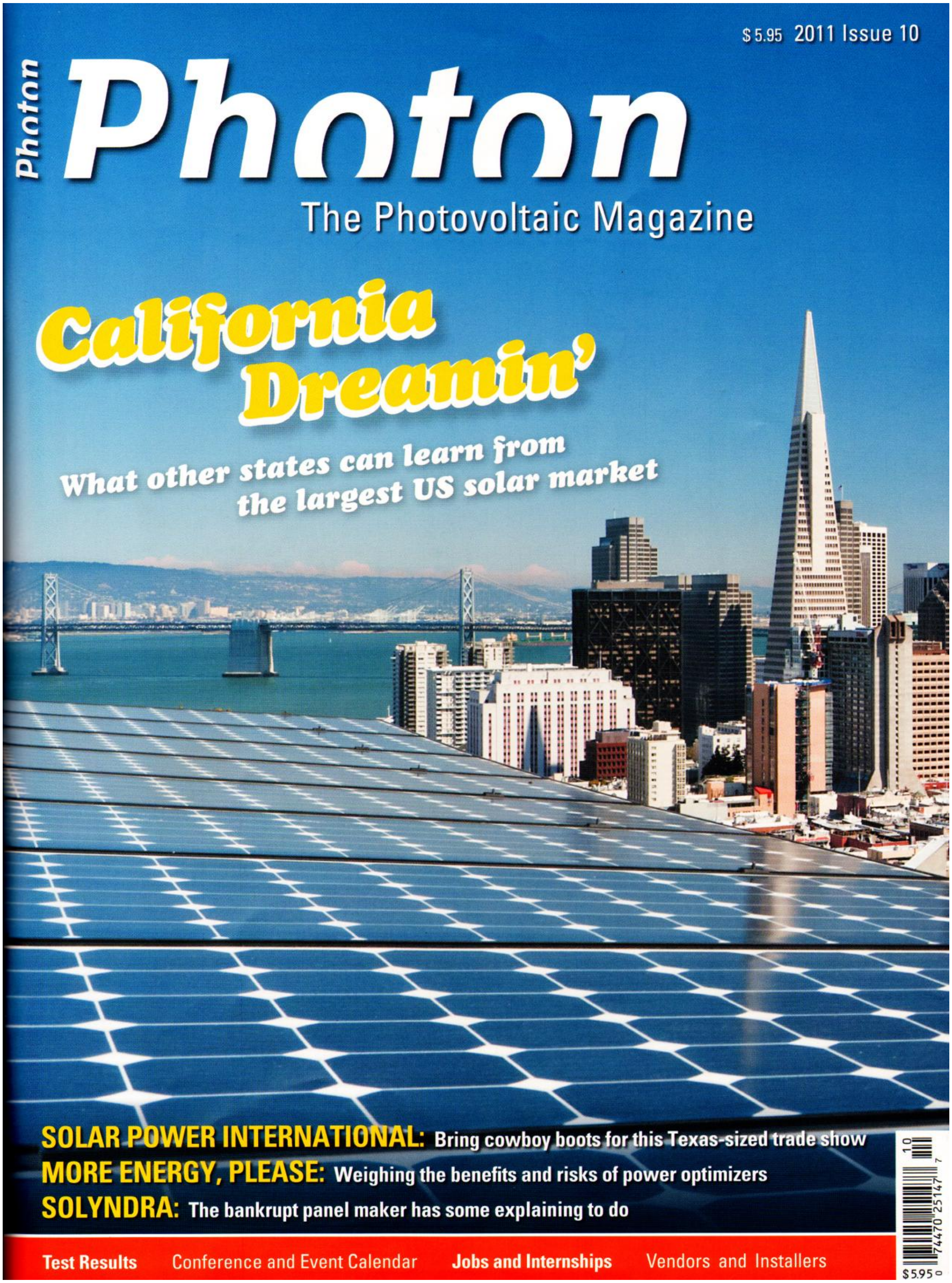
SCHWARTZ MSL



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Photon

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The Photovoltaic Magazine

California Dreamin'

What other states can learn from the largest US solar market

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EARLY **ADOPTER**

With power optimizers, consumers must weigh as yet unproven benefits and potential risks

Power optimizers – devices that promise reductions in yield losses from shading in PV arrays – are a source of controversy in the solar industry. PHOTON's market survey features 20 optimizers from nine manufacturers; three additional producers say that they have devices in development. While these proliferating products offer compelling financial advantages, not to mention safety and monitoring features, installers have both positive and negative reviews.

