



Markets & Trends

Japan: Official projections regarding the country's future PV strength may in fact be too conservative. *Page 24*



Industry & Suppliers

1,500 volts: As utility-scale solar seeks lower LCOE, 1,500 V components are making their mark. *Page 51*



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Top 20 tech: We round up 20 of the most exciting storage technologies on the market. *Page 59*

pv magazine

PHOTOVOLTAIC MARKETS & TECHNOLOGY

Bending your ear

Talking heads talk solar tech in our conversation special. *Pages 20, 30, 34-50, 54-58, 67*



Jonathan Gifford with Sonnenbatterie CEO Christoph Ostermann.



pv magazine Editor in Chief meets CAB Solar's Allen Smith and Tim Wedding.

Photos: Andrea Jeremias/Solarpraxis AG

Solar in conversation

Some things change while others remain the same. In this dynamic industry, sitting eye-to-eye and speaking with a leader from within the solar industry firmly remains one of the great pleasures of being a part of the **pv magazine** team. The knowledge, the insights and the experiences that can be gained in conversation are, quite simply, invaluable.

At last month's Intersolar North America trade show, a plethora of face time with industry pioneers and key innovators was available and snapped up with some relish. Across the four days in San Francisco, **pv magazine** met and spoke to numerous industry veterans, such as SolarWorld's Frank Asbeck, SunPower's Howard Wenger and Jinchen's Yinsheng Li, who all shared valuable time and candid insights, drawing on many decades of solar experience. Newer arrivals such as Sunprime's Farhad Moghadam, Siva Power's Brad Mattson, Sonnenbatterie's Christoph Ostermann and Open Energy Group's Graham Smith also made themselves available during the show, each providing a look inside their potentially disruptive technological or financial innovations currently making headway in the thriving U.S. market.

In this special "in conversation" edition of **pv magazine**, the editorial team has conducted an array of interviews with players active in all aspects of the global solar supply chain and downstream industry to provide key information directly from the horses' mouths, so to speak. But that's not to say our fast-growing industry presents answers to every question looming on the horizon.

The rapid internationalization of the PV industry, from markets to manufacturing, is continually throwing curve balls requiring businesses to be agile and adapt to rapidly changing circumstances. This is true of markets such as Ukraine (pp. 20–23) where leading developer Activ Solar had to make quick decisions as to how to de-risk its activities in the face of fast-evolving geopolitical instability. But as one door closes, another

opens, as regulations in electricity hungry nations such as India (pp. 70–72) and Nigeria (pp. 74–76) present opportunities for solar to light the way.

The shifting hues of the global solar manufacturing environment, arguably as a result of duties in key markets, is also requiring manufacturing equipment suppliers to stay on their toes and develop truly global support operations (pp. 38–40 & pp. 46–50). And as always, technological innovation (pp. 42–43) plays a key role, pushing efficiencies higher and PV's LCOE down (pp. 30–31 & pp. 50–52).

And who can ignore the rapidly evolving role of battery storage in taking PV to the next level, facilitating higher penetration rates of renewable energy on the grid? To kick off this year's Intersolar, Tesla cofounder and CTO JB Straubel delivered the message that with manufacturing volume and deployment, "batteries are going to win the day." In line with this message, 20 leading storage technologies and applications are featured in this edition (pp. 59–66). Key figures from storage also speak, with ABB's Otto Preiss (p. 67) and DNV GL's Ray Hudson (pp. 56–58) delivering their verdicts on the role of storage in opening up markets to solar. For Hudson, assuring quality and safety are key for wide-scale battery adoption, hence DNV GL's new battery program.

Quality of components in modules is an ongoing discussion and was again a feature at Intersolar. To play its part in the quality conversation, **pv magazine** has launched its "Black Sheep Campaign" to provide a vehicle through which whistleblowers can report quality issues in components or installations for further investigation (pp. 54–55). Feel free to get involved and call out those who cut corners endangering the rapid growth of our ever-changing industry.

Jonathan Gifford
Editor in Chief



Photo: flickr/ Bryan Jones



Photo: juwi group

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A positive, but modest outlook for PV. The economic efficiency of PV power will determine policy change.

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Affordable storage technologies set to lend the mining sector a hand. Solar hybrid projects take root.

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Photo: Xcell Automation



Photo: Aquion Energy

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Australia's booming mining sector has begun to embrace solar PV with renewed vigor now that affordable and reliable storage solutions have entered the market.

PV powers resource sector

Storage for mines: Long apparent, the attraction of bringing solar power to bear on remote mining operations waned in recent years as the price of diesel plunged. But solar's potential is being mined by the emergence of affordable and reliable storage technologies, writes Thomas Hillig of specialist consultants THERnergy.

