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pv magazine special

The energy transition knows no borders

PV inverters and smart technologies
are supporting the new energy future

Saudi Arabia's crowning of PV

The Kingdom is embracing solar technology

Pages 10 – 11 & 19 – 20

Advancing microgrid technology

Smarter solutions are on the rise

Pages 14 – 16

SPECIAL EDITION DEVELOPED IN PARTNERSHIP WITH

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TBEA: System service specialists in PV and power electronics

Photo: pv magazine/Thomas Beetz

Last November, TBEA New Energy Industry invited me to attend the opening ceremony of the company's new GW-class energy equipment manufacturing base in Bangalore, India. TBEA is no stranger to the Indian market. In fact, the group of TBEA companies is an energy powerhouse with a focus not only on power generation, but also materials, transmission and distribution solutions. TBEA's first factory in India produces transmission gear in Gujarat, and the manufacturer can leverage this experience to roll out its Bangalore production hub with an initial capacity of 2 GW, including both string and central photovoltaic inverters.

Just a short time after the factory opening in Bangalore, I visited TBEA New Energy Industry's headquarters in Xi'an, the ancient capital of China. The city has increasingly become a manufacturing hub for high-tech PV equipment, particularly solar inverters and modules – the two key components of a PV system. In an interview with CEO Elvis Hao, he summarized the range of TBEA's expertise in photovoltaics: "Besides the PV panels themselves, which we don't do, we do almost everything. That includes the raw material silicon, but also the PV inverter, SVG, storage systems, and even the energy router. Because we have a wide range of know-how in this field, we can provide lots of services for whatever kind of need."

This "wide range of know-how in this field" includes a global track record of providing 30 GW of PV capacity equipment since the company was founded 20 years ago. It covers more than 400 patents protecting the key technology that TBEA has developed, not only for its state-of-the-art components such as its 1,500 V inverters, but also innovations to achieve highly efficient PV power plants, microgrids, and energy management systems. For example, the TBEA microgrid energy router has an efficiency of more than 98.5%, further optimizing microgrid performance and its use of clean energy.

Static VAR Generator (SVG) technology is another area of TBEA's expertise, and this technology is being used to boost the performance of both PV-powered microgrids and grid-connected utility-scale PV plants. SVG optimizes power quality – whether inside a microgrid or for utility grid exports. As PV penetration increases in countries around the world, providing clean energy and power quality to go with it, TBEA's technology will prove increasingly important to stabilize grids and integrate even more renewable energy capacity.

In this special edition we profile TBEA's "wide range of know-how," be it component technologies such as the inverter or SVG, or system-level technologies like microgrids, EMS and lean O&M solutions. TBEA's design and EPC expertise, both at home and overseas, is also highlighted. Collectively, **pv magazine** provides a comprehensive overview, demonstrating that TBEA is truly at the cutting edge of the energy transformation to smart grids powered by clean renewables – such as solar PV.

Eckhart K. Gouras, Publisher, pv magazine

Photo: TBEA Xi'an Electric Technology

Photo: TBEA Xi'an Electric Technology

Going global

Driving toward a new energy future, the internationalization of PV manufacturing brands presents great business opportunities – but not without challenges. Market selection, strategic partnerships, and local know-how are crucial to achieve success.

Advancing microgrid technology

Decarbonization, digitalization, and decentralization are all on the rise – and microgrids are stepping up to take a starring role in the energy transition. Technological advancements and cost reductions are expanding both on-grid and off-grid applications.

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Photo: TBEA Xi'an Electric Technology

Photo: Sakaka Solar Energy Company

Let's talk R&D

"The PV system has already changed, with voltages moving from 1,000 V to 1,500 V – and will be higher in the future. Inverters will change to support the grid, rather than adapting to it," says Hao Xiang, TBEA's president of product development.

Saudi Arabia's first utility-scale plant opts for SVG

The Kingdom's Vision 2030 poster child PV project, Sakaka, is amplifying its efficiency and utility grid support with water-cooling Static VAR Generators.

Markets & Trends ▸

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The global transformative role of inverters

The renewable energy sector shows great promise for a more prosperous future – both economically and environmentally. Zhang Jianxin is the general manager of TBEA Sunoasis, with nearly 20 years of experience in the PV sector. The industry veteran recently met with pv magazine to discuss the Chinese company's experience in expanding to global markets, the challenges it faces, Covid-19, and what the future may have in store.

TBEA 特变电工

As the leader of TBEA's renewable energy division, how would you explain the current state of the PV industry and future outlook, since you first got involved 20 years ago?

Since the promulgation and implementation of China's Renewable Energy Law of 2006, 14 years has passed. During these years, the solar photovoltaic industry has rapidly grown into a pillar of the world renewable energy industry. Fourteen years may be a short time in industrial history, but within this fugacious time period, China achieved great progress in the development of photovoltaic technology and stepped to the top of the world for the industry. With many people's efforts and contributions, an entire industry, market, and supporting framework environment were established from zero. Facing pressure to continuously reduce costs, the PV industry is still full of competition and with challenges in profitability. However, we believe the overall environment for a rapid and sustainable development of the industry has been established, and the future prospect for this industry is bright.

What are the trends you are seeing for inverter products?

