fasteners	10, 15, 20, 25, 30	I-beam	All major brands	Fully integrated grounding	Virtually any grade can be accommodated	ETL listed to UL 2703	20 years
	Ballasted GMS	Aluminum and galvanized steel components; stainless steel fasteners	20, 25, 30	Pre-cast concrete ballasts	All major brands	Fully integrated grounding	Up to 5% grade	ETL listed to UL 2703	15 years
SunModo *www.sunmodo.com*	Hybrid Ground Mount System	Aluminum, steel	15 to 45	Post, auger or ballast	All major brands	Integrated grounding	n/a	UL	10-year limited
S:FLEX *www.sflex.com*	Single Post Ground Mount	Galvanized steel, stainless steel hardware, aluminum	5 to 35	Rammed post, ground screw, helical pier	Framed and frameless modules	Integrated grounding	North-South up to 15° East-West up to 10°	Conforms to IBC, various stamped PE certification letters, UL 2703 in progress	10 years. Extension available.
	Two Post Ground Mount	Aluminum, hot-dipped galvanized steel foundation post, stainless steel hardware	Up to 45	Rammed post, ground screw, helical pier, concrete foundation, post with base plate	Framed and frameless modules	Integrated grounding	North-South up to 45° East-West up to 6°	Conforms to IBC, wind-tunnel tested, various stamped PE certification letters, MCS Certificate by BBA, EG Certificate by TÜV-Rheinland, UL 2703 in progress	10 years. Extension available.
	Ballasted Ground Mount	Aluminum, galvanized steel connection to ballast, stainless steel hardware	Up to 45	Above ground concrete ballast	Framed and frameless modules	Integrated grounding	North-South up to 15° East-West up to 6°	Conforms to IBC, various stamped PE certification letters, MCS Certificate by BBA, EG Certificate by TÜV-Rheinland, UL 2703 in progress	10 years. Extension available.
Unirac *unirac.com*	Ground Fixed Tilt (GFT)	Aluminum, steel	5 to 30	C-shape pile; driven or cast-in-place	All major brands	Integrated bonding	10 Degrees: East-West	UL2703 bonding and grounding and fire certification	20-year manufacturing warranty

U.S. Racking & Mounting Models

Solar Canopies and Carports

COMPANY	MODEL	APPLICATIONS	MATERIALS	FOUNDATION	MODULE COMPATIBILITY	SPAN BETWEEN POSTS	INSTALLATION SERVICE PROVIDED?	WARRANTY
Baja Construction Co.	Braced single post and back to back solar carports	Parking lot and parking garage PV	Galvanized steel	Concrete embedded	All commercial available	18' typical and custom available	Yes	One-year workmanship and extended available
www.bajacarports.com	Boxed fully cantilevered and TEE solar carports	Parking lot and parking garage PV	Galvanized steel	Concrete embedded	All commercial available	18' typical and custom available	Yes	One-year workmanship and extended available
	Tapered fully cantilevered and TEE solar carports	Parking lot and parking garage PV	Galvanized steel	Concrete embedded	All commercial available	18' typical custom available	Yes	One-year workmanship and extended available
	SR SERIES braced single post and back to back solar carports fully integrated with racking and grounding solution	Parking lot and parking garage PV	Galvanized steel carports and aluminum racking	Concrete embedded	All commercial available	18' typical and custom available	Yes	One-year workmanship and extended available
	SR SERIES boxed fully cantilevered and TEE solar carports fully integrated with racking and grounding solution	Parking lot and parking garage PV	Galvanized steel carports and aluminum racking	Concrete embedded	All commercial available	18' typical and custom available	Yes	One-year workmanship and extended available
	SR SERIES tapered fully cantilevered and TEE solar carports fully integrated with racking and grounding solution	Parking lot and parking garage PV	Galvanized steel carports and aluminum racking	Concrete embedded	All commercial available	18' typical and custom available	Yes	One-year workmanship and extended available
	Solar RV and boat storage canopies	RV and boat storage	Galvanized steel	Concrete embedded	All commercial available	24' typical and custom available	Yes	One-year workmanship and extended available
Crider Solar	1001	Carports	Steel and aluminum	Multiple	All	Up to 40'	Yes	10 years
www.crideramericas.com	2000	Carports large span	Steel and aluminum	Multiple	All	Up to 70'	Yes	10 years
	3000	Carports roof parking	Steel and aluminum	Multiple	All	Up to 36'	Yes	10 years
GameChange Racking	GC Carport System		0, 5 and 10	Concrete, spread footing	All panels	20 ft'	Yes	20 years
www.gamechangeracking.com								

Solar Canopies and Carports

COMPANY	MODEL	APPLICATIONS	MATERIALS	FOUNDATION	MODULE COMPATIBILITY	SPAN BETWEEN POSTS	INSTALLATION SERVICE PROVIDED?	WARRANTY
M Bar C Construction *www.mbarconline.com*	T Structure and Semi Cantilever or custom design	Carports	Steel - heavy gauge	Flagpole style	Any	Up to 27'	Design and build	1 year
Orion Solar Racking	Titan	2x2 parking array; modular; commercial	Titan-beam; titan-leto-column; end purlins; end purlins, ([) shaped; shared purlins, (t) shaped; bolts; gator clamps	Depends on P.E. to design	Most modules with frames	20'	Upon request	15 years
www.orionsolarracking.com	Leto	2x1 parking array; modular; commercial	Leto-beam; titan-leto-column; end purlins; end purlins, ([) shaped; shared purlins, (t) shaped; bolts; gator clamps	Depends on P.E. to design	Most modules with frames	20'	Upon request	15 years
	Kronos	1x1 parking array; modular; residential	Kronos-beam; kronos-column; end purlins; end purlins, ([) shaped; shared purlins, (t) shaped; bolts; gator clamps	Depends on P.E. to design	Most modules with frames	13'	Upon request	15 years
Patriot Solar Group *patriotsolargroup.com*	Galactic Car Port	Utility, commercial and residential scale	10 gauge galvanized steel / Bolted or field weld connection	Concrete	All commercially available panels	Standard- 19 Foot	Yes	10 Years against mechanical failure
Polar Racking *www.polarracking.com*	PRP Solar Car Port	Car Port	Galvanized steel (different grades for different locations)	Concrete pour with rebar, ballasted	All	2-4 stalls	Yes	20 years
RBI Solar *www.rbisolar.com*	CP-ST	Commercial/ utility	Steel	Concrete pier, helical/screw foundation and spread footing	All commercially available panels	Up to 36'	Yes	20 years

U.S. Racking & Mounting Models

Solar Canopies and Carports

COMPANY	MODEL	APPLICATIONS	MATERIALS	FOUNDATION	MODULE COMPATIBILITY	SPAN BETWEEN POSTS	INSTALLATION SERVICE PROVIDED?	WARRANTY
RBI Solar *(continued)*	CP-TR	Commercial/ utility	Steel	Concrete pier, helical/screw foundation and spread footing	All commercially available panels	Up to 36'	Yes	20 years
www.rbisolar.com	CP-KT	Commercial/ utility	Steel	Concrete pier, helical/screw foundation and spread footing	All commercially available panels	Up to 36'	Yes	20 years
Schletter	B1	1 row of vehicle arrangement	Aluminum	Slab Foundation, Micro Pile, Drilled Shaft	All	Up to 27'	Just micro pile	20-year limited warranty
schletter.us	B2	2 rows of vehicle arrangement	Aluminum	Slab Foundation, Micro Pile, Drilled Shaft	All	Up to 27'	Just micro pile	20-year limited warranty
	B3	North-South, 2 rows of vehicle arrangement	Aluminum	Slab Foundation, Micro Pile, Drilled Shaft	All	Up to 27'	Just micro pile	20-year limited warranty
	R1	Canopies, walkways, storage, 1 row of vehicle arrangement	Aluminum, Galvanized steel posts	Drilled Shaft	All	Up to 27'	n/a	20-year limited warranty
S:FLEX	PV Carports 3 High, 4 High, 5 High, 6 High, 7 High, 3-3Y	Cantilevered carports for parking lots	Galvanized steel, stainless steel hardware, aluminum	Concrete foundation, spread footings, helical pier/concrete footing	Framed and frameless modules	Typically 27' spans	Yes	10-year limited warranty. Extended available.
www.sflex.com	PV Canopy	Large span requirement, rooftop parking structures, concrete rooftops, parking lots	Galvanized steel, stainless steel hardware, aluminum	Attachment through brackets to existing structure	Framed and frameless modules	Optimized for any local, wind, snow and seismic load requirements as well as structural span requirements	Yes	10-year limited warranty. Extended available.
Zilla *www.zillarac.com*	Rac Pac	Canopies, carports, awnings, pole mounts, Etc.	Aluminum, stainless steel hardware	Depends on design	Framed modules	Depends on design	Can be provided through partner companies	10 years

Solar Trackers

COMPANY	MODEL	TRACKING TYPE	DRIVE TYPE	MOTOR TYPE	MODULE COMPATIBILITY	ARRAY HEIGHT	RANGE OF MOTION	WARRANTY
AllEarth Renewables	AllSun Tracker Series 20	Dual Axis	GPS-based active tracking	1/4 HP hydraulic power unit	Most commercially available 60 cell modules	18 to 20 feet	0 to 360 degree yaw range; 0 to 60 degree tilt range	10 years
www.allearthrenewables.com	AllSun Tracker Series 24	Dual Axis	GPS-based active tracking	1/4 HP hydraulic power unit	Most commercially available 60 cell modules	18 to 20 feet	0 to 360 degree yaw range; 0 to 60 degree tilt range	10 years
Array Technologies	DuraTrack HZ	Horizontal single-axis tracker	Linked rotating gear drive system	1.5 to 3 HP, 3 Phase, 480V AC	Most commercially available, including frameless thin film	48" standard, adjustable	Tilt angle: 0° E-W tracking range: +/- 45°, also available up to +/- 60°	5 year limited, 10 year extended available
arraytechinc.com	DuraTrack HZSR	Horizontal single-axis row tracker	Gear drive	Heavy duty gear drive, 24 VDC nominal	Most commercially available	~ 5' variable	Tilt angle: 0° E-W tracking range: +/- 45°	10 year limited
	DuraTrack HZLA	Horizontal single-axis row tracker	Linear actuator	Heavy duty linear actuator, 24 VDC nominal	Most commercially available	~ 5' variable	Tilt angle: 0° E-W tracking range: +/- 45°	10 year limited
	DuraTrack AZ	Single-axis azimuth solar tracker	Gear drive	Heavy duty gear drive, 24 VDC nominal	Most commercially available	~ 14' variable	Tilt angle: 45° E-W tracking range: +/- 120°	10 year limited
	DuraTrack DA	Dual-axis azimuth solar tracker	Gear drive	Heavy duty gear drive, 24 VDC nominal	Most commercially available	~ 15' variable	N-S tracking range: 5° - 60° E-W tracking range: +/- 120°	10 year limited
Exosun *www.exosun.net*	Exotrack HZ	Horizontal single-axis for utility-scale plants	Brushless gear motor	3 phases, 400 VAC (CE) or 460 VAC (UL)	Compatible with most modules	4.9 ft in stow position; 7.5 ft while tracking	± 50°	Up to 20 years
Grupo Clavijo	SP 1000/20º	Single Axis	Linear actuator	1,1 Kw / 1.500 r.p.m.	Any	Depending on project	from +-45º to +-55º	10 years for metal structure; 20 years for galvanizing
www.grupoclavijo.net	SP 1000	Horizontal Single Axis	Linear actuator	1,1 Kw / 1.500 r.p.m.	Any	Depending on project	from +-45º to +-55º	10 years for metal structure; 20 years for galvanizing
	SP 120	Horizontal Single Axis	Linear actuator	0,37 Kw / 1.500 r.p.m.	Any	Depending on project	from +-45º to +-55º	10 years for metal structure; 20 years for galvanizing
	SR 35	Dual Axis (Azimuth and Zenith)	2 Planetary gearboxes and reinforced tooth slewing ring (azimuth); Central + 2 hydraulic cylinders (zenith)	Two 0,33 Kw / 1.500 r.p.m. Reinforced pinion gear (cemented) motors; 0,75 Kw / 1.500 r.p.m.	Any		270 º (-135º / +135º) Azimuth; 0º to 50 º Zenith	10 years for metal structure; 20 years for galvanizing

U.S. Racking & Mounting Models

Solar Trackers

COMPANY	MODEL	TRACKING TYPE	DRIVE TYPE	MOTOR TYPE	MODULE COMPATIBILITY	ARRAY HEIGHT	RANGE OF MOTION	WARRANTY
Grupo Clavijo *(continued)*	SR 29	Dual Axis (Azimuth and Zenith)	2 Planetary gearboxes and reinforced tooth slewing ring (azimuth); Central + 2 hydraulic cylinders (zenith)	Two 0,33 Kw / 1.500 r.p.m. Reinforced pinion gear (cemented) motors; 0,75 Kw / 1.500 r.p.m.	Any		270 º (-135º / +135º) Azimuth; 0º to 50 º Zenith	10 years for metal structure; 20 years for galvanizing
www.grupoclavijo.net	SR 25	Dual Axis (Azimuth and Zenith)	2 Planetary gearboxes and reinforced tooth slewing ring (azimuth); Central + 2 hydraulic cylinders (zenith)	Two 0,33 Kw / 1.500 r.p.m. Reinforced pinion gear (cemented) motors; 0,75 Kw / 1.500 r.p.m.	Any		270 º (-135º / +135º) Azimuth; 0º to 50 º Zenith	10 years for metal structure; 20 years for galvanizing
	SR 22	Dual Axis (Azimuth and Zenith)	2 Planetary gearboxes and reinforced tooth slewing ring (azimuth); Central + 2 hydraulic cylinders (zenith)	0,33 Kw / 1.500 r.p.m. Reinforced pinion gear (cemented) motors; 0,75 Kw / 1.500 r.p.m.	Any			10 years for metal structure; 20 years for galvanizing
	SR 19	Dual Axis (Azimuth and Zenith)	2 Planetary gearboxes and reinforced tooth slewing ring (azimuth); Central + 2 hydraulic cylinders (zenith)	0,33 Kw / 1.500 r.p.m. Reinforced pinion gear (cemented) motors; 0,75 Kw / 1.500 r.p.m.	Any		270 º (-135º / +135º) Azimuth; 0º to 50 º Zenith	10 years for metal structure; 20 years for galvanizing
	SR 10	Dual Axis (Azimuth and Zenith)	Planetary gearbox and reinforced tooth slewing ring (azimuth); Central + 2 hydraulic cylinders. Electric linear actuator (zenith)	0,75 Kw / 1.500 r.p.m. Reinforced pinion gear (cemented) motors; 0,33 Kw / 1.500 r.p.m.	Any		270 º (-135º / +135º) Azimuth; 0º to 60 º Zenith	10 years for metal structure; 20 years for galvanizing
	SR 07 1E	Single Axis (Azimuth)	Swivel module (guiding crown + spindle)	0,25 Kw / 1.500 r.p.m.	Any		270 º (-135º / +135º)	10 years for metal structure; 20 years for galvanizing
	SR 04 1E	Single Axis (Azimuth)	Swivel module (guiding crown + spindle)	0,25 Kw / 1.500 r.p.m.	Any		270 º (-135º / +135º)	10 years for metal structure; 20 years for galvanizing
	SR 04	2 Axes (Azimuth and Zenith)	Swivel module (guiding crown + spindle) Azimuth; Motorized electric sprindle (Zenith)	0,25 Kw / 1.500 r.p.m.; 0,25 Kw / 1.500 r.p.m.	Any		270 º (-135º / +135º) Azimuth 0º to 60 º Zenith	10 years for metal structure; 20 years for galvanizing

