

A large black oil pumpjack stands in a flat, arid desert landscape under a cloudy sky. In the background, several solar panels are visible, suggesting a combined energy or industrial site. The foreground shows a dirt ground with some pipes and a yellow-wrapped pipe.

# Proud technical creativity

Bill Mellema, Director of Engineering and Brad Berwald, Product Manager and Technical Training Manager, at Morningstar Corporation, met up with PES to bring us up to date on the solutions offered by this innovative, employee owned company. Here the workers are proud of their products and provide only the highest quality and efficiency to the market. They have a balanced portfolio: residential, industrial and off-grid and keep a keen eye on the markets to see where improvements are possible. Read on, you're sure to be impressed.





Bill Mellema



Brad Berwald

**PES:** Hi Brad and Bill, it's a great pleasure to welcome you to PES Solar. We have worked with your company for quite a few years now, and are sure our readers would be interested in a brief overview of Morningstar, so shall we begin with that?

**Brad Berwald:** So, we've been the solar charging experts for the off-grid PV industry for over a quarter of a century, and, unlike many other companies, have the same management and ownership. In fact, we're employee-owned, which is the main reason we're so focused on maintaining the industry's lowest hardware failure rate and highest reliability. Our own individual reputations ship with every product.

**Bill Mellema:** We have over 20 patents and a dozen trademarks, leading the field in off-grid power conversion technology. Our low turnover and long-term team approach foster an environment where technical creativity thrives, resulting in an IP portfolio that's very broad and comprehensive for a company our size. Morningstar's patents cover areas which include thermal engineering, mechanical design, charging and control, advanced electronic topologies, safety systems, and more.

**PES:** With energy storage becoming such a growing area, how has that affected what system designers are looking for in solar charge controllers and inverters?

**BB:** The growth of energy storage affects power electronics in a number of ways. For one, system set-up is more complex. Installers have to deal with variables such as absorption, float, equalizing voltages, time and temperature compensation factors, high-voltage disconnect/reconnect for the battery and low-voltage disconnect/reconnect for loads, all critical settings to battery health and longevity. These are highly important, because with the costs of PV modules getting lower than ever, a battery bank is now often the single most expensive part of a system.

There's a saying in solar installation: 'any problems in your design you'll learn about in your batteries first.' No one wants to learn that very expensive lesson! Advanced battery chemistries also present new challenges. For example, lithium batteries can be damaged if one attempts to charge them under cold conditions. So, it's incumbent on the systems' electronics, most notably the charge controller, to be 'smart' enough to anticipate errors and minimize any problems.

**PES:** Morningstar is unique, in that it started as a charge controller company and for more than 25 years focused its efforts in

**that category. You have an unusually wide range of controllers, something like 40 models in eight lines, other companies may have two or three in comparison. Why did you diversify so much in this area?**

**BB:** Well, it was really in response to demand. Several examples: there are industrial users who need controllers that can operate under hazardous conditions, such as in oil and gas production facilities or mines. There are strict international safety requirements for electrical products in those environments. So, we responded with our SunSaver and SunKeeper charge controller lines which are rated for what's called Class 1, Division 2/ Groups A&D use.

This ensures they are approved for use where ignitable concentrations of flammable gases, liquids or vapors may be present, including Acetylene, Propane, Gasoline, Naptha, Benzene, Butane, Ethyl Alcohol, Acetone and Methane. This makes it easy for industrial users to use solar electricity in a variety of locations and conditions.

We make another SunSaver version called the Duo, designed for RV/caravan and marine use with two batteries. Another is our SunLight controller, specifically designed for solar-powered lighting applications including streetlamps and parking areas.

The Essential Series, another line, was developed to make Morningstar quality available to a wider audience, with more basic versions of our ProStar controllers. All of our controllers are available in different amperage ranges and some in different voltages, so if you're as serious about charge controllers as we are, your line naturally expands to meet diverse user needs.

**PES:** You're getting into inverters now, what's behind the progression from solar controllers to inverters, and what do these different devices have in common?

**BM:** Having over 25 years of experience in



Minas TS MPPT



TriStar 600V fanless solar controller

building best-in-class charge controllers actually had direct application to the inverter we conceived, for four reasons.

The first is our background in proprietary software architecture, which extracts the maximum performance possible out of every individual processor on-board our controllers. This means they are able to provide more power and maintain constant output because, unlike competitor designs, they don't need to 'drop down' and then recalibrate as incoming power changes. A principle which also applies to the new MultiWave inverter/charger.

The second is an internal layout based on performance instead of economics. Morningstar internal circuitry is laid out in a way that makes the most engineering sense, as opposed to the cheapest to manufacture and produce. This greatly improves Mean Time Between Failures (MTBF), maintains signal integrity, increases efficiency, and reduces excessive heat, all of which improve performance and dependability.

Third, we use higher-quality, 'over-spec' components. If Morningstar used the same quality components as our competitors, we could still achieve better performance and reliability with our software and electronic design advantages. But instead we 'over-spec' critical components to create hardware to take full advantage of our design.

By oversizing key parts, we achieve an industry-beating hardware failure rate of less than 0.4%, and are the only manufacturer who publicly publishes this kind of

specification. Over-spec components are even more critical in a high-voltage power-conversion platform such as an inverter.