Daniel Sullivan has a dilemma on his hands. Lately, the owner of the San Diego, California-based installer Sullivan Solar Power has found that two of his most important business goals – providing high-quality, reliable installations to his customers and closing enough sales to make sufficient revenue – are in conflict. That's because many of his prospective residential photovoltaics (PV) customers are requesting that a new technology called power optimizers be included in their arrays. Power optimizers are per-module devices that, according to claims of the manufacturers, help boost the energy output of solar systems, particularly at sites where there is shading.

Sullivan doesn't like to rush into incorporating any new product without a careful evaluation of its performance, yet he risks losing customers if he doesn't give in to their wishes. »You're sitting at somebody's living room table, and they've heard from three different companies that this is the best thing since sliced bread,« says Sullivan. »You feel compelled to offer it to them.«

Making this pressure particularly acute is the fact that one of California's largest solar installers, REC Solar Inc., includes power optimizers from Tigo Energy Inc. as a standard feature in residential project bids. Sullivan believes that REC's embrace of power optimizers is premature, and he fears potential maintenance headaches down the road if these products prove to be unreliable. His solution was to introduce power optimizers as a beta test for 10 consumers that insisted on the product. His company is monitoring them closely for 2 to 3 years, and if they don't pass muster, they get discontinued. »That's the approach the entire industry should take,« he argues. For now, Sullivan notes, »it's too early to say« whether they work.

Sullivan's dilemma with power optimizers reflects a broader ambivalence in the PV industry toward these devices. On one hand, they offer some compelling advantages, such as yield improvement and ease of system design. But as with any early-adopter technology, the ultimate magnitude of these benefits – and the potential pitfalls – is yet to be revealed through long-term field experience.

Young but growing: Power optimizers have been on the market for just a few years, but they are already gaining traction among commercial customers. This 780 kW PV array at the headquarters of headset manufacturer Plantronics Inc. in Santa Cruz, California, is equipped with power optimizers from Tigo Energy.

This ambivalence is particularly relevant now: PHOTON's first market survey of power optimizers shows that the number of manufacturers in this space is growing rapidly. While just two manufacturers had commercially available products 2 years ago, this survey boasts nine manufacturers with a total of 20 different models (see table, p. 46). Three additional companies – California-based PV inverter manufacturer Power-One Inc., Accurate Solar Power, which was founded by Newdoll Enterprises LLC and is also headquartered in California, and Taiwanese firm Tapollop Technology Co. Ltd. – declined to participate, saying they are not far enough along in their product development.

Minimizing shade impacts

There's a reason for the recent interest in power optimizers on the part of installers and end-consumers. One of their commonly stated benefits is that they can help to gain back some of the

One common feature, many designs

In this survey, we define power optimizers as devices that maximum-power-point-track the output power of a solar panel on a per-module basis. In PV arrays where there is performance mismatch between modules, this feature helps to decouple the output of a given module from other modules on a string, and optimize energy yield. Beyond per-module maximum power point tracking, power optimizer models diverge into basically two different design concepts and one mixture of these two concepts.

Buck: Azuray Technologies and Tigo Energy employ a »buck« topology, which decreases the output voltage of a shaded PV panel and increases output current to match the current of unshaded modules in the same series. A research paper on power optimizers published earlier this year by the National Renewable Energy Laboratory (NREL) says that buck devices are most effective in PV systems »where shade or mismatch occurs only on a few PV panels. In this case, the buck converter is installed only on those PV panels experiencing shade.«

Boost: This topology, employed by Eiq Energy, ST Microelectronics and Sunvision, increases the module voltage to match the voltage requested by a central inverter, optimizing its efficiency. The NREL paper says that this kind of optimizer typically requires the installer to connect an optimizer to every PV panel. Eiq's technology boosts the voltage to 300 V, allowing the installer to place panels in parallel.