Solar Trackers

COMPANY	MODEL	TRACKING TYPE	DRIVE TYPE	MOTOR TYPE	MODULE COMPATIBILITY	ARRAY HEIGHT	RANGE OF MOTION	WARRANTY
Patriot Solar Group *patriotsolargroup.com*	Dual Axis Tracking Mount	Azmuith Enznitch	Liner actuator and slew drive	Electric	All commercially available panels	18 feet	10 to 70 degrees	10 years against mechanical failure, 2 years on electronics and workmanship
QBotix *www.qbotix.com*	Robotic Tracking System (RTS)	Optimized dual-axis	Robot actuates passive linear actuator (tilt) and slew drive (Azimuth)	Gear motor	Standard crystalline PV modules, 6 x 60-Cell or 6 x 72-cell in landscape or similar	2.1 m (6.8 ft) at 0° tilt and 2.9 m (9.5 ft) at 70° tilt	AZ: 360 degrees; Tilt: 0 to 70 degrees	5 years, extended optional
Schletter *www.schletter.us*	SP1000	Single axis	Linear actuator	1.5 horsepower drive motor	All	Varies	East-West, -45 to +45 degrees	10-year limited warranty on the structure, 2-year limited warranty on electrical and drive components
Solar FlexRack *solarflexrack.com*	FlexRack Series TDL	Single axis	Distributive drive	Linear actuator 24VDC	Adaptable to most styles	70"	45 to -45 degrees	10 years
SunLink *www.sunlink.com*	ViaSol Tracker	One-axis horizontal	Fluid power	208 V 3-phase, 3 hp typical	All major brands	Stowed array height is 4 to 6 feet – adjustable per site specifications. Typical max height of module edge at full tilt is 6.5 feet.	45 to - 45 degrees	Mechanical and structural components - life of the PV system - C ontrols and actuators - 10 years

1

Solar Generation Technologies

(Concentrated, Thermal, Thin-Film, Polycrystalline, Monocrystalline)

Which generating technology has the greatest advantage in the U.S. market?

In a perfect world, all solar technologies would work together.

There are no perfect worlds. Until that happy day comes, all solar technologies have advantages and disadvantages, and all have to contend with being a variable resource.

Technology For Residential

Crystalline photovoltaic technologies are bankable and continue (even with a 9% increase in module prices in 2013) to be affordable, as well as being higher in conversion efficiency than thin-film technologies. Thin-film technologies, with the exception of First Solar's CdTe technology and Solar Frontier's CIGS technology, face bankability concerns currently. CdTe is not a preferred technology for rooftop solar.

CPV and CSP technologies are not appropriate for the residential application. The current tariff dispute is already leading to higher module prices in the U.S. market as manufacturers begin building risk into their price strategies.

Large Ground-Mount Installations

First Solar's CdTe technology is the only thin-film technology currently with an advantage in the United States for ground-mounted installations. Given that crystalline has a 91% share of global shipments (and capacity), as well as the technology's efficiency advantage (even with the current uptick in module prices), crystalline technologies currently have the advantage. It would take a significant increase in prices for crystalline modules as well as considerable growth in CdTe capacity for there to be a shift in advantage in favor of thin-film technologies.

CSP technologies do not have a

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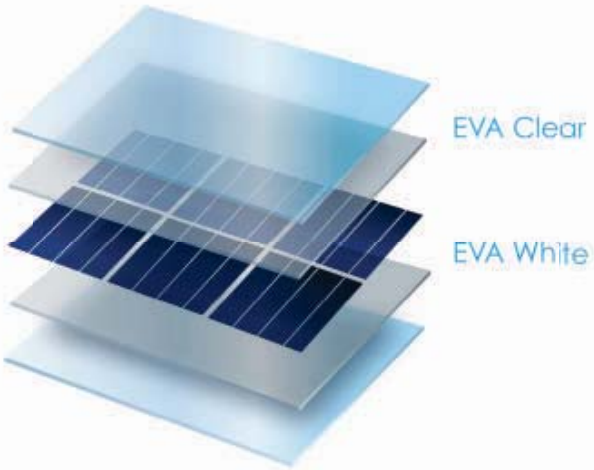

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1 Solar Generation Technologies

cost advantage for installations less than or equal to 1 MW.

CPV technology continues as an emerging sector and, faced with lower-cost crystalline, do not have an advantage. With continued deployment and demonstration of high levels of production, CPV could begin to gain share, but this will take time as well as committed investors who choose CPV for demonstration reasons.

Multi-Megawatt Installations

As with large ground-mount installations less than 1 MW, First Solar's CdTe technology is the only thin-film technology currently with an advantage in the United States for the multi-megawatt (utility-scale) segment. Again, however, there is a capacity issue and here, again, crystalline has the advantage. Cost is crucial for this segment, which requires the lowest cost of hardware. Even with increased prices for crystalline modules the margin squeeze is likely to fall on the side of the developer/investor.

CSP technologies would seem ideal for this application. The most appropriate areas for deployment are on public lands away from communities. Concerns in this regard are federally protected Indian cultural lands and endangered species. CSP technologies require a long build time, which adds to the long development timeline for projects of this size.

By Paula Mints, SPV Market Research

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2

Inverters

What does the smart inverter of 2015 look like?

Photo Courtesy of SMA America

Growing levels of distributed PV in all market segments in the United States have created increased challenges associated with the corresponding grid-integrated power. In areas where solar has grown exponentially in recent years, utility companies and electrical grids need to keep up with the increased volume and the intermittent nature of PV power.

The smart inverter of 2015 must have advanced grid management features to solve these technologically complex challenges. Smart inverters with grid management capabilities are already helping to meet the needs of the utility market. However, the PV market segment is expected to experience the most growth in coming years is the commercial sector, which will require state-of-the-art PV components to combat the effects of increased PV penetration. These devices must bring the sophistication of utility-scale technology to commercial applications. Likewise, in select markets—such as Hawaii—where PV penetration levels have become significant or where modern electrical infrastructure is lacking, grid management functions will be required in residential inverters too.

The suite of grid management features of tomorrow's smart inverter will be comprehensive and customizable based on local regulations. It will include reactive power with fixed, on-demand or dynamic control, and frequency-dependent power reduction that provides responsive grid stability. Also included will be on-demand power reduction for grid safety management, as well as low-voltage ride-through for complete, dynamic grid support.

Monitoring communications tools that complement the inverter will play a large role in initiating these grid management capabilities. These devices provide reliable monitoring and control of several inverters at a time for larger plants and simple plug-and-play usage for small systems. Myriad sensor connection options allow for

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2 Inverters

precise evaluation. Backstopping these integrated technologies will be a service center capable of actively managing system portfolios, interpreting data to improve performance and dispatching operation and maintenance crews.

To perform successfully, the smart inverter of 2015 must be extremely reliable and efficient, while also offering design flexibility and enhanced safety. It will have high conversion efficiency and advanced maximum power point tracker (MPPT) algorithms that minimize the effects of shade for maximum energy production. Residential and commercial inverters will feature greater design flexibility through wide input voltage ranges, multiple independent MPPT inputs and the ability to mount the inverter in a variety of ways. They will also be safer with AFCI functionality. The utility sector will leverage products with greater system integration including power conversion, plant control and medium-voltage technologies.

Luckily for installers looking for smart technologies and solutions today, leading PV manufacturers already offer inverters with these functions, which are able to help increase PV penetration on the grid. Regardless of application, the key is to plan for the future while offsetting the challenges of today by choosing an inverter with advanced features and a support team that can make their business goals a reality.

By Brandie Leathers, Director of Application Engineering and Project Management at SMA America

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2.1

Microinverters

Photo Courtesy of APS America

Will microinverter use grow along with the U.S. solar market?

Since entering the solar market less than a decade ago, microinverters—which convert the DC current from individual PV modules into usable AC power for home and business—have been enthusiastically embraced by system designers and installers. They're turning up in larger, more sophisticated solar installations every day, a trend that's not going to change anytime soon.

The tremendous advantages that today's microinverter technology offers over traditional "string" units is well documented: optimized yield thanks to individual module output, monitoring and control (no more "shading" effects crippling a whole array); flexibility of system design and ease of installation; lower costs, including balance of system components; and the increased safety of distributed current.

Perhaps even more exciting is the fact that microinverters have only scratched the surface of their potential, as focused research and development across the industry pushes this technology even farther forward.

New microinverters will support the evolving demands of thin-film/CIGS modules now entering the solar market in residential and commercial installations, promising still higher energy yield per array area. Microinverters' flexible design accommodates the higher voltages of the new module technology, while rapid shutoff features ensure safety for system installers and emergency

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2.1 *Microinverters*

responders. As highlighted in the NEC 2014 changes, safety will continue to be a key feature going forward as state electrical codes are modified to keep up with the spread of solar across our communities.

The introduction of microinverter technology offering true 3-phase (277/480) DC power output will further boost microinverters' value in the marketplace, simplifying and enhancing the use of solar arrays in the largely untapped niche of large-scale commercial developments. This is one more example of the ongoing trend toward product differentiation across the microinverter market; new features and improved performance mean microinverters won't be mere commodities, indistinct from one maker to the next. The future will belong to the innovators.

We'll also see continued evolution of module monitoring with cloud-based systems that offer faster response time, improved ease of access to performance data and enable remote array troubleshooting. All of these will improve the user experience while boosting energy output and speeding investment payback. This is where it really counts, at the consumer level.

With so many advantages, it's evident why solar industry analysts agree that the microinverter market, and module-level power electronics in general, will see strong capital investment, innovation and growth for the foreseeable future.

By Michael Ludgate, Vice President for Business Development at APS America

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2.2

String Inverters

Photo Courtesy of KACO

What projects are best for string inverters?

The age old argument between string and central inverters goes something like: I want a central inverter because the initial costs are lower vs. I use string inverters because all inverters fail at some time and I don't want my entire array down while I wait for repair.

Looking back 15 years ago, both of these arguments had merit, but today the discussion is more complicated. Power electronics have gotten more robust. Think back to the last inverter failure you had after commissioning. It probably was not the nuisance it was just a few years ago. Components have gotten much better while engineering, research and development have also improved. Most inverter manufacturers also now offer some sort of service system to make repair time much shorter.

We are creatures of habit. You were taught to tie your shoes a certain way and you probably have not woken up one morning thinking you need to do it differently. The same goes with learning to design solar arrays. It's easy to stick with the same methodology through the years. So as arrays got bigger we just hung more string inverters and added combiner boxes. But then cost crept in. Labor rate and other balance of systems (BOS) costs made cents per watt really matter. Manufacturers responded by building units with long mean time to failure (MTTF) data and ensuring supply chains had parts in stock to ensure a repair time under 48 hours. These are all signs that the industry is growing up.

So today there are different aspects to consider when choosing between string and central inverters.

Rooftops don't always have the structural support for a central inverter, so usually string inverters make more sense for these types of installations. String inverters also make sense if you can't get a crane to the site due to weight or zoning restrictions.

You could use a central inverter for a rooftop solar installation if you're able to mount the inverter on the ground and run the DC down from the roof. Central inverters also make sense for sites with high costs of labor since they take less time to wire and install.

Personal preferences also play a significant role in making inverter decisions. Each project has unique needs so that neither string nor central inverters are the better solution all the time. What's important is to find quality manufacturers that are will to invest in you and your projects with their time, engineering resources and training to allow you the most flexibility. Your customers will thank you.

By KACO Americas

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2.2 String Inverters

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2.3

Central Inverters

Photo Courtesy of Parker Hannifin

What features make central inverters suitable for larger solar projects?

Central inverters are intended for larger applications at higher voltage levels, so they are more likely to be self-contained and field-ready than string and microinverters. They are typically provided in enclosures suitable for direct outdoor installation with integrated switchgear, circuit protection and condition monitoring. In performing basic DC to AC conversion, they are similar to string and microinverters, but central units are more likely to include advanced features like power factor control, reactive power on demand and revenue metering. Central inverters generally include robust fault ride-through provisions, allowing them not only to continue to operate through a fault, but also to offer grid support. Thanks to their larger size, redundancy can be designed into these inverters to offer continued operation even during a component failure. Users also benefit from the intrinsic lower cost per kilowatt of a larger inverter, which—combined with the right feature set and high efficiency—can result in a lower total cost of ownership.

Some manufacturers are incorporating liquid cooling technology in their central inverter models for a smaller footprint and little or no air filter maintenance. While water/glycol cooling systems are the most widely used, a two-phase evaporative cooling system with pumped refrigerant is emerging as an alternative. This results in a more compact and efficient system that removes a lot of heat with a little liquid. Such a system also minimizes consumable items like filters and coolant additives. This non-conductive system is also much safer than mixing water with high-power electronics.