Finally, we build everything around superior thermal design. Morningstar is the only solar electric manufacturer that does not use fans to cool high-power electronics. Fans have three problems in charge controllers. They make the system inefficient, because they require power to run and are a parasitic load. They suck dust, dirt and debris into the insides of components, which shortens their life. And they can fail because they have moving parts.

**BB:** The thermal design excellence behind Morningstar's charge controllers is integral to the unique design of the MultiWave inverter/charger: it stands alone in its power class without needing a cooling fan.

**PES:** What innovations and benefits to the customer can Morningstar bring to this well-established category?

**BB:** Even before it gets to the customer, or end-user, it brings benefits: MultiWave weighs a lot less than comparably powered inverters, making it much easier for installers to handle. This is due to its high-frequency electronic design which reduces a lot of the heavy internal components typically associated with inverter/chargers. For the user, they can expect an exceptionally stable, reliable inverter with very high peak efficiency across a wide load range.

It also has unprecedented charging capability, and is able to 'stuff' electricity

into advanced batteries including lithium faster than conventional designs, increasing system autonomy, or the ability to go for longer periods using stored electricity. It also addresses fear of obsolescence with a unique ReadyRail expansion system, where the user can snap-in ReadyBlocks to add communications and control, generator support, battery management and other features.

**PES:** We are hearing a lot about off-grid solar in rural and industrial projects, do you see the solar industry shifting to off-grid and hybrid systems in other sectors?

**BM:** It is inevitable and in fact is underway. Look at the state of California in the United States, where utilities are promising years, perhaps decades, of 'managed outages' to mitigate wildfire risk. There's as much solar electricity in California as there is in the rest of the country, but because it's almost all grid-tied with no back-up it's useless during outage conditions.

So, there's been a surge of interest in installing new systems with battery back-up and even upgrading existing systems with energy storage, through AC and DC coupling schemes. It may be a cliché that 'necessity is the mother of invention,' but it's one helping drive the energy storage business in many sectors right now, and we don't see that slacking off.

**PES:** Geographically speaking are there any new markets you would like to break into?

**BB:** It's not so much new geographic





Sunsaver 20L 037

markets, but new applications for off-grid solar. Depending on the region, our products intended for one type of customer, often find a new market when used someplace else. Our Essential Series is an example. It's Morningstar quality and performance, with a reduction in communications and other features including certifications.

In developing countries, it serves a lower-priced market segment for general off-grid solar electric systems. But in developed countries it serves consumers and the leisure market, specifically RV/caravan and marine systems.

**PES:** There is rapidly growing interest in lithium batteries, along with applications for them, as well as other advanced storage chemistries today. Do you see this replacing lead-acid technology or co-existing with it? And what special requirements come with adopting or switching to lithium storage?

**BM:** Like a lot of innovations, it isn't an 'either/or' proposition. Lead-acid has advantages in addition to cost, including wider tolerance for temperature extremes and uniform safety among the various configurations. They have disadvantages as well. Lead-acid batteries can have their life dramatically shortened by a system that keeps them in 'partial state-of-charge,' for example, whereas the life-span of lithium batteries is actually increased under those conditions. As with anything, it's application-centric, and there are applications where lead-acid may be a better choice.

So, we'd paraphrase a famous author and state that 'reports of lead-acid's death are greatly exaggerated, we see the two types not only co-existing, but complementing each other in some instances.

One other thing: as far as recycling goes, it's a long-established saying that lead-acid batteries are a poster child for success in that area, industry data shows a 99% recycling

rate! So, assuming that green environmental values coincide with clean energy, lead-acid enjoys a compelling value proposition in terms of its contribution to the eco-system.

**PES:** What makes your products stand out from the competition, why should customers choose you?

**BB:** It's easy to get over-excited about this type of question and run on, but if we had to boil it down to one thing something that one of our own customers said recently in an on-line review says it better than we ever could: 'Morningstar is the second charge controller I bought, and the one I should have purchased first.' That says it all!

**PES:** What do you think will be the greatest opportunities for off-grid solar in the next few years, and the greatest challenges, for Morningstar and the industry in general?

**BM:** Perhaps we see the geopolitical and economic picture for solar a bit differently,

since we have a pretty balanced portfolio of regions and markets to serve. When the residential sector shows signs of weakness, for example, industrial, rural and commercial applications often pick up, and vice-versa. So, we're looking at some immediate challenges and opportunities of a more technical nature.

The challenge in my view is the expanding adoption of Lithium batteries for energy storage. This will require smoother and more effective integration, charging support, no unified interface, and monitoring. Our Energy Storage Partners program is a step in that direction, where Morningstar and selected battery brand partners collaborate and provide pre-determined settings, which make it easier for installers to design lithium storage into new systems or drop lithium batteries into existing ones.

**BB:** For me the opportunity is lower cost PV, which means systems can and will get bigger, with higher capacity chargers and inverters scaling accordingly. This will mean significant, additional hardware sales.

The challenge: evolving code standards domestically, the drive for safer systems will require novel and cost-effective solutions. This is true in industrial as well as residential systems. Morningstar has some experience here, with charge controllers specifically designed and rated for use under hazardous field operating conditions.

The opportunity: data access, or more specifically making sense of data i.e. big data. The challenge of reliable remote connections affects this; expect to see more embedded data systems that don't require constant connectivity to be effective.

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TriStar MPPT multiple