Buck-boost: This concept, used by SolarEdge and Ampt, can either increase or decrease the output voltage of a PV panel. According to the NREL study, in PV systems with shading on just a few panels, buck-boost optimizers can be installed only on the shaded panels to buck the voltage, thereby eliminating the current mismatch between shaded and unshaded modules. They can also be employed in systems with parallel strings of different lengths, in order to boost the voltage of the shorter string to match the other strings. *mdm*

EIQ Energy (formerly Sympagis Technology Inc.)

Power optimizers from EIQ Energy were incorporated into this 1.2 MW plant at Granite Construction in Coalinga, California. The installation uses thin-film modules from Solar Frontier.

production losses due to shading of PV arrays. It's well known that a small amount of shade on even one module can significantly diminish the performance of unshaded modules in the same string, due to the fact that they are connected in series. When a series of modules have different electrical properties – a situation called »mismatch« – the panel with the lowest current limits the others. By performing peak-power tracking on each individual module, power optimizers decouple the output current of the shaded module from the rest of the string, which in theory increases the overall output of the array.

Yet testing of several power optimizer models by PHOTON Laboratory in 2010 revealed that their ability to minimize shade impacts varied widely depending on the type of shadow and string configuration (see 12/2010, p. 68). In some unshaded situations, the optimizers actually resulted in reduced output. The conclusion of this research was that it's not possible to offer any general advice about when to use power optimizers, since there are so many factors that influence the energy harvest gains achieved by the devices. Given this finding, how should an installer decide whether the performance improvement of these products justifies their additional cost?

There is a way to make an informed decision, says Lior Handelsman, the founder of Israel-based optimizer maker SolarEdge Technologies Inc. He points out that commercially available simulation software from Swiss company PVsyst SA allows users to predict how much energy gain can be achieved in shaded situations by the addition of SolarEdge devices. The simulation capability was introduced in 2010.

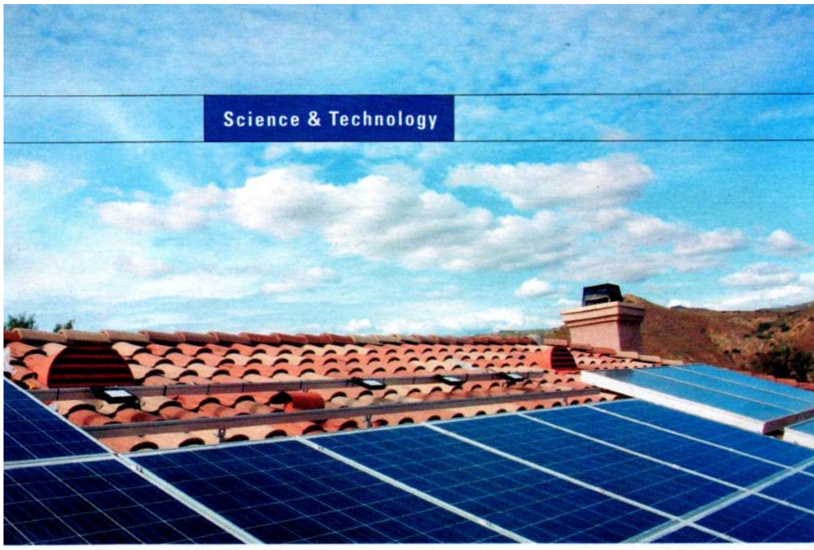
When it comes to shading simulation, other companies appear to be behind SolarEdge. Oregon-based Azuray Technologies Inc. has created its own simulation program, called ShadeCalc, as a means of performing shading simulations, but because the company produces its own line of power optimizers, there is some doubt about the impartiality of the software. Three other companies interviewed for this survey, Tigo Energy, Ampt LLC and EIQ Energy Inc., say that there is no commercially available software that works with their products, though Tigo's director of marketing, Paul Grana, says his company has an internal model that it uses with some large-scale commercial customers.