On the operational side, central inverters are evolving into more than just power conversion devices. Features that make the inverters more grid interactive increase their value to the owner as a dispatchable asset. Many models offer flexibility with dual operating modes, allowing the inverter to work equally well on command in grid-parallel or island mode. Improved monitoring and fault detection with a robust communication interface is another increasingly desirable feature.

Serviceability is also an important concern with central inverters. While a smaller inverter can be literally swapped out on site, central inverters have traditionally had larger and harder to access components. To counter this disadvantage, newer modular designs with lightweight interchangeable phase modules, capacitors, inductors and fans improve field serviceability. With an accessible, modular design, scheduled maintenance or even major repairs can be done in an hour or less—rather than several days. Preferably, all serviceable components can be accessed externally without requiring an operator to enter the inverter enclosure. External access panels also enhance safety and simplify permitting.

Central inverters tend to be the most attractive options for ground-mounted installations that are 400 kW and higher, and when 1,000-V or higher input capability is required. Central inverters designed and built

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2.3 String Inverters

with environmental sealing and self-contained cooling systems can be sited in desert or coastal conditions without needing housing. Central inverters with "smart" features are also desirable in situations that require energy management. Such central inverters can provide grid support with power factor control or by providing reactive power on demand.

As more renewable sources are deployed, grid power quality will become an increasing concern. There will likely be a corresponding demand for "smart" central inverters that can support the grid. We see a growing demand for devices that will meet both current and proposed industry regulations, and anticipate that this trend will continue.

By Louis Lambruschi, Marketing Services and E-Business Manager at Parker Hannifin Corporation

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2.4

Off-Grid Inverters

Photo Courtesy of OutBack Power

Why is off-grid solar becoming increasingly important?

Solar provided about 22% of the U.S. utility-scale electricity production added to the grid in 2013. If hydroelectric is added to the "renewables" definition then renewables have been providing about 12% of all electricity production in the United States since 2012. In energy-challenged places such as California, renewables are mandated to provide a much greater share—the state is on-track to meet a legislature-imposed requirement that 33% of electricity be supplied by renewables by 2020.

Off-grid solar is becoming increasingly important as solar, in general, grows because these systems possess abilities grid-tied solar doesn't. Most significantly, off-grid systems can store renewably-generated electricity for use later, instead of requiring continuous consumption or selling-back in the "use it or lose it" scenario presented by simple grid-tied PV/solar schemes.

Storage is the fulcrum over how renewable energy's leverage will play out as it moves from a single to double-digit contribution to the total electricity mix. On one side of the balance are the utilities. For them, the ability to cost-effectively store renewably-generated electricity is critical since it is a variable, but inconsistent supply with which to meet steady-state power demand. "Clouds so swift, the rain moving in," as Bob Dylan once sang, is an apt description of the daily technical challenges facing solar electricity harvesting. The solution isn't simply "blowing in the wind" because that too has its ups and downs.

For example, California has made commendable progress toward its goal by currently generating half (15%) of its electricity from renewable sources. But that's actually about 40% more renewably-generated electricity than the state's grid—in its current technological state—can actually use, according to statewide system operator CAL-ISO. Grid instability occurs when greater amounts of inherently-variable renewable sources are present and, when interrupted, require the rest of the grid's power resources to make up the deficit. Because those sources include coal, nuclear, gas and other fossil-fuel plants that are comparatively inelastic in their ability to meet sudden spikes in demand, the result is grid instability when abundant renewably-generated electricity suddenly disappears.

For this reason alone, it's no wonder that a variety of industry intelligence sources cite utility power storage as one of the fastest-growing PV-related investment areas. But energy storage on a non-utility scale is the other side of renewable energy's leverage in influencing future electricity distribution scenarios. While storage gives utilities the means to offset grid instability by more smoothly blending the mix of renewable and fossil sources, it also provides the same benefits to

2.4 *Off-Grid Inverters*

homeowners and other system owners on a more micro-grid or even "nano-grid" scale. It enables them to offset grid consumption around the clock by drawing on locally stored electricity harvested previously.

The economics for small local system owners work out as lead-acid batteries mature to the point of maintenance-free operation and more advanced chemistries yielding longer operational life, making it possible for energy storage to take its place over the long-term solar payback equation for home and business owners. Joining today's most popular batteries through their growing practicality and affordability are more exotic types including aqueous, flow and lithium-ion technologies. Industry sources predict much more widespread adoption over the next half-decade as prices drop and popularity surges.

The emergence of local energy storage is all thanks to proven off-grid technology, through inverters and other power electronics that can intelligently charge and maintain batteries. Cost-reduced versions incorporating grid-interactive design (transfer switching, interconnects and other circuitry) have placed this technology on a more competitive level with simple grid-tied "daytime only" inverters and within the reach of new system buyers. Newer types include operating modes that can "zero out" the grid, effectively keeping the homeowner off-grid whenever possible and drawing on the grid only to meet peak needs or charge batteries when renewable sources are insufficient.

Such systems might never sell-back to the utility, devoting all their functionality to offsetting usage through self-consumption. And most tellingly, these new-technology systems may never have to sell-back to achieve payback, enabling their owners to become true "grid defectors," cutting the utility wires entirely. Just as this decade has seen savvy consumers "cutting the cord" on cable and satellite TV for online entertainment sources, the next one likely will see a generation successful at off-grid living in urban and suburban settings with their own micro- and nano-grids made possible by smarter system electronics and affordable local energy storage.

An indicator of this trend is the fact that the average size of a residential system is inexorably moving upwards. While an 8-kW inverter seemed oversized for home needs just a few years ago, this and larger sizes (and stacked systems) are becoming increasingly "mainstream" as residential users look to move beyond simply selling back and actually living off their renewable

Photo Courtesy of OutBack Power

system. Solar is scaling-up at the local level to do more than supplement other energy sources. The race is on as to whether utilities or their customers will master energy storage first. For the utilities, the stakes are high: Preventing the much publicized "death spiral" by which their customers increasingly defect as adding more renewables raises the prices for those who remain on-grid.

Ironically, in the early days of nuclear power the technology was promoted with the promise that atomic plants would result in electricity being "too cheap to meter." Several generations later, solar energy might actually be at the threshold of delivering on that promise as the utility/customer dynamics play out through more widespread adaptation of off-grid technology and energy storage.

By Mark Cerasuolo, Marketing Director at OutBack Power

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3

Power Optimizers

Photos Courtesy of SolarEdge

What are the benefits of using power optimizers and smart modules?

The module-level power electronics (MLPE) market is one of the fastest growing segments in the PV industry, rapidly moving beyond niche status to become a crucial component of residential and commercial installations. Today, approximately two out of every three residential systems in the United States features an MLPE solution, and analyst reports indicate the global market will reach 5 GW installed by 2017.

The MLPE market includes both microinverter technologies as well as DC power optimizer technologies. These products enable PV systems to overcome performance challenges stemming from module mismatch, caused by a number of common factors including variances in module tolerance, partial shading, soiling and/or uneven aging. Through maximum power point (MPP) tracking at the module level, MLPE products mitigate mismatch effects and allow each module to operate at their maximum power levels. By eliminating any electrical reason to decrease the size of a PV system, MLPE technologies help designers to install more modules on the rooftop. For installers, this means increased revenues. For end-users, the added system output equates to lower electricity bills.

MLPE systems are also equipped with module-level monitoring to provide operators greater transparency into the performance of a system. Any issues can be pinpointed from a remote location, enabling more efficient maintenance and higher system uptime. Moreover, these systems feature enhanced safety measures that reduce system voltages during instances of extremely high temperatures and/or grid disconnection.

Within the MLPE space, power optimizers are showing the largest percentage increase in customer acceptance. Whereas microinverter technologies replicate the inverter completely at the module level, power optimizers only deploy a minimal amount of electronics on the rooftop to handle the MPP tracking and DC to DC conversion, leveraging a centrally located inverter at the end of the string. The benefit of this approach is that installers can reduce the hardware on the rooftop improving reliability and slashing costs.

Power optimizers can also be used in a fixed-voltage mode where the inverter determines current draw based on a predefined voltage target. The optimizers will all lock in

on the same current value and deliver the remainder of the power as voltage. This advanced mode of operation means that string length is no longer determined by voltage but is now determined by power. The benefit is string lengths that are boosted by 60% in residential systems and by over four-times in commercial systems. An added benefit is that inverter manufacturers can design inverters to accept voltages at the optimal level for DC to AC conversion reducing the need for DC boosters and other internal components. These reduced parts lead to lower cost products. Fixed voltage mode is the secret sauce for how SolarEdge's inverters and optimizers function.

Since power optimizers are smaller and more compact, they can also be embedded by module manufacturers during the manufacturing process as a replacement for the traditional junction box. The resulting "smart modules" further reduce parts count and streamline installation at a project site.

The value proposition for power optimizers is compelling, and the market will only grow as providers enhance their performance capabilities and cost structures at the residential, commercial and utility scales. Look for this technology to be a standard component of PV systems of all shapes in sizes in the not-so-distant future.

By Peter Mathews, General Manager; and Dru Sutton, Technical Marketing Manager for SolarEdge in North America

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4

Racking & Mounting

(Ground, Pole, Roof, Utility)

What is happening with racking and mounting fire codes?

Over the past several years, as the solar industry transitions from start-up to maturity, we've thoughtfully begun to develop the codes and standards needed to ensure a secure future for the sector. In 2013 alone, new standards and proposed standards emerged related to seismic, wind and fire safety. Each of these new developments have marked major transitions for the industry, with new testing and design requirements for every module and mounting system manufacturer.

Regarding the fire safety arena, in October 2013, American National Standards/Underwriters Laboratories announced that a PV module manufacturer could no longer receive a fire classification rating based on tests of the module or panel alone. The new UL 1703 Standard for Safety for Flat-Plate Photovoltaic Modules and Panels would require modules to be tested together with the mounting system as well as the roof covering upon which the modules are installed. Where do we stand?

California is often regarded as the leader in solar standard adoption, and fire testing is no exception. Though provisions for the fire classification of roof mounted PV modules have been updated to comply with UL 1703-2013 in the 2013 California Building Code, implementation has been temporarily deferred. Recognizing that there was an insufficient supply of UL 1703 compliant fire-rated,

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4 ***Racking & Mounting***

tested and listed PV module+racking systems, the California Building Standards Commission filed an emergency rulemaking change delaying the effective date for fire classification requirements until January 1, 2015. Now however, with no time remaining in the grace period, permitting officials and other AHJs are poised to begin requiring UL 1703-2013 compliance. The same is true in other parts of the country.

Module manufacturers are busy classifying their modules as Type 1 or 2 for framed modules or Type 3 for glass-on-glass to allow testing to proceed. Racking manufacturers are heading to testing laboratories to assess the performance of their mounting systems with each module type.

For those mounting systems that have been developed in the last 18 months, 1703-2013 guidelines were available to guide new product development. However, for the vast number of mounting systems in the industry designed prior to 2013, much work remains. To pass the fire safety tests, legacy systems will likely require fire shields, components to change the geometry of the system, or other modifications that may require additional costs over the short term until new products take their place. Given the pricing pressures already faced by the mounting system segment, any additional material or installation time-related costs imposed by fire safety won't be sustainable over the long term. The upside is that pricing pressures will likely drive a faster pace of product innovation.

Though the path to alignment with 1703-2013 is costly and time consuming for both module and racking manufacturers, the positive outcomes for the industry far outweigh the difficulties posed by the process. With greater fire safety and more advanced product designs, the industry will be one step closer to maturity and the future of solar power adoption more secure.

By Yury Reznikov, Vice President of Products and Strategy at SunLink

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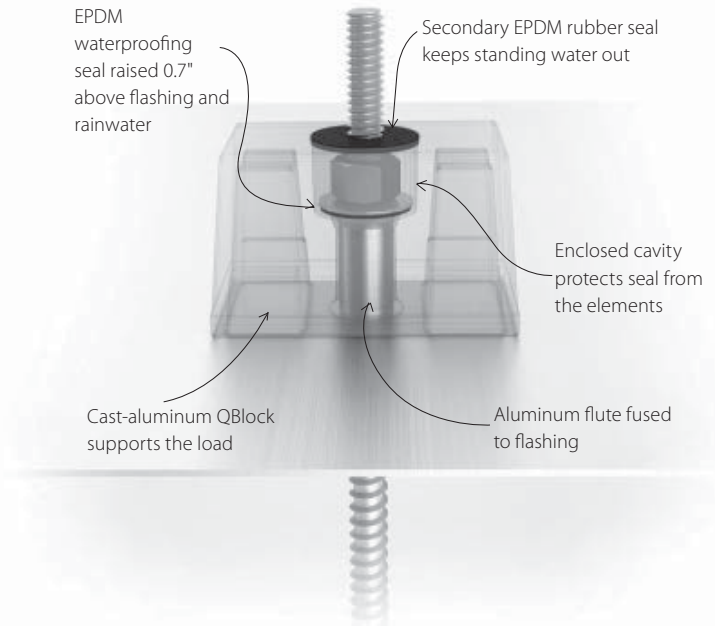

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4 *Racking & Mounting*

How can contractors prevent galling on mounting systems?

Galling is a misunderstood phenomena that few take the time to learn about. As a result, when galling occurs, many mistakenly assume that faulty hardware or a poorly designed mounting system must be the cause.

If you're working with stainless steel hardware or have employees doing so, it is in your best interest to understand galling and to teach your workers not only how and why it occurs, but also more importantly, how to prevent it. These simple actions could save you time, money and aggravation.

Galling is a form of wear caused by friction, and can result in metal surfaces being friction-welded together. Under the right set of circumstances, galling can easily develop between the threads of stainless steel nuts and bolts, in particular those with coarse threads.

As fasteners are tightened, the pressure that builds up between the contacting thread surfaces breaks down the protective oxide coating into small shavings. These shavings interlock and bind themselves together, generating even more friction and heat. This combination of events generates enough heat to fuse (cold weld) the nut and bolt together. All this can happen in an instant, especially when using a high speed driver and/or impact driver. But it can also happen with a simple hand held wrench, particularly if the stainless steel hardware is thermally heated from sun exposure and/or from sitting on a hot rooftop surface.