We see two obvious trends. The first is pertaining to the voltage of photovoltaic plants, shifting from 1,000 V to a higher 1,500 V requires 1,500 V inverters to support. Higher voltage can improve the inverter power density and reduce system costs correspondingly. The second growing trend is that the role of inverters have evolved, from adapting to the grid to supporting the grid. Working in conjunction with storage, and also with active safety protections through arc monitoring and string IV scanning, inverters can be highly integrated with transformers and switch cabinets. They are constructing a support center for grid safety.

In addition to the inverter business, what other products and solutions does Sunoasis now provide to its customers?

We have already developed the world's largest string inverter with a power of 225 kW, which has been utilized not only in the Chinese market, but also overseas markets such as India, Europe, and others. This product uses a cost optimization design, and integrates AI and smart diagnosis technology to achieve an LCOE that is 3% lower in general. This has received wide acclaim from our customers.

We also developed the TB-eCloud, our own smart operation and maintenance online platform, based on advanced technologies including big data, cloud computing, and AI. With this platform, the O&M efficiency can be raised by 10%, power generation be increased by 2%, and LCOE dropped by 4%. We have already 5 GW solar PV and wind power projects connected to and running on this platform.

In the field of power transmission, we have developed the new generation of medium and high voltage water-cooled TSVG, which significantly reduces power generation

Photos: TBEA Xi'an Electric Technology

"When we first entered the Indian market, it was our excellent products that gained the trust of our customers and made us one the best-sold inverter brands of this market"

Zhang Jianxin is the general manager of TBEA Sunoasis.

loss. In power distribution, we invented the world's first power router with efficiency up to 98.2%.

This power router has been utilized in several model projects in the Guangdong province of China. We have also established our own digital engineering design platform which integrated resource evaluation, 3D design, engineering simulation, and intelligent transferring. This makes the design and construction process of power plant more standardized, with higher efficiency and better quality.

When did TBEA Sunoasis start to explore overseas markets? And what is the status of overseas business?

We started our international market expansion in 2014, mainly focused on the inverter business. Our first step was in the India market, and then we turned to Southeastern Asia, the Middle East, Europe, and onwards. Now we have customers in dozens of countries including Malaysia, Australia, Pakistan, Algeria, Thailand, Vietnam, Chile, Ukraine, and Saudi Arabia. Our 100 MW photovoltaic project in Punjab, Pakistan, that has a total capacity of 900 MW, was the largest single solar power generation project in the world at the time of installation. In two years, the cumulative power generation is approximately 630-million kWh, which meets the demand of nearly 280,000 households, and alleviates the power shortage in Pakistan. It was the first One Belt One Road project to be completed in the Sino Pakistani economic corridor, and the first grid-connected generation project to obtain electricity charges from Pakistan.

Among all these countries in which we already have penetration, we have several key strategic target markets, including India, Vietnam, Australia, Thailand and Bangladesh. The Middle East and European markets are also key markets where we will take more efforts on.

What is key to expanding in overseas markets, and what have been the challenges in your path to internationalization?

Product is critical in the way to overseas markets. When we first entered into the Indian market, it was our excellent products that gained the trust of our customers and made us one of the best-sold inverter brands of this market. A long-term, stable strategy is also important when establishing business relationships with local partners and customers in the EPC business. In the Middle East, we spent a lot of time and effort in deepening relationships with local partners and customers and just last year it started to pay off.

However, we also learned the high risk of the internationalization process. We are trying to establish a system which is more suitable for international engineering management. And also the localization of work force is also being pushed. Just like Rome wasn't built overnight, internationalization is not something easy to achieve – but we are on our way.

What is TBEA Sunoasis' approach to Research and Development?

TBEA has always attached great importance to R&D, with annual investment accounting for more than 5% of sales revenue. We maintain that the products' development strategy integrates pre-research for cutting-edge technology, research for mainstream technology, and production of mature technologies. We have gathered a strong group of R&D talent, with many of them holding doctorates degrees from top universities of China such as Tsinghua University, Xian Jiaotong University, etc. Currently, 21% of the company's personnel have masters degrees or higher, and the company has set up a postdoctoral workstation with two people. A complete research system was built and with an efficient experimental platform, our R&D team has worked with top China universities and institutes to keep our innovation in the lead.

The Covid-19 epidemic has impacted the entire world. How do you view the global PV industry under the disease? What are Sunoasis' response strategies?

The Covid-19 pandemic is an unexpected "Black Swan." However, we are now in an era of innovation and change. Just like big data, cloud computing and AI, which is changing the traditional energy industry fast – these new technologies include advanced communication and collaboration technologies make remote work more efficient than ever before. We are constantly applying new technical means to respond to external changes – so as to meet needs of both customers and organizational development.

Where do you see the future of the industry market and for TBEA?

Grid parity of solar PV is very close to becoming a reality in 2020, but the last step relies greatly on technical innovation. The traditional competitive strategy, relying on scale advantage, needs to give way to a new strategy, relying on technological innovation. The inverter will take a more central and driving role in the future of PV systems, changing from a traditional part to a more digitized and intellectualized central component to better integrate storage, smart operations and maintenance, and grid stability support. TBEA is ready to dig deeper in the renewable energy field and make continuous efforts to achieve our vision of becoming a global outstanding green smart energy service provider.