This summer, another round of testing by PHOTON Lab on SolarEdge power optimizers yielded a more positive result: the devices increased energy harvest in all shaded and unshaded scenarios (see article, p. 62). Josh Cutler, residential solar manager at California-based installer Chico Electric, has also found that SolarEdge boosts yield in all situations. But that's not the only reason why Cutler is happy about SolarEdge. The price is also helping him to justify the investment. Cutler has found that a PV array with SolarEdge's complete system – which includes power optimizers and the company's own inverters – costs about the same as a comparably sized PV plant without optimizers and equipped with a Sunny Boy inverter from SMA Solar Technology AG. So any extra output from the SolarEdge system is gravy, says Cutler. That said, SolarEdge's price is not as attractive if the installer wants the flexibility of being able to use another company's inverters.

It's not just about shading

The widely varying yield improvements obtained by optimizers in shaded situations cast some doubt over their alleged economic benefits. When asked about this uncertainty, manufacturers point to the other situations in which their products can boost yield. Tigo's Grana, EIQ's Vice President of Business Development Michael Lamb and Ampt's Mark Kanjorski all argue that shading is not the only source of module mismatch – and, thus, of output losses. They say that there are also significant mismatch losses due to panel manufacturing, module degradation over time and uneven temperature and soiling across an array. Of course, some of these sources of mismatch will vary depending on the local environment, and installers need to gauge them on a case-by-case basis to make the best decisions.

Another economic advantage trumpeted by the manufacturers is reduced balance-of-system costs – in other words, costs for labor and all components besides panels. For instance, SolarEdge's Handelsman says that the fixed string voltage feature of his company's technology allows installers to design longer



A solar installation in California that uses power optimizers from Israel-based SolarEdge Technologies.

strings and thereby reduce wiring and combiner box costs.

With EIQ's system, an installer can usually achieve a balance-of-system cost reduction that is equal to the cost of the company's hardware, according to Lamb. EIQ's technology boosts the voltage of each module up to a constant level of 330 V. This feature, however, creates the need for a parallel system architecture that, on the one hand, simplifies system design and installation, but at the same time increases the cost of wiring. Lamb adds that balance-of-system savings will vary based on the system geometry and the type of module used. PV arrays with thin-film modules enjoy more cost savings with optimizers, he says, because the higher voltage outputs of the modules require system designs with more strings. Kanjorski had a similar message about the cost reductions that come with Ampt's optimizers, saying that they depend on many factors.

The value of monitoring

All nine companies in this survey offer module-level monitoring with their products – an option that allows installers and system owners to characterize and track the performance of each panel. Considering that it's difficult to find underperforming or defective modules without monitoring, this feature reduces risk for customers who use panels from new companies without track records or from doubtable sources. Koralie Hill, an installation crew leader with Berkeley, California-based installer Sun Light & Power Inc., says that the monitoring capabilities of power optimizers save her company time by allowing it to quickly identify problems – such as an unconnected string – during big PV construction projects.

Grana says that monitoring is the No. 1 selling point for Tigo products with commercial customers, while energy harvest is presented as a secondary benefit. Many such clients have strict performance goals through their financing arrangements, adds Grana, and monitoring can provide them with better system visibility to meet these goals. Monitoring can also help installers cut costs by reducing the number of maintenance visits, argues SolarEdge's Handelsman. »The ability for an installer to prove to the customer that the system is optimized without leaving the office is worth a lot of money,« he says.

Nevertheless, consumers run the risk of technical bugs that come with a new feature like module-level monitoring. One example: while Cutler of Chico Electric speaks of the benefits of seeing an array's production profile on SolarEdge's online monitoring portal, he reports that the company's website has often been down. He adds that SolarEdge's email alert feature – designed to inform users about problems in their arrays – is not always functioning properly. Handelsman says that these glitches occurred because SolarEdge's database was overwhelmed by unexpected consumer demand: »We were caught by surprise by the amount of systems that were installed.« But he claims that his company recently upgraded its server and has not heard of any problems since June.