Galled hardware usually cannot be taken apart but must be cut or broken for removal and replacement. Unfortunately, this type of action may also damage the very parts secured by the hardware. Fortunately, galling can be avoided by implementing certain preventative measures and educating everyone at the job site about galling.

Galling Prevention:

1. Always apply an anti-seize lubricant to the threads. A molybdenum disulfide or silver grade variety is preferred and is available in tubes, cans or aerosol dispensers. Apply in small amounts directly to the threads before assembly.
2. Never use an impact driver. If using a high speed driver, set it to a slow speed. Remember, high speeds

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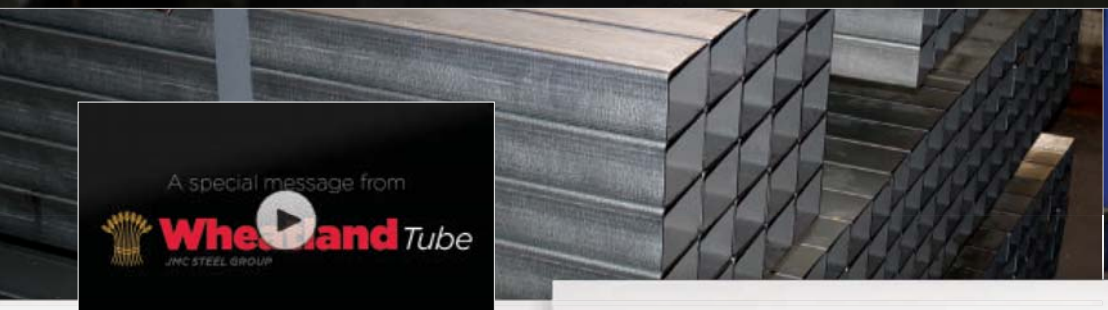

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generate more heat and friction, which lead to galling. High driver speeds do not equate to faster job completion or higher profits if galling occurs.

3. Before installing, keep stainless steel fasteners out of direct sunlight and away from heat sources such as hot rooftops. Remember, thermally heated fasteners contribute to galling.

By DPW Solar

Do limited or unattached ballasted systems make sense in seismic zones?

The solar industry has long struggled to develop a design methodology standard that mitigates seismic impact on low sloped rooftop photovoltaic systems. However, recent technical publications and enhanced design methodologies have provided solutions to this historically difficult issue. Ecolibrium Solar, with the help of industry leading structural engineers, implemented these new techniques into the design of the Ecofoot2 and Ecofoot2+.

In general, local building officials reference the International Building Code (IBC), and local or state modified versions of the IBC, for guidance on questions related to building and construction. The most recent version of the IBC was published in 2012. For structural design questions, including seismic design, the IBC directs building officials and engineers to the American Society of Civil Engineers' Minimum Design Loads for Buildings and Other Structures (ASCE 7), which was most recently published in 2010. Specifically, Section 1613.1 of the IBC guides users to ASCE 7 to design and construct all portions, including nonstructural components, of structures.

Section 1613.1 of 2012 IBC

"Every structure, and portion thereof, including nonstructural components that are permanently attached to structures and their supports and attachments, shall be designed and constructed to resist the effects of earthquake motions in accordance with ASCE 7..."

Historically, photovoltaic systems on low sloped rooftops have been governed by ASCE 7 Chapter 13, Seismic Design Requirements for Non Structural Components. Section 13.4 of ASCE 7 requires all nonstructural components to be anchored without considering frictional resistance.

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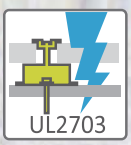

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4 *Racking & Mounting*

Section 13.4 of ASCE 7-10

"Component attachments shall be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity."

This code reference, in the opinion of Ecolibrium Solar and most seismic experts, does not allow for other more cost effective techniques of mitigating seismic forces on low sloped photovoltaic arrays. Expert opinion is that frictional resistance does play a role in the capacity of a photovoltaic systems to resist seismic forces. Prohibiting the use of frictional resistance results in overdesigned systems with an unnecessarily large number of price prohibitive mechanical attachments. Additionally, the anchoring of arrays to the building structure arguably can cause more seismic problems than solves.

The solar industry clearly needed a new approach to seismic design for low sloped roof photovoltaic systems. The IBC and ASCE 7 provide allowances for alternative materials, design and methods. Section 104.11 of the IBC allows for a design approach not prescribed within the code as long as the building official finds that the approach is satisfactory, complies with intent of the code, and is at least equivalent of the prescribed method. Section 11.1.4 of ASCE 7 allows for an alternative method of construction to those prescribed as long as the method is approved by the authority having jurisdiction.

Section 104.11 of 2012 IBC

"The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety."

Section 11.1.4 of ASCE 7-10

"Alternate materials and methods of construction to those prescribed in the seismic requirements of this standard shall not be used unless approved by the authority having jurisdiction. Substantiating evidence shall be

submitted demonstrating that the proposed alternate will be at least equal in strength, durability, and seismic resistance for the purpose intended."

In 2011 the Structural Engineering Association of California (SEAOC) formed the Solar Photovoltaic Systems Committee (PV Committee). The PV Committee consists of structural engineers, building officials, and industry experts. The PV Committee was formed with the goal of addressing the lack of clarity and specific requirements in applying structural code provisions to photovoltaic systems, all the while ensuring life safety performance. In 2012 the PV Committee published Structural Seismic Requirements and Commentary for Rooftop Solar Photovoltaic Arrays (SEAOC PV1-2012). The SEAOC PV1-2012 report provides requirements for alternative methods to address seismic design for low sloped photovoltaic systems.

The report classifies low sloped rooftop

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photovoltaic systems into categories: attached roof-bearing and unattached (ballast-only). The report's requirements for attached systems allow friction to be utilized, under certain conditions, to resist seismic forces. The attached system still requires anchorage, but the number of attachments can be drastically reduced to a feasible level. The requirements of the report also allow for unattached arrays under certain conditions. Rather than preventing the system from moving (through anchorage to the building structure), the unattached approach allows system movement. The approach ensures the system is (1) installed an appropriate distance from other structures on the roof in order to prevent collision in a seismic event and (2) sufficiently interconnected as to prevent pieces of the system from separating and posing a threat to human life in a seismic event. The SEAOC PV1-2012 report has received wide acceptance by building officials across the country. The approaches outlined in the report have been implemented successfully by Ecolibrium Solar, and many other racking manufacturers, on numerous projects nationwide.

More recently, the 2013 California Building Code (CBC), which is built upon the 2012 IBC, went as far as to implement the SEAOC PV1-2012 report's approach into the language of the code. Section 1613.5.2 of the CBC adds the definition of Ballasted Photovoltaic System and the allowance for unattached arrays to Section 1.2 and Section 13.4 of ASCE 7, respectively.

Section 1613.5.1 of 2013 CBC
Modify ASCE 7 DEFINITIONS as follows:
1.2 DEFINITIONS.
BALLASTED PHOTOVOLTAIC SYSTEM: A roof mounted system composed of solar photovoltaic panels and supporting members that are unattached or partially attached to the roof and must rely on its weight, aerodynamics and friction to counter the effect of wind and seismic forces.

Section 1613.5.2 of 2013 CBC
Modify ASCE 7 Section 13.4 as follows:
13.4.7. Solar PV panels or modules installed on a roof as a ballasted system need not be rigidly attached to the roof or supporting structure. Ballasted systems shall be designed and installed only on roofs with slopes 1 inch per foot or less. The ballasted system shall be designed to resist sliding and uplift resulting from lateral and vertical forces, using a coefficient of friction determined by acceptable engineering practices. In sites where the Seismic Design Category is C or above, the system shall be designed to accommodate seismic displacement determined by approved analysis or shake table testing, using input motions consistent with ASCE 7 lateral and vertical seismic forces for non-structural components on roofs.

Ecolibrium Solar fully expects these new seismic approaches will be, much in the same way as the CBC does, integrated and/or referenced directly in future versions of the IBC (2015) and ASCE 7 (2015). In the interim, Ecolibrium Solar will continue utilizing the methodology in the SEAOC PV1-2012 report and supporting Ecofoot2/2+ installation partners' permitting and inspection efforts as necessary.

By Ecolibrium Solar

4 Racking & Mounting

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4.1

Carports

Photo Courtesy of RBI Solar

What should installers consider when choosing a solar carport solution?

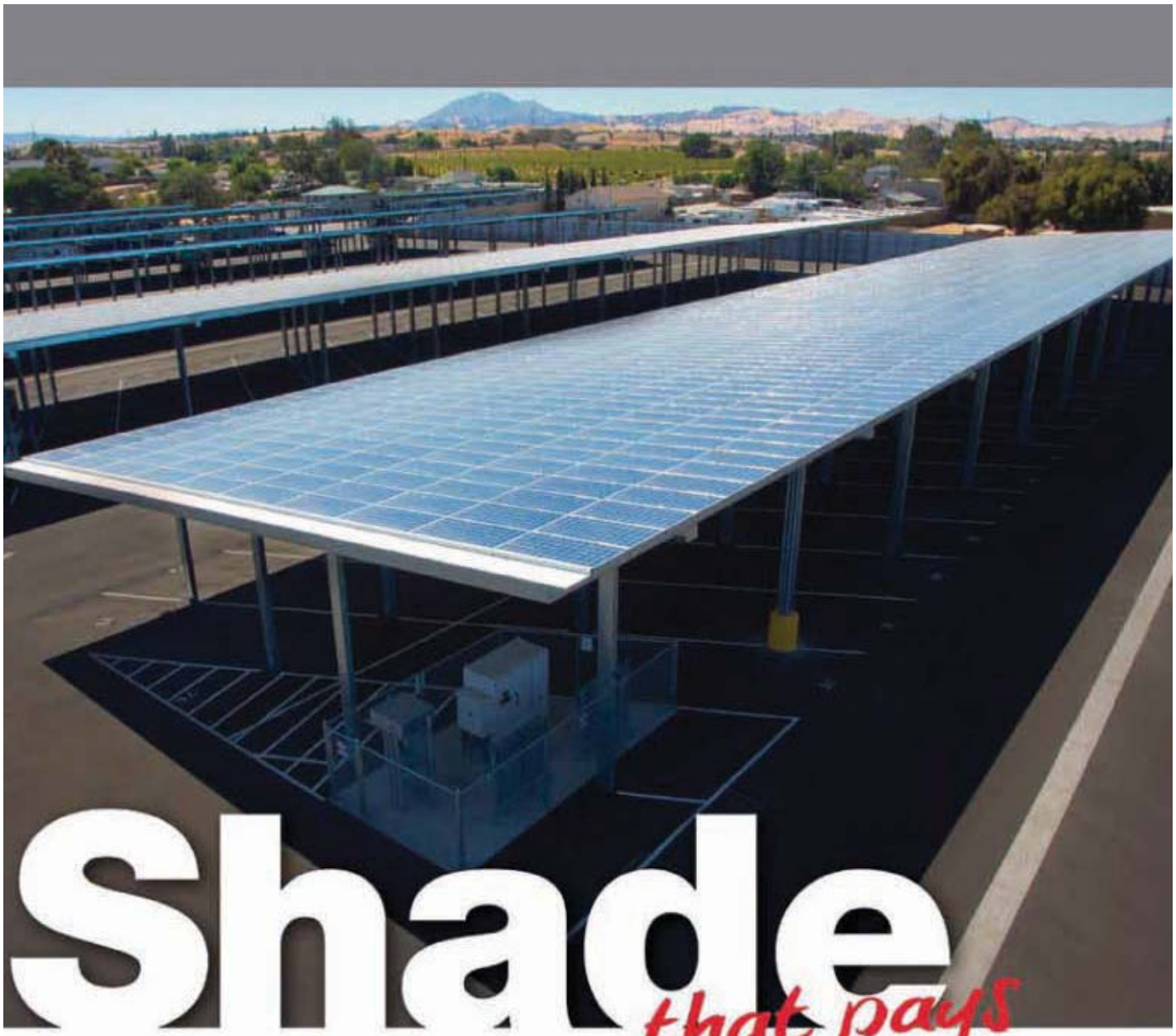
With changes in incentive programs, such as those seen recently in Maryland and Massachusetts, solar carports are becoming more and more popular in the urban market place. Solar carports offer better use of real estate and provide shade for cars as an added advantage while generating 100% clean energy. Carport is the only segment in the non-residential solar market that is showing constant growth and has a promising forecast for years to come.

Every parking lot is different, and that leads to multiple designs for carports, such as single slope, double slope, inverted slope and full coverage. Developers are becoming more comfortable with different aspects of carport projects. Minimum clearance, span between two posts, custom design and coating options are the main factors consider when choosing carport solutions.

Total project cost has reduced considerably for carport structures in the past few years. Reduced system price and lucrative state-level incentives are making carports a preferred choice for potential customers.

Some manufacturers offer installation. The added scope offers EPCs and developers the combination of lower costs and higher quality control of installation. Solar carports are the answer if rooftop liabilities are hindering a customer decision to reduce their utility bill.

Carport manufacturers are exploring a variety of material and coating options to further reduce the racking price, making the type of system even more efficient. Galvanized steel structures perform better in areas with heavy snow loads and high wind speeds. Speed of installation, foundation design and pre-assembly options are other important factors that



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4.1 *Carports*

must be considered before choosing a supplier. More and more racking companies are providing pre-assembly options to cut down the installation time. Depending upon project needs, a pre-assembled option may be more cost-effective. It is important to have a racking partner that offers several different options based on site requirements.

Industry Trends: The solar carport industry is adopting the changes in codes and standards including UL 2703, UL 1703, 2014 NEC and IBC 2012. Product design, structural and electrical design, bonding and grounding of modules and wire management must comply with regulations. Following the required state regulations is one of the factors that developers must consider before choosing the racking and mounting solution for an upcoming carport project.

By RBI Solar

Photo Courtesy of RBI Solar

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4.2

Extruded Frames

How can solar contractors know they are receiving high-quality metal products?

Solar projects often use aluminum and steel in their construction. Each of these materials has an accompanying set of material standards and design specifications to help ensure quality. The Steel Construction Manual (*aisc.org*) offers guidelines for steel, while the Aluminum Design Manual (*aluminum.org*) covers standards for aluminum.