From India and Asia … to beyond

The internationalization of TBEA Electric started in 2014. Considering the experience the company had within the domestic market and future market potential, TBEA Electric selected India as its first target for expansion. Since then, the company has expanded around the world – and is supporting the smart energy revolution with new solutions.

In today's perspective, the first order from the Indian market was quite small, with just 2.5 MW of capacity for its inverter business, but it was a milestone in a new market. With rapid growth in the Indian PV market since 2014, TBEA Electric achieved flourishing sales growth to match. Its inverter orders exceeded 1.2 GW in 2017, and its total installation capacity for its inverters in the Indian market currently exceeds 3 GW.

Aside from sales of TBEA's traditional products, the Indian market has also provided the company with the opportunity for new product trials of its latest technologies and applications under complicated scenarios. In 2019, when the 1,500 V 208 kW string inverter was developed

Photos: TBEA Xi'an Electric Technology

"Localized staff and innovative system solutions are key to opening the international market"

and ready for market launch, it was first deployed on an Indian project. The trial proved the technology's feasibility and advantages, providing a successful example for other customers in the international market.

Xu Yiyao, vice general manager of TBEA Electric, has participated and witnessed the company's global market expansion – attesting that great achievements for TBEA's global market expansion have been gained from the Indian market. "As an international inverter enterprise that entered the Indian market early, TBEA Electric has always been committed to providing the Indian market with system solutions of the best LCOE (levelized cost of energy)," Xu says of the company's past success.

Since its entrance into the market, TBEA has become one of the top three inverter suppliers in India, with more than 3 GW of capacity currently installed in the country. The company has projects installed in a range of environmental conditions across India, such as the Bhadhla desert of Rajasthan, the hills of Uttarakhand, and the wetlands of Odessa. "With so many local photovoltaic benchmarking projects, TBEA Electric won good reputation here and became one of the top inverter brands in the Indian market," says Yiyao.

With its successful footing in India, TBEA has since expanded to other overseas markets. The Asia-Pacific region is familiar in many ways, which is why it became the second step in the company's expansion process.

Southeast Asian countries show promise for PV development, with an abundance of sunshine. In conjunction with continuous cost reductions, solar PV is quickly becoming the most competitive renewable energy source for the market, and it has the support of regional governments. As one of the most active manufacturing regions of the global economy, power demand across Southeast Asia is increasing by approximately 6% per year. "All of these factors make Southeast Asia one of the best solar PV markets – and

A 30 MW solar PV installation in Vietnam, supplied with TBEA's inverter technology.

TBEA doesn't want miss the chance to participate," says Yiyao.

With several years' hard work, TBEA Electric has delivered iconic projects to several key Southeast Asian markets, including Vietnam, Thailand, and the Philippines. "All of those projects are operating stably, contributing continual power and profits to investors," says Yiyao, noting that this has gained the company high praise across the region.

However, TBEA Electric has not ignored marketing opportunities in other countries. In Australia, the company has successfully developed large SVG projects in South Australia, among other states. It is also moving into the solar PV inverter and microgrid market.

And in the Middle East, TBEA Electric has established strong partnerships with active large international developers and local EPCs to deliver many solar PV projects – expanding beyond inverters and SVG products.

"The 45 MVar + 30 MVar water-cooling SVG power quality solution that has been installed for the Saudi-based 300 MW solar project last December was a good example representing the quality, credibility, and reputation of TBEA's products," Yiyao says in reference to the Middle Eastern market. "Because this Sakaka project is the first utility PV project since the Saudi Arabian 'Vision 2030' national energy strategy was released, it has received great attention."

With TBEA's water/electric isolation technology, the SVG eliminates electrical short-circuit problems caused by water leakage when device failures occur, and improves product lifetime by stepping down the IGBT peak voltage. The company's SVG adopts the technology of IGBT temperature real-time monitoring to stabilize module performance, and uses waterway parallel connection and pipeline equalization technology to optimize heat dissipation balance and pressure. "We have achieved 99.9% utilization efficiency, which is not easy," says Yiyao.

In its process of internationalization the company says TBEA respects the cultural differences between Chinese companies and local employees and markets, balancing know-how between localization and internationalization. "When we first decide to enter a particular market, we study the country across many aspects – including policies, laws, commercial customs, traditions, and etiquette," says Yiyao. "And when we establish local branches, we hire local staff with profound industrial and business experience, and we learn about the market and customers from them."

TBEA Electric is expanding its global operations to new markets, such as Egypt.

From his perspective, having a strong international team accompanied by "localized staff and innovative solutions are key to opening the international market."

"Our Chinese employees cooperate with regional colleagues and establish a working environment of harmony, so its balanced in localization and internationalization," Yiyao says.

And now, TBEA has built its first gigawatt-level overseas production base, located in Bangalore, India. The facility possesses brand new production lines for both 1,500 V string inverters and centralized inverters.