Are power optimizers reliable?

One obvious concern about power optimizers is that they introduce a new possible point of failure into a PV system. This begs the question: are they reliable? During the first year of his beta test, Sullivan of Sullivan Solar Power found that at least one device failed at all 10 of his company's PV installations with optimizers. But Hill of Sun Light & Power has had a different experience: on a recent installation with 1,500 per-panel power optimizers, only three were not communicating properly, and Tigo was »very responsive,« helping to fix the problem. Of course, this is feedback from just two companies, and a massive installer survey over several years would be required to appropriately gauge the failure rate of power optimizers. The point is: long-term, field-based reliability statistics are simply not available yet.

Chris Deline, an engineer at the National Renewable Energy Laboratory (NREL) who conducts research on power optimizers, believes these devices »stand a better chance of having long reliability« than PV inverters, partly because they don't contain large capacitors. He adds that they are one step removed from the grid connection of a PV array, and thus insulated from surges that can fry sensitive electronics. Gil Miller of Azuray Technologies says his company has addressed the reliability issue by using automotive-grade components. Indeed, Azuray's optimizer has the highest temperature rating of all surveyed companies, reaching up to 90 °C. Tigo's Grana says his company will limit the possibility of failures through its technology roadmap to reduce the number of parts in its device from 52 to four.

Even if optimizers prove to be reliable, there is the risk that a given manufacturer in a new product class will not last long enough to support warranty claims. Already, two companies – National Semiconductor Corp. and Xandex Inc. – have discontinued their product lines.

Safety: »A huge sleeper«

There's one benefit of power optimizers that at the moment brings no cost savings, but could ultimately be the strongest driver of their adoption: safety. Power optimizers offer a means of shutting down a PV system at the module level – a feature that could assist emergency responder operations in the event of fires. The National Fire Protection Association is coordinating a dialogue in the industry to develop new PV safety requirements in the 2014 National Electrical Code (NEC), the safety standard that governs solar installations in the US. Standards committees are working to determine what types of systems would be required to bring down the voltages on rooftop PV arrays to safe levels.

Most of the power optimizer models in this survey include a feature to deactivate a PV array. Several models, for instance, employ a »normally off« mode: the module and power optimizer will not deliver power unless they receive a »life-signal,« even when the sun is shining. A module-level disconnection requirement in the NEC code would be a game-changer for power optimizers. »It's a huge sleeper,« says EIQ's Lamb. Yet because different states adopt code updates at different times, it could be several years before new regulations take effect.

Partnerships with panel makers

The economics of power optimizers could get a boost if they are integrated into the backs of modules at the factories of module manufacturers. Using such »smart« modules, an installer can skip the step of individually connecting each optimizer to an array, saving on labor.

It appears that the power optimizer market is moving in this direction. Many manufacturers, including SolarEdge, Azuray, Tigo, EIQ and Sunvision Srl, are working with panel companies on joint solutions. These include devices that embed directly into the module junction box or attach to the frame. There is currently only one commercially available product: panel maker Solon SE offers the Solraise module, which integrates SolarEdge's power optimizer. Handelsman hints that SolarEdge will have two more product launches »with Far East module companies« at the Solar Power International (SPI) trade fair in Dallas, Texas, in October. Tigo and Azuray are also planning announcements at the same event. Some companies, like Ampt and Azuray, are collaborating with junction box producers.

Moving too fast?

When power optimizers first hit the market about 3 years ago, they were primarily a product for residential PV systems. But the two companies with the most market share, SolarEdge and Tigo, both say that their commercial businesses are growing. Grana says commercial projects account for half of Tigo's sales, and there are already several Tigo-equipped megawatt-scale projects in service. Handelsman says 55 MW worth of SolarEdge systems were installed in 2010, and he expects well over 100 MW in 2011.