Solar contractors care about their reputations, which are built on products that perform at or better than customer expectations. Contractors should work with mounting and framing system suppliers to ensure that the products they use—and, importantly, the materials from which they're made—can deliver on expectations.

Suppliers should be able to demonstrate the quality of their materials with examples and details, not by unsupported claims. Suppliers who design systems should understand the functional and locale requirements of an installation and have designs, equipment and processes capable of creating the structures and parts needed to meet expectations.

Photo Courtesy of AEC

Solar contractors should require that system suppliers and designers disclose how their designs are developed, taking into account the following:

- Proper design objectives and methodologies
- Locale requirements, including appropriate snow and wind loads
- Panel, mirror or other functional requirements and constraints
- Use of structural framework software or other verified methods to properly analyze different geometries and frame member capabilities
- Consideration for alternative alloy and temper choices that may be more appropriate for member loadings
- Resultant member loads on the structural members that make up their designs
- Use of the Steel Construction Manual or the Aluminum Design Manual concepts, formulae, material properties and other requirements
- Corrosion prevention requirements, including galvanic corrosion and environmental corrosion (aluminum does not require coatings while different types of galvanized or painted surfaces can be specified for steel, each possessing processing and performance characteristics)

Once the design is developed, the contractor should work with the supplier to ensure that the company has the appropriate equipment, processes and quality systems in place to develop high-quality products. Suppliers must fully understand critical aspects such as the time and temperature requirements of the steel or aluminum processes to ensure and prove that these and other requirements are reliably met.

While ISO 9000 certification indicates that the appropriate metal production processes are used, it does not always follow that the identified and followed processes will achieve the desired effect. Contractors should also verify the existence and adherence to documented quality system that cover all critical processing parameters referenced in the material standards and design and construction manuals, as well as any other referenced national standards (e.g.: ASTM) for the specific material and process requirements.

Exceptional suppliers should be able to clearly demonstrate their design and execution capabilities, providing proof—not just assurances—that all critical requirements are met. By focusing on this, the contractor can help to ensure that they receive the best quality products.

By Craig Werner, President of Werner Extrusion Solutions and Chair of the Aluminum Extruders Council's AEC Academy

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4.3

Trackers

What should contractors look for when investing in solar trackers?

Project developers and EPCs alike are beginning to recognize the added benefits of solar tracking systems. Trackers can offer a speedier ROI period and increased electricity production during peak demand hours. New products increase ease of installation and reduce system maintenance. These are some of the reasons why solar project developers are using solar tracking systems for sites all around the world. But not every solar tracker is equal.

While the selection process is different for every project, the following considerations are important to keep in mind when investing in solar tracking technology:

Reliability: The tracking system needs to last the expected project life with minimal cost to maintain and operate. Quality, reliability and life expectancy should be held in the highest regard, to ensure maximum uptime, minimum maintenance and long-term performance to successfully meet the financial goals of each project.

It is fundamental that the proper design categories be applied with at least 25-year design considerations to ensure long-term structural integrity, even during major weather events.

Other considerations, such as designing for site-specific wind load without relying solely on a wind stow devices are key to increasing uptime, longevity and minimizing maintenance. In addition to offering greater reliability, companies with established track records, varied experience and a high-volume of installed capacity are able to provide creative and quick solutions to unforeseen site issues because they have experienced and overcome a variety of challenges.

Ease Of Installation: A tracking system must be designed to install quickly and with high quality, regardless of worker skill levels. High man-hour per MW counts not only add cost to a project but result in lost opportunity costs, as contractors are work on one project longer than expected. A tracker supplier who is able to offer pre-assembled components and kitting, as well as on-site training and support, is already ahead of the game to save the EPC time — and the site owner money — during the installation process.

LCOE: Reliability, ease of installation, production gain and product cost all contribute to the lowest possible LCOE (Levelized Cost of Energy), which is normally the primary objective of PV developers. A proper comparative LCOE analysis will consider, at a minimum, the following factors to determine which system will provide the lowest cost of energy:

- energy gain derived from solar tracking
- total installed cost, including land costs
- operations and maintenance cost
- reliability, uptime and structural failure risk assessment
- time-of-day multipliers, if applicable, should be included in the financial model, as well as the energy output profile of the systems

Tracking System Type: Due to economies of scale, installation efficiencies and other factors, single-axis horizontal tracking systems have become the go-to tracking technology for projects greater than 100 kW.

More specifically, linked tracking systems have become the prominent technology for utility-scale and large commercial sites. These systems use simple installation practices, usually with relaxed tolerances, which allow for fast deployment and seamless commissioning. Linked systems minimize motors and controllers per MW, which are the two most common failure points in a tracked array.

Some linked systems employ rotating drive mechanisms that enable an articulating joint connection between rows. The articulating joint creates a driveline with installation flexibility in any direction, which is key when dealing with sites that have any sort of undulating terrain or topography issues. Not only does this feature save installers time due to high installation tolerances, but it also decreases the need for extensive grading, ultimately saving money and decreasing installed cost.

During And After Installation Support: Customer service is everything. Site owners and EPCs will experience clear benefits by working with tracker companies that offer engineering support, on-site project management services, commissioning teams and solid warranties.

By: Array Technologies

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5

Electrical Components

(Combiner Boxes, Encoders, Gearboxes, Pyranometers, Switchgear, Transformers)

How do you protect PV system equipment from lightning?

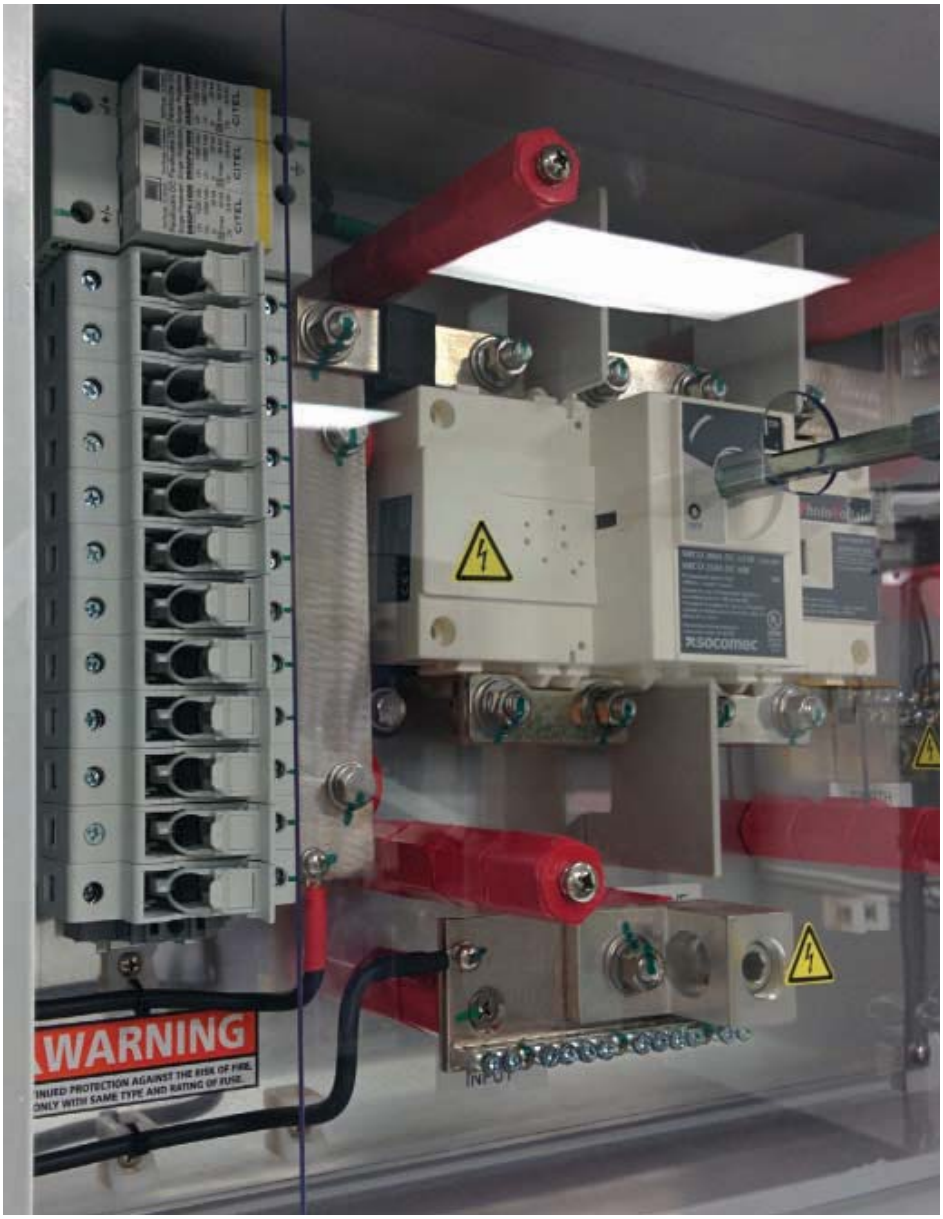

Photo Courtesy of CITEL

You know the saying "Lightning never strikes twice?" Turns out, it's a myth. Lightning can strike twice, three times or even more. It also has some favorite targets, with photovoltaic (PV) systems — including combiner boxes, inverters and datalines — at the top of the list.

The increased risk for lightning strikes close to PV systems largely has to do with the size and location of such installations. These systems are usually large and in open areas. While this is ideal for collecting solar rays, it's unfortunately also great for attracting lightning. All it takes is a split second of a surge from lightning and your entire PV system could be severely damaged or shut down. Even if the lightning does not hit the system directly, a "near strike" hit to the ground in close proximity can still cause significant damage, sending thousands of uncontrolled volts into the system. If a power surge from lightning damages or destroys the system, the cost to replace or repair the affected components can be an expensive blow to the investment and significantly delay ROI. It often takes a few years of successful operation before PV systems begin to pay for themselves, and damage from lightning can be a serious setback.

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5 *Electrical Components*

But there is a solution. Surge Protective Devices (SPD's) are specifically made to protect PV systems from these harmful surges so that the installation can continue to operate. SPD's are designed to react to any overvoltage the system experiences, such as one caused by lightning. The instant a surge is detected, the SPD is activated. By catching and safely redirecting the electrical surge from lightning, an SPD prevents damage or destruction to the piece of equipment that experienced the surge. An SPD also stops the surge from propagating through other pieces of equipment.

There are three vital components of a PV system that should be protected by SPD's: Combiner box, inverter and datalines. The combiner box and the inverter contain some of the most expensive parts of a PV system. They are susceptible to direct lightning surges as well as ground surges from lightning strikes, surges coming off the grid, and surges that have traveled through the datalines. Lightning striking power lines is a familiar occurrence; the power line gets hit and the lights go out. The equipment and datalines in PV systems respond to surges in a similar way.

SPD's make it possible to easily prevent lightning surges from destroying your PV system. By conducting a risk analysis on your specific installation, you can determine the level of protection needed to maintain optimal functionality and prevent costly repairs and equipment replacement. Risk analysis can be quickly done by a surge expert based on factors such as system size, location and configuration. It's a small step that can have a big impact on your PV investment.

By CITEL

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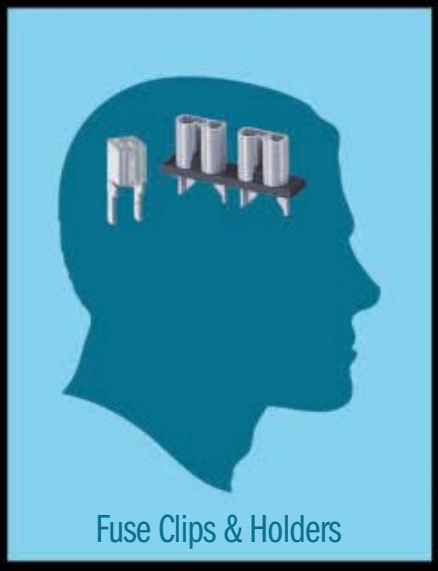
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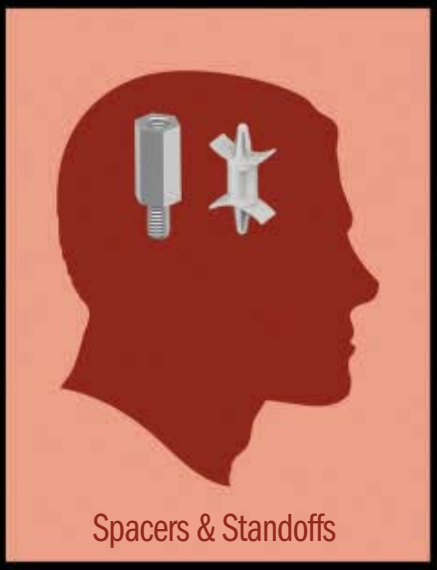
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5.1

Motors & Drives

How installers can ensure solar trackers have quality components?

Photo Courtesy of Dunkermotor

The list of solar manufacturers meeting their demise continues to grow. This is no different in solar trackers, much of which is due to inordinate Total Cost of Ownership (TCO). TCO consists of capital, operational and maintenance costs, the last of which is least considered but most important. Many out-of-business companies have failed the TCO litmus test.

When a tracker is not working, not only is a project losing money in paying for labor to repair, but is also less-optimized for energy production and therefore diminishes revenue. A leading cause of solar tracker malfunction is that their components are not built to survive the harsh environments of many solar sites where trackers are used. When trackers are made with inferior, sub-standard components, replacements become necessary and TCO rises.

Root Causes Of Inferior Tracker Components

Solar trackers must work for more than 20 years in tough conditions. For example, the Ivanpah solar project in California's Mojave Desert sees temperatures above 120°F and below 0°F. The daytime humidity is up to 100%. The project experiences nighttime condensation, as well as rain, dust, snow and sleet. Saline-laden ocean breezes near shorelines are prevalent. All these conditions corrode tracker components.

Installers are looking for a tracker with equipment life of 20 years or more. These companies want a tracker that will perform the best in their application with the lowest TCO and lowest cost per watt. The responsibility to ensure that electro-mechanical equipment meets these expectations rests with the component manufacturer. The lowest TCO is a shared responsibility, between all partners engaged in engineering the solar tracker. All companies involved in tracker engineering should begin with a mutual understanding that environmental conditions must be studied and integrated into a design.