After numerous headlines and an expected boom for solar-diesel hybrid applications deployed at mining sites around the world, the development of this niche sector slowed for quite some time a few years back. This contraction of a fledgling industry was mainly driven by lower oil and diesel prices, which distorted many expectations – even though the business cases were still positive for the majority of large-scale remote mining applications. However, in the last few months, two off-grid solar diesel hybrid projects have made notable progress at a couple of large mines in Australia.

Sandfire Resources has recently signed a contract with the French IPP Neoen for their DeGrussa copper mine in Western Australia. German renewable energy specialist Juwi has developed the project and will provide engineering, procurement and construction (EPC) as well as

operation and maintenance (O&M) services. Besides a 10.6 MW solar PV plant, the project will also comprise a 6 MW energy storage solution that will enable the diesel generators to be shut down during the day.

In addition to this development, the Australian resource company TNG has signed an inaugural memorandum of understanding (MoU) with an as yet-undisclosed battery manufacturer for supplying a vanadium redox flow storage solution to their Mount Peake project, which is located in the Northern Territory. The battery supplier will also be a vanadium customer of the vanadium-iron-titanium mine. In a second step, TNG signed a MoU with the renewables group Energy Made Clean (EMC) for constructing a solar plant and the storage system required to power the Mount Peake mining project.

Off-grid mines typically run on diesel gensets. Particularly in remote locations, electricity from diesel gensets is extremely expensive due to high transportation costs. Renewable energy can help to reduce this finite fuel consumption and improve the overall energy costs of mines. Although the mining industry has already seen a handful of solar-die-

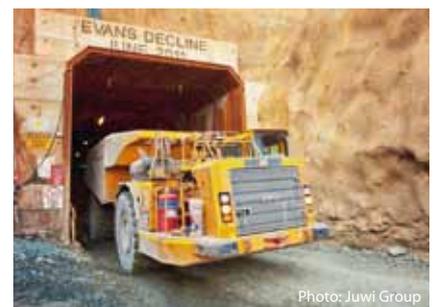


Photo: Juwi Group

The DeGrussa copper mine will soon benefit from a AU\$40 million solar and storage installation.

sel hybrid projects realized, the majority of these have been deployed without storage backup.

Diesel's shortcomings

In hybrid energy applications, storage allows for buffering electricity to balance the volatile output of renewable energy sources such as solar PV. When clouds cast shade over a solar array, the level of electricity production is affected immediately. Diesel gensets are not completely flexible and need a time to start up. If only diesel gensets are used to cover the energy loss, they have to provide a large spinning reserve. This means at the same time that the diesel gensets cannot be switched off and, in addition, that they are run below their optimal efficiency point.

To a rather small extent the diesel reductions from the solar power plant are lost again by using the diesel gensets inefficiently. Energy storage can assist as well in coping with reverse power and frequency issues. One of the main advantages of storage for hybrid systems is that it can increase the share of renewable energy in the power system considerably – up to the point that during sunny days diesel gensets are switched off completely. Then diesel is then only used to power the nighttime operations.

Both new projects in Australia show that storage is still in its infancy in the mining industry. The DeGrussa project is supported to a large extent by the Australian Renewable Energy Agency (ARENA). The Mount Peake projects is heavily driven by a bi-directional supply-buyer relationship. Therefore, it can only be speculated whether these projects would otherwise have been pursued as quickly.

If the projects are financed by external investors the return on investment (ROI) and internal rate of return (IRR) are the key drivers – given a minimum

project size that is often in the range of at least a few million dollars. If the project is realized without energy storage, the investment is considerably lower. Extending the project size with storage requires a double investment: first, in the storage itself, and second, in higher generation capacity. This all means that, at the same time, the PV installation has to be increased accordingly. Taking into account that the price for the diesel electricity is stable throughout the day at off-grid mines, it becomes obvious that the ROI is considerably higher for the part of the project that does not require storage.

If attractive projects are too small to pass the threshold for external investors, storage might have some positive side effects as the investment volume is increased considerably. The main driver for energy storage at mine sites in the near future will, however, be falling production costs.

Storage might also become an attractive solution even for mining operations that lack a renewable energy power source. In the past, many mining companies have looked to renewable energy because they had problems with their power supply. Power outages or load shedding are common afflictions for many grid-connected mines. Often volatile renewable energy solutions do not provide an optimal solution.

Diesel gensets are used as backup power, but normally they run for short time periods. When this happens, diesel reduction through solar power is often not yet an attractive business case. In these situations, storage as back-up or bridge-to-backup might well provide quick solutions and would be benchmarked in some cases even against costs that are derived from production losses. At the same time, storage forms the basis for adding renewable energy generation systems at a later stage. ♦ Thomas Hillig



Photo: Juwi Group

The 10.6 MW solar array will be located beside the mine, supported by a 6 MW storage system.



Photo:THEnergy

Thomas Hillig is the founder of mining and island renewable energy consultants THEnergy.

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