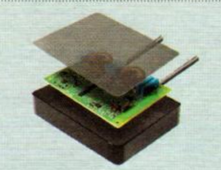
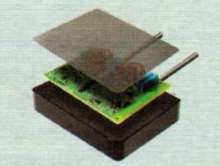
But Sullivan of Sullivan Solar Power expresses concerns about the rapid adoption of power optimizers: »These optimizers marry unproven technology with a historically great product. That is a disservice to our industry,« he argues, adding, »I would advise my peers, ›Don't be so quick to jump on a bandwagon and grab the newest thing off the shelf.‹«

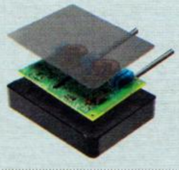
Michael D. Matz

Power optimizers in development

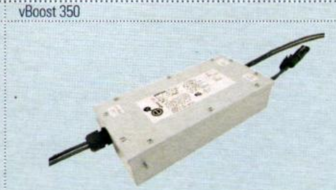
Manufacturer	Model	Market launch	PHOTON Lab test	Notes
Accurate Solar Power Inc.	SMART DC Boost Module	–	undecided	pre-series product
Darfon Electronic Corp.	DC-Optimizer	–	undecided	certification pending
Delta Electronics Inc.	PV Panel Optimizer	2012	undecided	–
IPM System GmbH	–	fall 2011	no (not appropriate for testing in solar simulator)	power is optimized at the solar generator level by continual renewal of module interconnection
Power-One Inc.	OPTI-0.3-TL	early 2012	undecided	–
SolaireMed	IQSun	fall 2011	undecided	–
Solar Power Technologies Inc.	The Clarity System	–	undecided	pre-series product
Solarcraft Inc.	–	–	planned	–
Sunvision Srl	SPC Plus	first quarter 2012	undecided	–
Tapollop Technology Co. Ltd.	SPB-250	–	undecided	prototype stage
TwentyNinety Ltd.	Active Array 2.0	fall 2011	planned	–
Yamaichi Electronics Deutschland GmbH	–	early 2012	undecided	–
Power optimizers integrated in terminal boxes				
Huber+Suhner GmbH	–	available for purchase	not applicable – this is not a custom solution	terminal box is only used as a current carrier system for electronics from diverse manufacturers
Molex Deutschland GmbH	SolarSpec Smart Junction Box	available for purchase	not applicable – this is not a custom solution	integrated in terminal box, electronics from SolarEdge circuit board
Shoals Technologies Group Inc.	–	–	not applicable – this is not a custom solution	terminal box is used as a current carrier system for Tigo Energy electronics