Ensuring High Quality Components

High-quality tracker motors will meet the following recommendations:

Insulation: Electric motors driving the solar tracker must have a higher class of insulation to withstand temperature extremes 185°F to -4°F.

5.1 *Motors & Drives*

Lubrication: Planetary and worm gearbox assemblies require durable lubrication. The lubricant must remain stable over the 20-year tracker life, withstand the full high and low temperature range. It also must be suitable for low rotational speeds and high torques (usually twice the nominal rated values).

Moisture-Out Membrane: Moisture, which results from condensed daytime humidity, gets trapped inside the motor housing, likely damaging the electrical components. Moisture-out membrane helps to vent the trapped moisture.

High Ingress Protection: Electro-mechanical and electro-optical equipment must be protected from penetrating dust, rain and snow. It's best to seal equipment completely. At a minimum, the equipment should meet an IP54 rating, but it is preferable to seal the enclosure to a higher degree of protection, such as IP65 or IP67.

Enclosure Corrosion: Electrical motors and gearbox enclosures should be protected from corrosion. The corrosion protection must include all metal surfaces. Coating materials with varnish, electroplating or anodizing to prevent exposure to corrosive elements is a must. If plastic enclosures are used, they, too, must have an equivalent field life. The materials should have excellent UV environment inhibitors.

Low-Friction Gears: High torque and low speed are characteristics of solar tracker designs. The high torque will cause heat build-up inside the gearbox. Low gear turning speed/motion causes poor heat dissipation. For that reason, low-friction gears are essential to prevent the possibility of gears fusing into one another because of the intense heat.

Cable Termination: The cables and cable components exiting from the motor and controller, must be protected from water ingress and ultraviolet light.

By: Dunkermotor

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5.2

Networking

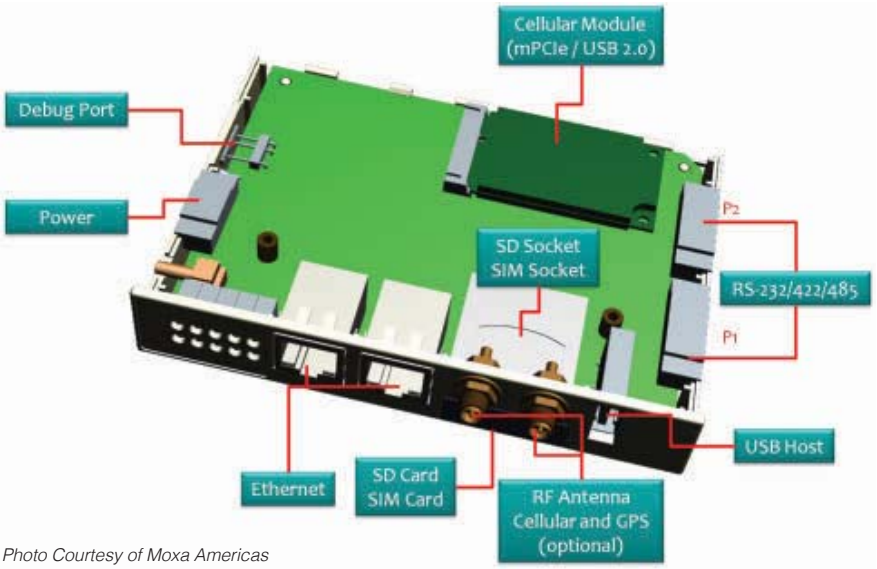


Photo Courtesy of Moxa Americas

Why is networking important in a solar project?

From utility-grade to residential solar installations, networking infrastructures are the keys to a good monitoring system. This, in turn, will affect the efficiency of the energy production.

The advent of transmission control protocol/internet protocol (TCP/IP), the prevalence of Ethernet and mobile-networking technologies, opens the possibility of allowing the field engineers, solar-equipment providers or the power companies to monitor all environmental indicators and the status of the equipment remotely. It allows people to conduct preventive maintenance or change of array configurations to ensure the best performance out of the system.

Take utility-grade solar deployment. Industrial networking equipment makes up the souls of control-and-monitoring systems. Only industrial-grade Ethernet switches and networking routers should be used to withstand the extensive heat and harsh environments where the arrays are installed.

Industrial networking equipments are designed using only components with long mean times before failure (MTBF) to avoid component degradation because of violent temperature or humidity changes. Network redundancy is also another important feature that needs to come with the networking equipment.

Most of the industrial networking switches are equipped with ring topology redundant. At the utility level, where the deployment might expand to involve hundreds of arrays, chain topology can be ideal. Chain topology offers not only the multiple routes redundancy, but it also gives the system administrators the flexibility to expand the network with ease as the site expands.

In commercial and residential solar installations, the demand for super-efficient solar power generation is not as strong as in utility applications. But the demand to see how the solar installations (which the homeowners and commercial building owners spent thousands of dollars on) can drive down their demand for power, or even sell any excess back to the grid, continues to grow. This is especially true as the subsidy from the government is dropping.

Solar monitoring systems for commercial and residential applications rely on a robust networking infrastructure, but they are somehow different from utilities in the following ways:

- They are remote and geographically widely spread.
- They need a cost-effective solution that combines networking function with a logger.

5.2 *Networking*

There is a trend in the industry to start using mobile networks for remote data acquisition. But a common problem in North America is that no cellular carriers have the full coverage, which means multiple carriers might be used by the solar-monitoring solutions providers. In this case, installers should consider the interchangeability of different cellular modules so the device can be used on different carriers' networks.

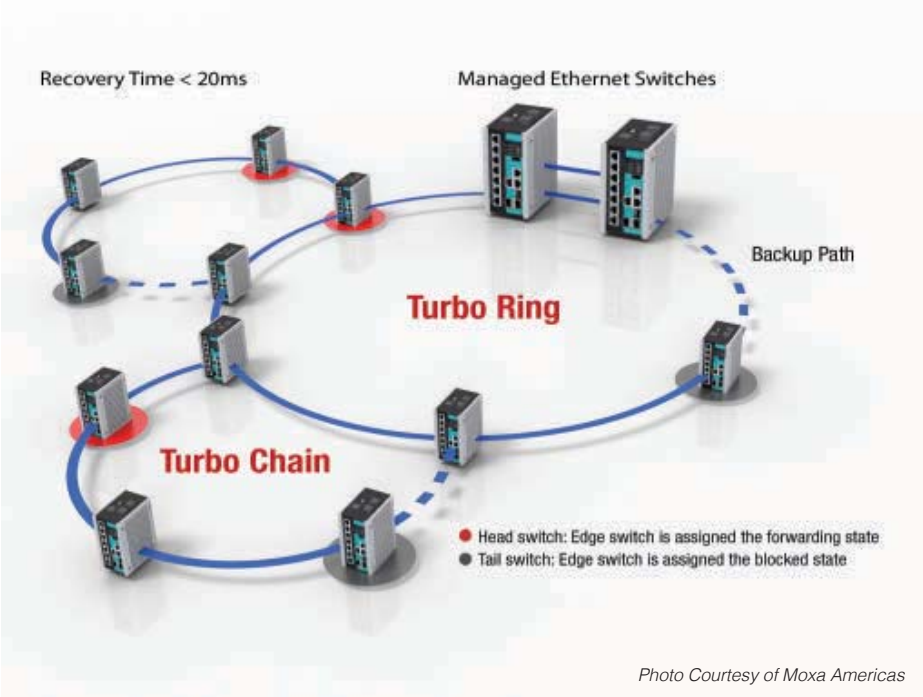
To serve the second requirement (to drive the overall costs down on a residential and commercial solar monitoring systems), a good solution may be embedded computing technology.

For example, a data-logging gateway that combines both data logging and cellular gateway into one box could be a good option.

Networking is the soul of all solar monitoring systems. A reliable and expandable network is important to establishing a successful monitoring system. Only a stable network can continuously provide important data information on power generation and environmental indices.

That data can then be used for preventive maintenance and operation optimization to maximize the investment. Without a stable networking, system administrators will find themselves spending more time on trouble shooting than conducting data analysis that will turn into real profits.

By Daniel Liu, Business Development Manager, Embedded Computing, Moxa Americas



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5.3

Solar-Charge Controllers

What is the most important factor in choosing the perfect charge controller for your solar project?

The most important job of all solar-charge controllers is to properly charge the batteries and to give them as long a life as possible. There are two types of charge controllers:

- Pulse width modulation (PWM)
- Maximum power point tracking (MPPT)

The difference between these two types of controllers is that the PWM is not as efficient the MPPT. The MPPT is the most common these days and can gain you up to 30% more power than the PWM controllers. The MPPT controllers also allow the strings of panels to be connected in series for higher voltages, keeping the amperage lower and the wire size smaller, especially for long-wire runs to the PV array.

When picking a controller there are a few steps that you must follow to make sure that you get the right controller for the job. The best thing that you can do is to use the manufacturer's sizing tools that are offered on their web sites. The other option is to give the manufacturer a call — their salespeople will usually be happy to help you to pick the best controller.

If you need to make some quick calculations, the following information will be needed to manually figure out the amperage of the controller needed:

- The wattage of the solar array
- The battery-bank voltage (12, 24, or 48). Typical bank voltage because inverters are offered in these voltages.

Now Ohm's Law comes into play: Amps x Volts = Watts

- Example: 3,000watt array/48volt battery bank = 62.5 amps, so you would need a controller capable of 62.5 amps. Most controllers out there are either 60, 80 or 96 amps so you would pick the controller with the next higher rating. In this case, it would be the 80 amp controller.

Now if you know the amperage of the controller, and you would like to figure out how the maximum solar array wattage that can go into the controller, you would also use Ohm's law:

- Example: 80 amp controller x 48 volt battery bank = 3,840 watts of solar pan-els. Note that most of the controllers will allow a bit more wattage to go into the controllers. This is where the sizing tools or a call to the manufacture can help out.

The next thing that you must ensure is that we do not exceed the input voltage the con-troller can take. Again the manufacturer will dictate what the input voltage should be in-cluded in the design. Temperature and open-circuit voltages have to be considered. Since PV open-circuit voltage (Voc) goes higher as temperature drops, you will need to make sure the controller's input voltage ratings can handle this in the cold of winter. Manufacturer's sizing tools will give you the best design for the controllers.

There are many makes and models of charge controllers available, but it's best to get the most options for the best price. The following is a list of features available on charge controllers — but not all controllers. The best will offer every option.

Photo Courtesy of Midnite Solar

- 150,200,250,600 V
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By: boB Gudgel & Kim Silva, MidNite Solar

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6

System Components

(Adhesives, Busbars, Cables, Clamps, Connectors, Tubing)

Is there any reason to not use connectors from different manufacturers together?

Photo Courtesy of Multi-Contact

The practice of claiming one's PV connector is acceptable for cross-mating to that of another company's connector has unfortunately become alarmingly common place. For the sake of clarity, "cross-mating" refers to the plugging of two connector halves of a different type or from different manufacturers. Popular products such as certain manufacturers' family of connectors are often a target for companies to claim cross-mating compatibility. However, unless the two connector manufacturers enter into a joint certification through the accepted certification agencies (UL, CSA, TUV, etc.) the certification for cross-mating to another company's product is not permitted by these agencies. The situation of two companies in a joint certification is extremely rare if not non-existent for PV connectors. Therefore any company claiming to have a connector certified for intermating with another's brand is being dishonest, if not flat-out lying.

Since some companies will even display a third-party test lab report from a reputable certification agency and try to pass it off as a certification (these reports often state clearly that they do not constitute a certification), the most assured way to check if a product can be mated to another company's product is to check the certification agencies websites directly. All the major organizations such as UL or TUV maintain an online certification directly that can be searched for what is covered by a company's certification. Often times, a statement such as "this connector system has only been investigated for use with products within its own product line" can be found.

The persistence of cross-mating connectors is a serious issue, with dire consequences including burnt connections, arcing failures and even structure fires. In the best case, the connectors mate so poorly that no electricity at all will pass through the connection and the system installer will become aware that something is wrong. However this is not typically the case and the problems instead do not manifest themselves right away. Usually the cross-mated pair of connectors will connect together and pass electricity without any

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6 System Components

Photo Courtesy of Multi-Contact

easily noticeable issues. But the misalignment of design dimensions and material compatibilities over time (possibly even years) can lead to loss of weather tightness and run away contact resistance that leads to eventual catastrophic connector failure.

The performance requirements for PV components are exceptionally severe: Survive outside in temperatures swinging from below freezing to near boiling, in direct sun or driven snow, arid dry or soaking wet, for 20-plus years without failing. A PV connector in a 1,000-V system may easily have as much as 30 kW of DC energy flowing through it, which is more than the service energy supplies to an entire residential home. Therefore the deceptively simple looking PV connector requires a tremendous level of engineering consideration, testing, validation and quality control to meet these requirements. Trusting that another company has achieved the same level of assuredness when mating to another company's product without any actual exchange of design or construction information ever taking place between them is extremely dangerous.

Please help maintain the PV industry's reputation for safety and reliability by spreading the word about the dangers of cross-mating. The safest and most reliable habit is to always mate only connectors from the same manufacturer.

By Brian Mills,Product Manager of Photovoltaics for Multi-Contact North America

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7

Batteries & Storage

Which battery technology will win the storage race?

Photos Courtesy of Crown Battery Co.

As more utilities cut off subsidies for grid-tied solar users, a growing number of homeowners are investing in battery storage for their renewable energy (RE) systems, using the money they'll save on utility bills.

So which storage technology will RE users prefer? Currently, flooded lead-acid and sealed lead-acid batteries command the largest marketshare, followed by lithium-ion cells in certain applications.

Lithium-ion batteries offer high energy density and low maintenance, two factors that have contributed to their domination of the portable electronics market. However, lithium ion's cost—often more than $100,000 to provide battery backup for an average-sized house—makes them cost-prohibitive in most RE systems. In addition, lithium-ion batteries contain toxic materials that have to be disposed of in special landfills. So the batteries designed to store green energy actually end up harming the environment.

Lead-acid batteries are the most popular energy storage systems for renewable energy. They've been proven for more than 100 years. Because of their heritage and time in use, we know there's no danger of meltdown. And because battery engineers have refined manufacturing and design, they're able to lower costs and increase quality, reliability and lifespan. Even better, lead-acid batteries are 97% recyclable—the highest recyclability percentage of any product.