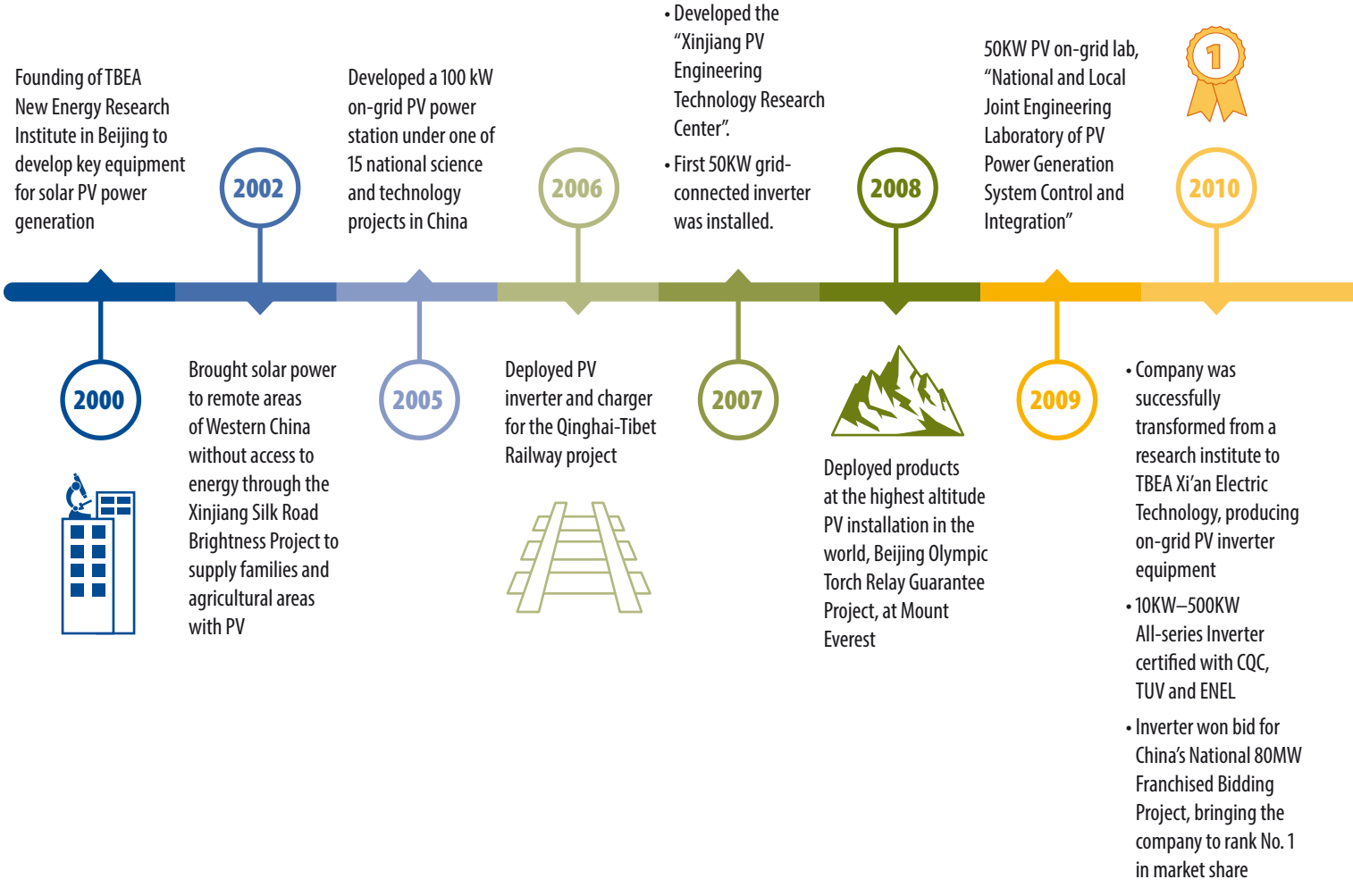
"This has enhanced our global delivery and operation and maintenance capability, and has significant influence on TBEA's overseas markets development of new energy equipments." Yiyao says, noting India's importance to the company among international markets.

"We have already entered active PV markets including Australia, Algeria, Pakistan, Thailand, Korea, Vietnam, Chile, Spain, Ukraine, Bulgaria, UAE, Saudi Arabia and other countries – but we are targeting more countries and markets," says Yiyao. "It is our deep hope to make this world greener and cleaner, with the products of TBEA."

> *"TBEA respects the cultural differences between Chinese companies and local employees and markets"*

TBEA: From Chinese research smart energy leader

In less than two decades, what started as an early Chinese research institute for PV has since evolved into one of the largest PV inverter manufacturers globally. TBEA New Energy has now deployed more than 30 GW of solar inverter capacity internationally, and is supporting an ongoing energy transition with innovation and a growing list of accolades of 'world's first' projects and technological advancements.



institute to global

特变电工

2011

- Developed System Integration and Key Equipment for Hundred-megawatt PV Power Station
- Developed 1.25MW PV on-grid Inverter with the maximum stand-alone capacity in the world
- Completed TBEA New Energy Xi'an Industrial Park with 1.5 GW of inverter capacity production

2012

- Became one of the first enterprises realizing incorporation of power stations of Chinese desert into the power grid
- Awarded First Prize and Second Prize for Scientific and Technological Progress in Urumchi, China

2013

Ranked in Top 5 for China's Most Competitive PV Inverter Companies

2014

- Established "National Post-doctoral Scientific and Technology Workstation"
- Contracted 3 GW and shipped 2.5 GW of annual inverter capacity

2015

Company's core product, TC500KH, was selected as the "leader" of the first batch of grid-connected photovoltaic inverters

2016

Supported China's first and largest commercial solar+stoage station, with 50 MW of grid-connected PV

2017

- Developed the world's first set of electrical router products.
- Company laboratory acquired the international level of technical testing ability in China.
- Annual inverter shipment capacity reached 5.5 GW, for a total shipment of 20GW, making the company rank among the top 5 in the world.