Market survey of power optimizers

Company	Ampt LLC	
Model	V40-i	V50-i
		
Optimization concept	active power management inside PV module junction-box; boost-buck converter and impedance matching	active power management inside PV module junction-box; boost-buck converter and impedance matching
PHOTON test	planned	planned
Communication / monitoring		
Operation of optimizers	stand-alone	stand-alone
Communication via	optional wireless	optional wireless
Monitoring on module Level	optional	optional
Monitored parameters	voltage, current, power (in/out), temperature, output enable/disable; and fault, fire and theft features	voltage, current, power (in/out), temperature, output enable/disable; and fault, fire and theft features
Status display	module LED and via communication	module LED and via communication
Technical parameters		
Description of system design	inside module junction box; option to deploy on select modules or strings, or on full array; string diode recommended	inside module junction box; option to deploy on select modules or strings, or on full array; string diode recommended
Supply voltage by	through the connected PV module	through the connected PV module
Energy consumption during operation	–	–
Energy consumption at night	0 W	0 W
Power connection by	soldered/crimped to ribbon, connectors selected by junction box manufacturer	soldered/crimped to ribbon, connectors selected by junction box manufacturer
Power box at module level		
Dimensions, weight	107 × 76 × 17 mm, 0.085 kg	107 × 76 × 17 mm, 0.085 kg
Type of protection	depending on junction box	depending on junction box
Temperature range	-40 to 70 °C	-40 to 70 °C
Additional hardware		
Additional hardware required	no	no
Dimensions, weight	–	–
Type of protection	–	–
Temperature range	–	–
Energy consumption	–	–
Electrical data		
Maximum input power	300 W at STC	320 W at STC
MPP range of the power box	10 to 38 V	17 to 48 V
Input voltage	0 to 46 V	0 to 58 V
Maximum input current	8.5 A at STC (IMPP)	9.2 A at STC (IMPP)
Minimum string voltage	0 V	0 V
Maximum system voltage	1,000 V	1,000 V
European efficiency	–	–
Conversion efficiency at 10%, 25%, 50%, 75%, 100% of nominal power	–	–
Safety features	power output enable/disable; arc and ground fault prevent, detect, interrupt and locate	power output enable/disable; arc and ground fault prevent, detect, interrupt and locate
Compliance with standards	IEC 62109, 61000-6-1, 61000-6-3, CSA to UL 1741; FCC Part 15 Class B	IEC 62109, 61000-6-1, 61000-6-3, CSA to UL 1741; FCC Part 15 Class B
Price / service / availability		
Installer purchase price excluding VAT	–	–
Price for 5 kW system (excluding modules, inverter, mounting system, installation)	–	–
Guarantee	25 years	25 years
Market entry	available now	available now
Countries where the product is available	various - through junction box OEMs	various - through junction box OEMs
Website	www.ampt.com	www.ampt.com

	Azuray Technologies Inc.	**Bitron-Industrie (Italy)**
V100-i	AP300	SPB Endana
 Ampt, LLC (3)	 Technica Communications	 Ehw-Research S.A.S.
active power management inside PV module junction-box; boost-buck converter and impedance matching	buck-converter	periodic reconfiguration
planned	planned	not yet decided
stand-alone	both	central communication between relay units and control units
optional wireless	power line	RS-485, Ethernet, USB
optional	yes	yes
voltage, current, power (in/out), temperature, output enable/disable; and fault, fire and theft features	voltage, current power, temperature	module level: power, VOC, VMPP, ISC, IMPP, full IV curve measurement, disconnection, theft detection system level: power output, system voltage and current
module LED and via communication	LCD on ACM 300 Communications Gateway	PC
inside module junction box; option to deploy on select modules or strings, or on full array; string diode recommended	any number of modules can be used on a string (shaded only if desired), parallel strings must have the same number of AP300s installed on each string, no diode needed	maximum of four modules are connected to relay units; these are connected in series to the control unit; 16 to 160 modules per control unit keep string voltage below 800 V
through the connected PV module	module	external power supply
–	less than 1% of Pin typical	less than Smart Power Booster
0 W	0 W	less than Smart Power Booster
soldered/crimped to ribbon, connectors selected by junction box manufacturer	soldered/crimped to ribbon, cables/connectors (various)	cable/connectors (MC4)
107 × 76 × 17 mm, 0.085 kg	150 × 113 × 23 mm, 0.46 kg	380 × 260 × 46 mm, 1.25 kg
depending on junction box	IP 65	IP 67
-40 to 70 °C	-40 to 90 °C	-40 to 85 °C
no	ACM 300 communications gateway up to 200 modules, plus appropriate DC coupling transformer	control unit; 1 MPPT entry per SPB Endana
–	198 × 176 × 49 mm, 0.64 kg	498.1 × 354.8 × 107.5 mm, 3.99 kg
–	fused on AC input (ACM 300)	overvoltage protection, reverse current protection, plus software protection
–	-25 to 60 °C	-20 to 70 °C
–	10 W nominal	less than Smart Power Booster
400 W at STC	300 W	600 W per input (at module level)
25 to 80 V	8 to 80 V	–
0 to 102 V	8 to 80 V	0 to 120 V
6.1 A at STC (IMPP)	10 A	10 A per input
0 V	as required by the Inverter	0 V
1,000 V	600 V / 1000 V (US / EU)	800 V
–	98.8%	–
–	97.7% / 98.7% / 99.1% / 99% / 98.9% at 35 Vin 300 W	–
power output enable/disable; arc and ground fault prevent, detect, interrupt and locate	optional central command for off mode	electromechanical relays, normally open – that is, no signal required to turn off
IEC 62109, 61000-6-1, 61000-6-3, CSA to UL 1741; FCC Part 15 Class B	AP300 - UL1741, CSA 22.2 C107.1, IEC62109, VDE0126-5, UL1703 ACM 300 - UL, EN60950	EN 50548:2009, table 6.17 of EN 60335-1:2008 EN 61000-6-2 and -6-3, CE, UL
–	–	–
–	–	–
25 years	to be defined	standard 5 years, optional up to 20 years
available now	–	2012
various - through junction box OEMs	–	all countries
www.ampt.com	www.azuraytech.com	www.ehw-research.com