Because RE batteries are subjected to brutal operating conditions, some batteries fall short on lifespan, performance and value. That's why one of the battery industry's biggest changes is the move toward automated manufacturing to produce advanced lead-acid batteries. That shift, including cast-on-strap (COS), computerized quality control and robotic assembly, is producing batteries that last longer and deliver more power.

Lead-acid battery engineers have spent decades improving their designs. But even the best-designed battery will die early—and perform sub-optimally—if it's forced to operate in extreme weather. Ideally, lead-acid batteries should be used in 77°F (25°C) temperatures. Yet many RE systems expose batteries to a scorching 100°F or more, and

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7 Batteries & Storage

freezing temperatures in other climates. These extreme conditions rob batteries of their storage capacity and can cut battery life by more than 50%.

That's why even the leading batteries should only be part of the equation. The other key factor is protecting batteries from performance and life-sapping weather conditions. One company, Mark Snyder Electric, created the world's first stand-alone structure built from the ground up to shield batteries and other RE system components from extreme weather.

Called Enertopia Multi-Purpose Utility Structure (EMPUS), this patent-pending structure keeps the elements at bay to protect batteries and other gear for up to 25 years. EMPUS marries low-maintenance temperature control with R-42 super-insulation from P2000—so the temperature in the structure stays at or near the ideal for longest battery life.

Because of their efficiency, cost-effectiveness and environmental sustainability, lead-acid batteries and protective structures will remain the most popular technology to lead the RE market.

By John Connell, Crown Battery Manufacturing Co.

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7.1

Solar Enclosures

Photo Courtesy of Allied Moulded Products

Why are enclosures a simple but important part of a solar project?

The basic premise of an enclosure is simple—it is a cabinet to store electrical components to prevent shock to users and to protect the contents from the environment. The enclosure is essential for its utilitarian purposes but should also fit aesthetically into its location.

There are a variety of choices available for the material and construction of enclosures. The two main categories are metal and nonmetallic. Metal enclosures can be made of carbon steel, stainless steel or aluminum. Carbon steel has an initial lower cost but must be painted or coated to provide resistance to moisture and other corrosive environments. Regular maintenance is required for carbon steel enclosures.

Stainless steel and aluminum enclosures have a higher cost, yet there is less maintenance (to prevent rusting) than with the carbon steel variety. Features include strength, corrosion resistance, chemical resistance and a residual scrap value when the life of the enclosure has ended.

The primary nonmetallic materials are thermosets and thermoplastics. Thermoplastics are injection molded products, with polycarbonate and polyvinyl chloride (PVC) materials being the most common.

These enclosures offer a degree of protection beyond painted carbon steel. They offer rigidity, durability, a lighter weight and non-conductivity. However, in outdoor environments they are more susceptible over time to the effects of UV and weathering degradation.

Fiberglass reinforced polyester (FRP) is an example of thermoset material. It provides greater corrosion protection than painted carbon steel and performs better than metal and thermoplastics in harsh, outdoor environments.

Although metal enclosures have been around the longest, there are a number of advantages to using nonmetallic enclosures. They have been proven especially reliable, providing longer life protection in both outdoor and indoor environments. There may be an initially higher cost over painted steel products, however, there is no maintenance required to prevent rusting. There is also a considerable savings over the premium metal enclosures. Aluminum is prone to oxidation and not recommended for all outdoor applications. Stainless steel products can rust over time, in addition to its limitations protecting against certain corrosive chemicals and harsh environments. Nonmetallic products will not rust. Another advantage of nonmetallic enclosures is the ease to modify, with modifications completed more quickly and without the need for expensive tools.

When considering the cost of an enclosure in relation to the overall solar project budget, enclosures should be considered more than just a box. One of the advantages of solar installations is the fixed cost of the solar energy system versus the utility-supplied electricity, which likely will increase over time. That fixed cost can be negatively impacted or increased if the protection an enclosure provides is compromised in any way and the controls inside are damaged or fail to function properly.

The resulting less-than-optimum system performance, including downtime and the expense to replace the enclosure, would result in final costs that are higher than if the correct enclosure had been initially selected. This is why it's important to understand that an enclosure is more than just a box; it is simply essential to your solar project.

By Bill DeRoche, Allied Moulded Products

8

Software

(Assessment, Designing, Monitoring)

Photo Courtesy of Folsom Labs

How software is changing the solar sales process?

Solar sales professionals are always looking for ways to gain an edge. They need to get access to deals and maximize their close rates—all while serving their customers' particular needs. Software has always played a critical role in this process. Recently, several new applications have come to market directly, addressing these issues by offering advanced functionality that helps business developers improve their effectiveness:

- Improve the team's throughput velocity
- Increase customer engagement
- Unlock value-based selling
- Encourage real-time collaboration

As a result, sales teams are able to close more deals, faster than ever before.

Increased Throughput Velocity

A sales professional's throughput is the most important driver of success. Leading developers are consistently able to improve the throughput of their sales teams by 10% to 50% annually.

Traditionally, a proposal for a commercial property must include a preliminary system design and an energy yield/revenue estimate, which means a typical sales cycle would involve a salesperson calling in a location to his engineering team and then waiting days or weeks to get back a layout and yield estimate. This caused both long turnaround times and significant delays.

New software products are shortening this process by allowing the users to quickly layout a system and generate an energy yield estimate simultaneously. Combining this into a single step dramatically reduces the time it takes to generate a proposal. Additionally, many sales professionals are able to

use the software themselves, cutting an entire step out of the process. Fewer steps means faster turnaround and less room for miscommunication or errors.

Customer Engagement
New software tools also help engage with customers in the middle of a direct sale:

- **Immediate customer feedback.** The customer may want input on the location of solar modules, inverter placement or other design decisions. New software allows users to modify a design on the fly, so sales professionals can immediately show the customer a revised system design and revenue projection. Most importantly, this eliminates an entire modification cycle, getting to a signed contract faster.

- **Mobile devices.** Many of these tools are completely mobile or tablet-ready, making them perfect for use right in the field. These applications can dynamically show different design approaches and financial scenarios.

Selling value
While some customers only want to know the bottom line, others are more interested in the full process. They are interested in the technologies and design options available to make sure they are getting the best performance out of their solar system.

New software products enable developers to easily run many different scenarios, making sure they are proposing the most cost-effective system. If this is something the customer is interested in, they can even present the design trade-offs directly to the customer, proving that they are proposing the most cost-effective system. This satisfies the customer's desire for more information, while making the developer look like they are working harder than the competition to meet their needs.

Sales are often cyclical, so sales professionals often find themselves in a crunch, with too many proposals demanding attention. New collaboration tools can help relieve that tension, making it easier to share work and close multiple jobs simultaneously.

While the solar industry is changing fast, the change is not just restricted to hardware costs: The sales process is also evolving quickly. Driven by new software tools, business developers and sales professionals can work smarter and faster, which generates more proposals while increasing their close rate. The result is a better bottom line for developers and a lower cost to install solar across the industry.

By Paul Grana, Co-Founder and Head of Sales & Marketing for Folsom Labs.

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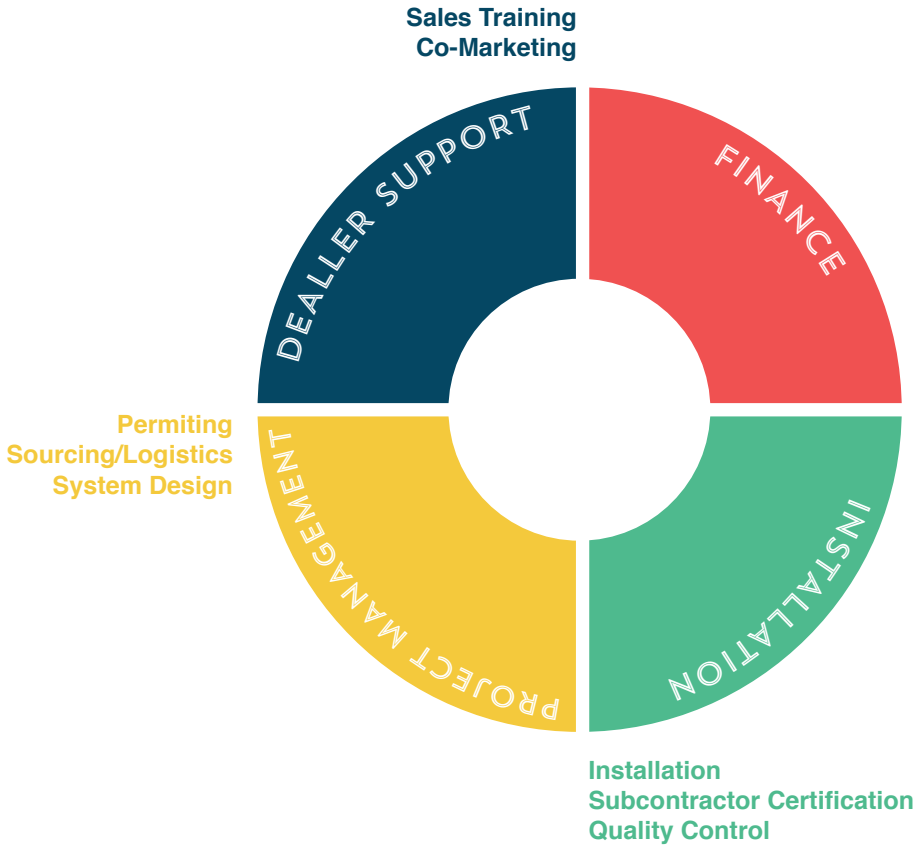
9

Distribution

How can distributors help installers improve their business practices outside of supplying components?



Demand for solar is at an all-time high. Worldwide solar demand will hit 40 to 46 GW this year and climb to 100 GW by 2018. A growing number of states in the United States want to implement renewable portfolio standards, and prices for modules have declined from $4/watt in 2008 to easily less than $1/watt today.

We're also seeing solar installers diversify into energy efficiency, roofing and other disciplines. Solar is also moving from a niche industry to a driving force in the housing and construction markets.

On the other hand, local solar dealers find themselves competing against national and global installers with greater buying power and larger marketing budgets than independent installers. Paperwork and permitting are taking up inordinate amounts of time and project financing is becoming more important adding complexity. If not managed correctly, a dealer can be mired in profitless prosperity.

Distribution is poised to reset this balance of power. Historically, distributors focused on delivery and fulfillment. Ordering through distribution simplified logistics and, in many instances, could result in better pricing. It was ultimately a product-centric business.

But the future of distribution will be increasingly focused on services. Pure-play solar distributors, for instance, will become a source for residential and commercial financing. Permitting and

project design will be automated through cloud platforms created and managed by distributors.

Recruiting partners will also be managed through distribution. In the future, solar dealers will depend less on recruiting and building their own installation teams. Instead, they'll have the option to focus on their core competency and leverage the distribution network for their other needs such as relying on contractors and teams of certified, vetted experts they will obtain through—you guessed it—distribution.

What's driving this? Largely, it reflects the maturity of the industry. Solar has operated like a specialty business. Installers relied on word-of-mouth to generate business and often worked on jobs in a serial fashion. As the industry advances, however, the business of solar becomes operationalized, compresses margins and turns into a price-competitive business that needs operational efficiency in many markets and also more deal flow to keep growing and profiting.

Just as important, distributors have come to realize that their most valuable asset isn't access to products, it's experience. You learn quite a bit being involved in thousands of installations. What are the benefits and nuances of different inverters? How long does a 5-kW installation in a particular area usually take? How do you get through a homeowners association quickly, or what can you do to get quicker permitting times for each local permitting office?

The first place where these changes are taking place is in financing. Independent dealers now have greater access to PPAs, once the province of national dealers. Mainstream banks are also entering the market. Independent solar installers aren't going to be able to examine all of these options in time to respond to a request for proposal (RFP). Distributors will serve as their back office, comparing rates and programs so the dealer can submit a winning bid.

Likewise, most dealers are not going to be in a position to develop their own remote-modeling tool for designing systems. They also aren't going to be in a position to test third party remote-modeling tools to determine which ones work best. Good distribution partners will bring dealers the knowledge of thousands of installs and the innovations they need to succeed.

Ultimately, if this transformation is successful, dealers will be able to get back the one commodity that is most important to growing their business: time to concentrate on what they do best.

By Jonathan Doochin, CEO of Soligent

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10

Financing

What will be the best way in 2015 to fund solar projects?

It's no secret that 2013 was a good year for solar. The industry saw record growth in 2013—with an increase of 41% of installed capacity—making it the fastest growing renewable energy source and second only to natural gas.

Rhone Resch, president and CEO of the Solar Energy Industry Association (SEIA), noted that in the 18 months leading to the beginning of 2014, more solar capacity had been installed than the previous 30 years combined.

It's safe to say that solar has finally hit primetime, but it begs the question will the good times keep rolling? As we take a step back to look at some of the trends in solar, it's clear that there are going to be some challenges ahead as the markets begin to mature. Along with those challenges, however, will come new opportunities and continued growth potential for the industry.

Relative stability and a longer horizon for federal tax policy have helped to lay solid foundations for solar investment. But the real accelerators have been the state programs. California has continued its dominance, but states like Massachusetts, North Carolina and Georgia are emblematic of new markets that have seen explosive growth.

These state programs are now becoming victims of their own success in that a number of them have already reached or surpassed their preliminary goals. For example, Massachusetts has already exceeded its stated goal of 250 MW four years ahead of schedule. As a result, Governor Deval Patrick increased the goal to 1,600 MW, but the incentive program could change significantly as state regulators finalize new regulations related to the change.

As state RPSs are reaching their goals, two countercurrents have emerged in the debate. The first is from utilities who charge customers for transmission and distribution based on volumetric tariffs. Utilities argue that customers with solar energy systems are not paying their fair share for transmission and distribution, and are essentially "free riders" on the grid. Solar advocates argue that this is counterbalanced by the broader system benefits of reduced transmission and generation requirements as well as increased peak shaving capacity. However, as evidenced by Arizona's implementation of a minimum distribution charge, regulators are beginning to listen to the utilities.