2018

Developed a DC microgrid project, the first international "Internet +" smart energy demonstration project, providing the world's largest ±10kV power router for the project

2019

30 GW

Cumulative installed inverter capacity exceeds 30 GW globally, ranking among the top five in the world. TSVG sales volume exceeded 6 Gvar.

Stepping up MENA's power

ACWA Power is a leading investor, owner, and operator of power and desalinated water production plants based out of the United Arab Emirates. Since the company's inception, it has planned for down-the-line profitability, rather than focusing on market pricing. CEO Paddy Padmanathan recently spoke with pv magazine to discuss how the company has maintained its competitive edge, and continues to grow its geographical footprint.

ACWA Power is the largest renewable energy company in the Middle East. What do you attribute to your company's success?

Pretty much everything we do is tendered, and typical contractor tendered mentality is to win on minimum margin compared to the next competitor. If you win with a bigger margin, then you have left with money on the table. Our business model is about investing millions or billions upfront, and spending this money in two to three years. We must provide the service, ensuring that our plants provide reliable power for decades – and that we get our money back over the long term. Our customer must have the ability to keep paying – which is about creditworthiness. But creditworthiness cannot be confused with willingness-to-pay. With the fact that technology keeps getting better and things are being built cheaper – as is being seen in the renewable industry – in the future, my client is going to buy new capacity and is inevitably going to be able to buy at a cheaper price. So, my tariff needs to be able to endure 25-35 years. The gap between today's tariff and some new tariff that will be coming in at 10 years' time, will become wider. And willingness to pay will be tested over time. We have already seen this with renewable, where many countries renege on feed-in-tariffs they signed up for. Recognizing this upfront when the business was founded, we convinced ourselves to forget about market pricing and to focus on winning by the minimum margin thus mitigating the risk of not getting paid in the latter years of a 20-25 year duration contract. So, we focus on designing and developing solutions with the absolute minimum cost required – instead of being opportunistic to get as much money as possible upfront. Applying that philosophy, and working with a supply chain that understands and accepts this business imperative we pursue, we end up with some spectacularly low pricing compared to the second bidder. We can't always get everyone to follow our model, and thus we don't always win, but we win a disproportionate number of tenders; we win three out of four and with a big margin compared to the second bidder. This is what has really set us apart.

Paddy Padmanathan is the CEO of ACWA Power, the largest renewable energy company in the Middle East.

Photo: ACWA Power

You have been awarded several multi-hundred MW projects in Oman, Egypt, and Ethiopia. What are the main differences and challenges of operating in the various countries of MENA and throughout Africa?

There are a lot of commonalities in each country, but of course there are specifics that are different. For instance if you take the GCC (Gulf Cooperation Council), with local currencies pegged to the

U.S. dollar, it's not that difficult to collect the tariff in Saudi riyal or UAE dirham, and to take investments or loans in any foreign currency and take the obligation to pay back in that foreign currency. But when you go to South Africa, Ethiopia, Egypt, or other more challenging African countries, you have exchange controls – where you can't simply take money out. Then the currency itself tends to be floating, so it changes by the day, and to compound the problem you cannot borrow enough local currency and even the small amount the local financing markets can make available will be for way shorter tenor, thus making the tariff high. In fact you have no choice but to borrow the bulk of the financing in foreign currency, and are stuck with figuring out how to hedge the fluctuating exchange rate and deal with the lack of certainty of repatriation to pay off the loans over the following few decades. Another significant difference comes from domestic construction capacity, which immediately impacts the price at which you can get something done. In one country, there is a lot of industrial capacity and capability so you can get things built, commissioned, and operating at a lower cost than in another country. Then of course, there are the varying environmental conditions. There is nothing standard about what we do and every project is a custom-made project. Each component of risk has to be looked at in great detail – and then you have to ensure it, mitigate it, or manage it.

A lot of developers have seen the opportunity to enter the MENA region but haven't achieved much success and exited the market. Why?

I wouldn't say they haven't been successful. EDF came a few years ago and have been very successful with partners, and others like Marubeni have been around for a long time and have successfully penetrated the renewable energy market. For newer entrants, the challenge is that everything will be "alien" – very different to what they have experienced elsewhere. For instance we just started developing in Asia, with projects in Vietnam and Indonesia. It takes getting to know the lay of the land, the market drivers that are different, understanding who potential partners are, and the specific pieces that you can utilize to create more value. All of that takes a lot of effort and commitment.