Market survey of power optimizers (continued)

Company	EIQ Energy Inc.	
Model	vBoost 250	vBoost 350
		
Optimization concept	boost	boost
PHOTON test	planned	planned
Communication / monitoring		
Operation of optimizers	with central communication box	with central communication box
Communication via	power line	power line
Monitoring on module Level	yes	yes
Monitored parameters	voltage, current, power (in/out), temperature, status	voltage, current, power (in/out), temperature, status
Status display	RS232 interface to communication module	RS232 interface to communication module
Technical parameters		
Description of system design	one box per 300 W of modules, depending on module type; true parallel wiring solution; real-time MPPT feedback servo	one box per 400 W of modules, depending on module type; true parallel wiring solution; real-time MPPT feedback servo
Supply voltage by	module	module
Energy consumption during operation	5 W	5 W
Energy consumption at night	0 W	0 W
Power connection by	inline connectors (Tyco, MC4, Weiland, Amphenol H4)	inline connectors (Tyco, MC4, Weiland, Amphenol H4)
Power box at module level		
Dimensions, weight	254 × 127 × 51 mm, 2.1 kg	254 × 127 × 51 mm, 2.1 kg
Type of protection	NEMA 4	NEMA 4
Temperature range	-40 to 65 °C	-40 to 65 °C
Additional hardware		
Additional hardware required	communications box: vComm; LAN connection (for web-based monitoring service)	communications box: vComm; LAN connection (for web-based monitoring service)
Dimensions, weight	609 × 406 × 152 mm, 11.6 kg	609 × 406 × 152 mm, 11.6 kg
Type of protection	NEMA 4	NEMA 4
Temperature range	-40 to 65 °C	-40 to 65 °C
Energy consumption	4 W	4 W
Electrical data		
Maximum input power	300 W	400 W
MPP range of the power box	20 to 50 V	30 to 100 V
Input voltage	20 to 50 V	30 to 100 V
Maximum input current	10 A	10 A
Minimum string voltage	–	–
Maximum system voltage	350 Vdc	350 Vdc
European efficiency	–	–
Conversion efficiency at 10%, 25%, 50%, 75%, 100% of nominal power	without distributed MPPT effect vBoost delivers 98.4% conversion efficiency to the DC side of inverter	without distributed MPPT effect vBoost delivers 98.4% conversion efficiency to the DC side of inverter
Safety features	normally off mode	normally off mode
Compliance with standards	UL1741, IEEE 1547, FCC Part 15; CAN/CSA-C22.2 No. 107.1-01; EN60950-1, IEC 61000-6-1-2005, IEC 61000-6-3-2006	UL1741, IEEE 1547, FCC Part 15, CAN/CSA-C22.2 No. 107.1-01, EN60950-1, IEC 61000-6-1-2005, IEC 61000-6-3-2006
Price / service / availability		
Installer purchase price excluding VAT	–	–
Price for 5 kW system (excluding modules, inverter, mounting system, installation)	–	–
Guarantee	20 years	20 years
Market entry	October 2009	October 2009
Countries where the product is available	US, Canada	US, Canada
Website	www.eiqenergy.com	www.eiqenergy.com

eIQ Energy, Inc. (2)