The other oppositional argument is coming from large energy consumers, rate payer advocates and pro-business trade associations who argue that state solar programs are expensive and driving up energy costs. Solar supporters point out not only the broader system benefits, but also the substantial economic benefits of a growing solar energy industry.

Another important trend that has contributed to the growth of solar is declining costs. We have seen some interesting developments—both encouraging and troubling. Soft costs will likely continue to decline as new and more efficient approaches to financing and risk management continue to develop. The more solar becomes a known commodity the more likely we are to see efficiencies in these areas. This will make financing easier.

Declining hard costs have been another success for the industry—but will this trend continue? It is likely that we will continue to see price efficiencies for many system components, as better design and manufacturing approaches drive down costs for racking systems, inverters and other system components.

While 2015 looks to be another good year for solar, there are several variables we need to watch that could have significant long-term effects on the industry on the financing side.

Despite these developing issues, 41% growth is an impressive number, and many industries would be happy with one quarter of that growth. As Yogi Berra might say, "The future ain't what it used to be." But from where we are standing, it still looks pretty good.

By Conor McKenna, Reznick Capital Markets

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11

Construction & Installation

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With the ITC winding down and facing a sharp reduction in 2016, how will it affect the construction of new solar projects going forward?

The utility-solar market is hugely affected by any change in project costs. We see this today with rising labor and commodity costs, as well as the effects of the ongoing trade dispute over imported solar modules.

With the ITC sunset looming at the end of 2016, it will add to these cost issues and severely affect the utility sector. We already see a number of projects that are on the bubble because of the uncertainty over whether they will be installed in time to ensure that they receive the ITC at its current rate.

Contractors and developers are already planning for the end of 2016, allocating additional resources to handle the ramp-up in capacity needs over the next 18 months to meet demand. During this time, these companies are also working hard to drive efficiencies and squeeze out as much cost as possible to be able to live in a post-ITC environment.

The industry as a whole has done great things over the last five years to bring costs out of the projects and be in a position to meet current pricing demands. The savings in module costs, while significant, have not been the only reason system costs have come down. Every aspect of the project build has seen significant cost reductions. Efficiencies in installation and manufacturing have brought down the balance of system costs by more than 50%. Equipment costs have been reduced by manufacturers scaling to the new demands. Overall, a lot of progress has been made.

Even with all of the great work done to date, the ITC is still a vital part of the business and a needed part of the financial equation. The cost effects seen recently only exaggerate the problem. We are getting a glimpse today of what the future will look like. The tariff rulings have increased the overall build costs by 10 to 12%, and we are seeing how that has affected or stopped projects. A 20% reduction in the ITC would be devastating to the utility market as we know it today.

But there is hope: If the industry can come together and find a solution to the trade issues, open up global manufacturing to free and competitive trade and embrace the challenges, we can continue to build in a post-ITC

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environment. The challenges are many—permitting, approvals, land use and access to capital—and will all need to be addressed. Continuing to rely on EPCs and manufacturers to drive out costs is not enough. While I still am a firm believer that construction costs will continue to come down as new efficiencies in modules and advancements in system design are achieved, soft costs must be a major part of the equation. Development and project acquisition costs make up such a large part of the overall project cost that streamlining them will have huge benefits.

I believe strongly that the solar industry has gained too much momentum to not overcome the ITC hurdle when it must. I hope that lawmakers in Washington understand the economic impact that solar has provided the U.S. economy, as well as the significant number of jobs it has created. Recognizing this, as well as the abundant need for clean, reliable power generation, will endeavor them to act and extend the ITC. Extension will allow the industry to address the challenges in today's market and be in a position in the not-too-distant future to be sustainable post-ITC.

By George Hershman, Vice President and Division Manager at Swinerton Renewable Energy

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12

Engineering Services

What role does an EPC play in a solar project?

Building a solar installation is your dream, not only generating power for your customers, but moving you to the forefront of an energy revolution. However, you're asking yourself how to do it, and who can help?

As we look forward to 2015, we will see the solar installation industry grow even larger to accommodate residential, industrial, community and commercial operations. With all this activity, there will be commercial developers who are seasoned, along with independent private investors looking to get in on the activity.

There are many aspects that can derail a project which, on paper, pencils out to be a good investment. Factors such as design schedule delays, material procurement issues and final construction issues can all contribute to a poorly run project that will end up making you wish you had never started.

So that begs the question, what kind of company can help from the start? This may be an option where engineer, procure, construct (EPC) consultants can step in and come to your rescue. If you're lost, an EPC can help you find your direction.

What Is An EPC?

Let's focus on a commercial installation and the advantages of the types of implementation techniques available: EPC, E/PC, EP/C and E/P/C. These variations of services are given because, in its purest form, EPC can be combined in several ways. Each arrangement detailed below is individual in its application, but somehow they all use the same three letters, which may lead to some of the confusion behind the term.

EPC, or engineer-procure-construct, defines the stages of a project and how it is executed. You can combine all three aspects however you would like to complete your project. How those aspects are combined imply different strategies in how you approach your project.

- **EPC**
  This is the most straightforward form of EPC, where you hire a firm to design your system, procure the equipment and construct the site. Everything is done under one contract, leaving you with one bill to pay.

- **E/PC**
  If you are not comfortable handing off your whole project to one firm, you could choose to keep the engineering in-house, subcontracting out procurement and construction.

- **EP/C**
  Another option is to keep engineering in-house and purchase major equipment, and then hiring a contractor to purchase minor equipment and construct the installation.

- **E/P/C**
  If you are a serious micromanager and are uncomfortable with giving one institution, including your own, full authority on a project, you can hire three different parties and let them each handle one task.

Which form to choose is dependent on your individual project goals. Each one has its advantages and has been listed in increasing order of your employees' engagement and time requirements. Firms capable of providing EPC services have bonding abilities to cover the full engineering, procurement and construction of your project.

Ask around your industry community and start the conversation and relationships before you get started. People generally recommend firms who they trust and good firms with good reputations are widely known.

By Michael Kraft, PE, Account Executive at Ulteig

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13

Operations & Maintenance

Why is O&M becoming so critical to the solar industry?

When investing in any other asset of similar value to a solar PV system, it's considered normal to have a budget and an annual maintenance plan to secure and prolong the life of the asset.

Assets such as cars, motorcycles, boats and holiday homes have annual maintenance budgets and plans. Why then is there still a myth about the importance of operating and maintaining solar PV systems?

The most likely answer is that because there are so few moving parts, we've come to believe that you point the modules at the sun and the system generates electricity for decades without having to do anything.

When I decided to move away from the solar installation business and form a solar maintenance company, I had accumulated more than 1 MW (that's a lot of 3-kW systems) in residential and more than 20 MW in commercial installations. I had primarily acted as the E and C in what we have come to know and accept as engineering, procurement and construction (EPC). This was in the dawn of sudden solar growth in the United States, which began in residential and suddenly flipped over to distributed generation (DG).

Much of this solar activity was concentrated in a small sector of the country, with large incentives driving the market. At that time, a typical solar system was installed for around $12 per DC or STC watt. Everything was (and still is) sold in watts, so a 3-kW residential solar system was installed at $36,000 before rebates and incentives, which at peak totaled about 50% credits toward the cost of the system, bringing a $36,000 system down to $18,000.

Fast forward to today, and that same system can be installed for about $11,500 before incentives which could bring that figure way below $10,000. What does this have to do with O&M? Glad you asked.

Prices of solar systems and the internal components—modules, inverters and balance of system (BOS)—are being slashed as federal and state incentives are being pulled away to ensure the industry can exist on its own merits without financial aid. This is great for the longevity of our industry, but as prices for materials are being slashed, labor isn't getting any cheaper. The poor solar installer is forced by the competitive trends to reduce his/her labor price to an agonizing rate.

The result is a tendency to cut corners, and the quality of systems suffers in both residential and DG. Thankfully this isn't a widespread issue—there are many high-quality contractors out there who simply refuse to drop their prices to what would affect a quality installation.

For this reason, I believe $1 per installed watt will most likely never happen. Therefore, long-term maintenance of the asset actually begins within the quality installation of the system, correct torques, wire management, mega-testing and, of course, scheduling and planning of mandatory annual preventative maintenance on critical moving parts of the system.

It's a scientific fact that the mechanical components such as racking and conduits expand and contract literally inches every day in the hot sun. Add snow, hail and high wind conditions, and imagine 25 years of this constant movement and severe weather on a 500-kW rooftop system that was worth $1.5 million when it was installed.

I conclude that a comprehensive maintenance plan of such an asset is mandatory for the longevity, reliability and performance of the PV system.

By Rue Phillips, CEO and Co-Founder of True South Renewables

Photos Courtesy of True South Renewables

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14

Project Services

(Consulting, Insurance, Legal)

Photos Courtesy of Alectris

At what stage do most solar projects run into problems, and how can a good asset management firm help navigate those difficulties?

This discussion addresses the challenges in the post-construction phase of the project (asset). Within this cycle, the focus is on the management versus technical aspects of the more than 25-year life of a typical solar project.

First let's define operations and maintenance (O&M) vs. asset management (AM).

"In the PV industry, the term O&M describes a set of activities, most of them technical in nature, that enable power plants to perform their task of producing energy in compliance with applicable rules and regulations," according to Cedric Brehaut of SoliChamba, author of the GTM Research report on O&M. "O&M is sometimes considered as a subset of asset management, which consists of the financial, commercial and administrative activities necessary to ensure that the plant's energy production translates into the appropriate revenue stream."

What are five major asset management challenges solar PV portfolio managers experience with growing and dispersed assets to ensure the return on investment is secure and properly channeled?

1. Multiple And Complex Reporting Requirements

The complexity of reporting requirements are caused by many factors including:

- Local and statutory requirements
- Reporting to financing entities (including forward-looking financial statements)
- Reporting to (international) investors
  - o Often requires complex consolidation
  - o Different valuation rules/accounting standards
  - o Deferred tax/IFRS/extensive support to audit process

2. Cash Management

Complex cash management results from account hierarchy and cash waterfalls.

3. Regulatory Changes

Changing legal and tax environments require continuous monitoring and fine tuning.

4. Local Diversity

Every country/state is different, making it very challenging to coordinate with local service providers.

5. Field vs. Administration

The (local) administrator doesn't always understand what happens in the field. Good coordination is crucial.

The resolution of solar portfolio challenges lies in the combination of the service provider's team experience and the robustness of its monitoring capabilities.

The Right Team

An experienced asset management team, whether housed internally or under an outsourced service, is critical to successful portfolio management. Implementing the structure to ensure asset-management challenges are addressed prior to experiencing profit degradation sits in the hands of the AM team.

Attributes of core AM team experience to confirm include:

- Communication
- Speed of communication
- Technical competency
- Creativity in solving problems
- Comprehensiveness of communication
- Clear hierarchy/points of contact
- Human resource qualities
- Motivation
- Honesty
- Attitude of communication

Fleet-Level Monitoring

As solar portfolios grow larger with more dispersed projects fleet-level monitoring is emerging to fulfill complex resource requirements.

(Author's Note: Solar Power World addressed this in a 2014 webinar entitled "When Did Solar Monitoring Start to Matter?" which is still available at solarpowerworldonline.com)

Solar monitoring is evolving from specific subsystem monitoring (energy output from solar panels as an example) into Solar Enterprise Resource Planning (SERP) systems for fleet-level management. This approach mimics holistic systems seen in corporate settings to integrate technical data arising individually out of the systems into a broader picture of operations and all the data subsets involved with a given solar asset.

A SERP should readily provide insight into all operational (technical) and reporting (warranty, insurance, financial reporting including investor statements) aspects of the each individual asset. Specific assets should then be aggregated up into portfolio reporting—quite handy for such financial innovations as YieldCo's.

SERP modules provide the best possible insights into the PV asset operations through:

- World-class monitoring systems
- Service management
- Asset management
- Integrated management of multiple and geographically distributed PV plants
- Extensive and customizable reporting capabilities

By Vassilis Papaeconomou, Managing Director at Alectris

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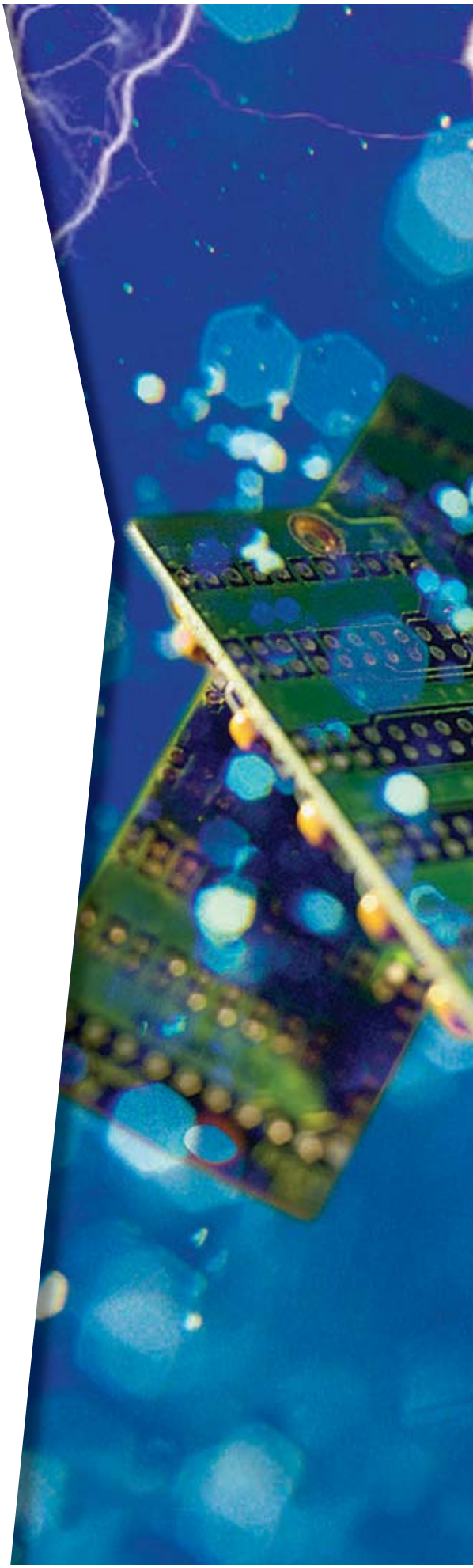

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