For new entrants to come into the MENA region, it would be no different than for them to go to any other new market of the world. You must be willing to last the course. You need to be willing to not win the initial bids or be successful in multiple bids from the get go. You should be committed enough to not just up and leave when you lose a few successive rounds – because on that basis, you're not going to succeed anywhere new. It is all about willingness to commit a significant amount of time and resources to meaningfully enter a market and understand it. In that process, nine times out of 10, it is about finding the right local partners, who are willing to not only open the door for you, but to roll up their sleeves and work with you – who understand the business model that you are pursuing, and to co-create with you. It's easy to put together a PowerPoint, but pretty difficult to win, deliver, and reliably operate a power plant.

The Sakaka project has received a lot of attention, being the first large-scale PV plant tendered by Saudi Arabia. You decided to use TBEA's Static VAR Generator (SVG). Can you talk more about this?

A Static VAR Generator is a device that is used in renewable energy plants to insulate the grid from the expected power supply quality problem. It is essentially a device that can compensate by providing reactive power to improve power factor and manage the grid better. PV-generated solar energy is famous for its intermittency issue, such as generation drops when clouds go over the solar field – and power grids don't like it when you inject a massive amount of power and then suddenly withdraw it. So, you have to somehow find a way to manage frequency and balance and keep the reactive power in place. There are other devices that can do it, but SVG is becoming more of a norm – it is more efficient and effective. In the case of Sakaka, TBEA provided a water-cooled SVG through the EPC contract. We are happy and have had no issues.

> *"You should be committed to not just up and leave when you lose a few successive rounds – because on that basis, you're not going to succeed anywhere new"*

'Post-Covid solar in India will bounce back pretty fast'

Refex Energy Ltd. is one of the leading domestic solar companies to install PV inverters for large grid-connected arrays and rooftop PV plants throughout India. In a recent interview with pv magazine, R.K. Sharma – the executive director of the company – discussed the Indian solar market, the impact of Covid-19, and the company's 110 MW project, which uses TBEA's central inverters.

"Covid-19 has impacted every business and the solar industry is no exception"

The Indian government has set a target of achieving 100 GW of solar PV by 2022. Is the government doing enough to promote solar?

India is one of the leading countries experiencing robust growth of PV. Total solar capacity has already exceeded 35 GW, when there was less than 30 MW in 2010. This primarily consists of grid-connected ground-mounted plants, and rooftop solar accounting for approximately 10%.

Achieving the 100 GW by 2022 would be a gigantic task over the next three years. All stakeholders are working tirelessly towards achieving it, despite the setback caused by the coronavirus pandemic.

In India, solar projects have been awarded through a competitive bidding process followed by reverse auctions, except for the first few schemes which were awarded under generation based incentive (GBI). The process is well established and has yielded good results, achieving near grid parity much sooner than the target date.

In order to spur solar energy adoption, the government has announced new guidelines to encourage the installation of smaller solar installations and for solar water pumps in agriculture sector. A major advantage of the scheme is that it provides additional income to farmers while reducing free or subsidized grid power for the electricity distribution companies of India (DISCOMs).

Rooftop solar has not grown as expected, as there is a clash of interests between DISCOMs and consumers. The government has announced new guidelines for a quick turnaround in the rooftop solar segment whereby DISCOMs will be the nodal agencies driving the installation of rooftop solar energy program. These schemes are expected to yield good benefits in future.

What are the challenges faced for deploying solar in India?

One of the major challenges is the non-existence of domestic manufacturing base for critical components like polysilicon, which results in large-scale import of finished equipment. In devising the tax structure, the government needs to adopt a reasonable approach while balancing the various interests of stakeholders in the solar industry. Further, there is a need for periodic technical audits of the solar installations to ensure their optimal performance, and also a need for long-term rules governing taxes and duties.

Leading analysts predicted a bright outlook for solar installations in India. But 2020 has been dimmed by Covid-19. What are you seeing as the short-term market impacts from coronavirus?

Covid-19 has impacted every business and the solar industry is no exception. The timely actions taken by the Indian government have contained the epidemic to a great extent. Though it is bit early to reach any conclusion, the general opinion is that our country has handled the crisis in a much better manner than other countries.

Solar development will be impacted to a limited extent in respect to Covid-19. This will

Photo: R.K. Sharma

R.K. Sharma, the executive director of Refex Energy Ltd., is confident that the India solar market will rebound quickly from the global pandemic.

only be a temporary phase, lasting maybe two to three months. Thereafter, the sector will pick up very fast. The electricity utilities of the government sector are major stakeholders in solar energy development, since they buy out energy generated. As the solar tariff is comparable to thermal tariffs, and solar is the priority sector, these utilities are likely to continue to sign new power purchase agreements (PPAs) and support solar energy.

String versus central inverters – what is your take and what trends do you see in the inverter market?

The two types of inverters have specific uses. While the central inverters suit grid-connected, large-scale PV plants well, string inverters are the obvious choice for rooftop solar and other small solar installations. Studies show that the deployment of string inverters results in slightly better yields. At the same time, central inverters are cost-effective compared to string inverters.

The specifications of inverters and other products are in accordance with the client's order for the project. The product should meet all the technical and operational requirements, up-time and product warranty, past performance, quality, and the response time for the services. We have used both central and string inverters for utility-scale solar projects. In India, large ground-mounted PV projects constitute a major portion of the total installations. So, the use of central inverters is overwhelmingly high compared to string inverters.

You have used TBEA inverters to set up a big ground-mounted solar power plant in the Ramanathapuram district of Tamil Nadu. What's your sourcing criteria?

There are leading global inverter manufacturers who have a manufacturing presence in India and are ready to provide services within India. TBEA is among the leading inverter providers in the world that we have chosen to work with. We found TBEA inverters suitable on all accounts – including the client's technical specifications, past performance, local and worldwide shipments, performance of installed capacity, quality of manufacturing, and field quality. Finally, their prices are also competitive.

We have used TBEA central inverters with 2.5 MW of capacity each, suitable for outdoor installation, to set up a 110 MW grid-connected plant for a reputed client. So, the project uses 44 inverters.

What are the major features of TBEA inverters?

These inverters are equipped with state-of-the-art features. Some of the major ones are integration with main control room and the SCADA, high efficiency at partial load and higher ambient temperatures, microprocessor-based MPPT control algorithms for optimal energy, suitability for outdoor installations, parallel operation of the two units of the inverters, an active anti-islanding detection and isolation facility, and automatic 'wake-up' and 'sleep mode' features.

> *"In devising the tax structure, the government needs to adopt a reasonable approach while balancing the interests of stakeholders in the solar industry"*

Grids getting smarter: Advancing microgrid technology

Microgrids have historically been used in remote areas without access to grid services, but they are now playing a more prominent role in the energy transition. Microgrids are independent, small-scale power generation and distribution systems composed of various distributed energy sources, as as solar+storage, energy conversion devices, and possible monitoring and protection devices. Microgrids can handle electricity transactions between different devices, but can also intercommunicate and even exchange electricity with utility power grids – and they are becoming increasingly smarter with time.

"Today's microgrids are now able to control power balance, optimize system operation, carry out fault detection and protection, and manage power quality"

With more functions and capabilities, microgrids are not only providing energy to remote areas most in need of power – they are also playing a supporting role in the energy transition. They offer value and reliability, while reducing carbon emissions, diversifying energy resources, and cutting costs. The microgrids of the past have gradually evolved into smart microgrids, achieving revolutionary breakthroughs in control theory and technology.

Smart microgrids are distributed energy resource (DER) power systems with the complete range of functions – generation, transmission, and distribution – to ensure safe consumption of energy on the user side. Working as distributed generation systems, they can improve the energy utilization rate of terminals through power scheduling with advanced information and communications technology (ICT).

Newer smart microgrids have at least two significant advantages. First, they are intelligent on the power generation side – monitoring and controlling the power generation of internal DERs, and balancing inbound power from utility grids and internal storage devices based on total loads in real time. Second, they are intelligent on the power consumption side. With centralized controls and the utilization of distributed energy resource management systems (DERMS), today's microgrids are now able to control power balance, optimize system operation, carry out fault detection and protection, and manage power quality.

TBEA's smart microgrid R&D

Huang Lang, senior R&D scientist at TBEA Electric, has focused on smart microgrid technologies for more than 10 years. He recently met with **pv magazine** to discuss the history of TBEA's advancements in microgrids over the years.

TBEA began exploring microgrids in 2014. And at an early stage, it researched power electronics transformer technologies, which are essential to power grids, as it continued to build on its already established track record with high-voltage electrical equipment. In 2015, the company joined a national Chinese R&D initiative (the 863 Program) focused on bidirectional inverters. Later in 2016, after significant investment and R&D, TBEA launched its core equipment for microgrids – the power router. This has been a significant technological development for smart microgrids.

"From 2014 to 2018, we only did R&D work in our laboratory of TBEA's New Energy Research Institute. But in 2019, based on deep business analysis, TBEA's management team saw the opportunity for microgrids reaching its turning point for marketization," said Huang Lang. "And we thus separated the microgrid department from the research institute and built up the product line."

Unique solution

"The unique characteristic of TBEA's microgrid solution lies in the principle of microgrid as a service, or 'MGaaS'. We provide an integrated energy system led by our core technical equipment, the multi-port power router, which is sup-

Photos: TBEA Xi'an Electric Technology

ported by TBEA's DERMS solution and modular energy storage system," said Lang. "The purpose of our system is to solve the most concerning challenges for customers, such as large energy consumption with cost reduction potential, high electricity quality requirements for electricity quality, and those with high electricity prices but low energy efficiency."

TBEA's microgrid system solution is comprised of three core products.

Power router

The company invented its power router in 2016, and has a specially designed module that integrates internal communications, power electronics conversion, advanced system controls, artificial intelligence, and other technologies for intelligent routing in a local power grids to efficiently use primary and secondary distributed energy. Its latest version has intelligent redundancy based on modular LPHS topology, with a low-loss system design based on silicon carbide devices, and online cluster efficiency optimization. TBEA says all of these advanced smart technologies provide the product with higher reliability and efficiency. Differing from historic traditional solutions of dispersed inverters, energy storage converters, gateway cabinets, and central controllers, the TBEA power router solution integrates primary and secondary equipment to improve the power efficiency.

TBEA's Energy Management System (TEMS)

If the power router is considered the heart of the microgrid, then TBEA's energy management system (TEMS) can be treated as the brain for the grid – controlling the entire system.

For power generation of the microgrid, comprised primarily of DERs – such as solar PV, wind, and even fuel cells – TEMS controls the output of these distributed power sources according to the specified voltage and frequency. TEMS supports the overall control strategy of the microgrid system and a scheduled dispatchment can be made and predicted according to the output of all major power sources.

For widely adopted energy storage systems used in microgrids, connected via inverters, TEMS sends instructions to determine operational functions and power generation. When the microgrid is connected to a utility grid, the storage system can ensure the stable output of the distributed power supply and assist with peak-shaving when at full electric load capacity. When disconnected from the main grid, the energy storage system focuses on maintaining the system stability and reducing power fluctuations for end users.

"When the microgrid is connected to a utility grid, the storage system is able to ensure the stable output of the distributed power supply and can also assist with peak-shaving"

> *"To improve power quality, it is able to support frequency curtailment and self-adjust voltage requirements"*

In terms of grid loads, the TEMS solution controls and predicts multiple power loads. The loads of the microgrid is managed in two stages – key loads and controllable loads. The key loads are given priority and protected with consistent power supply, while controllable loads can be cut off from the system in emergency situations. The company solution is able to react quickly according to the situation.

According to Lang, the TEMS solution provides "panoramic perception, real-time data collection, online monitoring, and accurate prediction abilities." With self-correcting multi-algorithm support, the company says it can predictively support multiple time duration forecasts, including zero to four hours, zero to 24 hours and zero to 168 hours, with more than 90% accruracy. To improve power quality, it is able to support frequency curtailment and self-adjust voltage requirements. The system is also able to optimize according to electricity prices by most effectively using internal transactions, trading, and the external utility grid. "We have an example in an industrial park grid, where the average power cost dropped by 30% with this TEMS installed," Lang noted proudly.

"The flexible soft-switching based on power electronics' transformer topology, the honeycomb active distribution network based on multi-port power routers, and the energy routing technology backed by power routers will become the core of the future of microgrids," says Huang Lang.

Storage Inverter

TBEA's smart inverter is the final core element for the company's smartgrid solution – which helps to maximize the efficiency of storage. TBEA's latest high-voltage inverter offering, scheduled to launch in the second half of 2020, is designed for 1.5 MW of capacity, and fit for 1,500 V battery systems. The company says that its design will improve the energy density of the entire system comprehensively, in order to effectively reduce the costs of power consumption.

TBEA currently has several smartgrid demonstration projects now running that are proving the advantages of the company's new solution. The TBEA Xi'an Industrial Park microgrid demonstration project was completed in 2019 and is functioning smoothly. This 863 Program-backed project consists of a 2.14 MW rooftop PV system, a 1 MWh lithium iron phosphate (LFP) battery storage system, and charging piles of 960 kW. Compared with traditional solar+storage projects, the company says that it records a 28% increase in total generation, and a 60% reduction in operation costs, with the smart energy management system.

Another field study, the Dongguan Songshan Lake Integrated Energy Project, is backed by China Southern Power Grid. For this site, TBEA provided a 2 MW power router system and fulfilled complicated connection requirements, with four different AC and DC voltage levels – including 10kV AC, 10kV DC, 380V AC and ± 375V DC. The company says it is now providing reliable power supplies for the Dongguan Easy Data Center and other loads. TBEA has worked with national grids and state-owned energy companies on other microgrid projects "in which the reliability, stability and economic factors of the smartgrid system have been continuously verified," said Lang.

Future of smartgrids

TBEA says it will continue to explore and expand its microgrid technology for business applications such as industrial and commercial parks, data centers, islands, and areas without electricity. It will continue to optimize its algorithms and products. Looking ahead, it aims to provide more advanced smartgrid solutions.

As an experienced electricity researcher and microgrid scientist, Huang shared his thoughts about future trends for power systems: "In the future, low carbonization, digitization, and decentralization will be the mainstream of the world's energy pattern." He adds that power systems will gradually incorporate the trends of comprehensive power electronics, cluster nestification, and system digitization. "The flexible soft-switching based on power electronics' transformer topology, the honeycomb active distribution network based on multi-port power routers, and the energy routing technology backed by power routers will become the core of the future of microgrids," he says. pv

Advancing technologies

Since its founding in 2000, TBEA Electric has accumulated an impressive portfolio with more than 5,000 wind, solar PV, and off-grid power plants, with a construction capacity of nearly 16 GW, including 5 GW of wind power and 11 GW of solar PV. Today, the company is focused on solar PV, wind, electricity, and energy internet-of-thing (IoT). And by the end of 2020, the company projects significant global operations, with 30 GW of PV inverter capacity developed, SVG products surpassing 6GVar, and its TB-eCloud smart energy cloud platform exceeding 5 GW of capacity across more than 30 international power stations. Hao Xiang, president of product development at TBEA Electric, discusses the company's R&D efforts and business-efficiency practices, as they are spurring the company's rapid global growth.

R&D is core to any solar inverter business. What type of investment is TBEA making in this regard to ensure that you remain competitive?

TBEA invested a total of CNY 230 million to build the largest high-power electronic product development laboratory in northwest China. The laboratory occupies 6,800 meters square, and has a technical team of 260 people, including academics, national scholars, senior engineers, etc. Doctorate scholars account for more than 12% of the entire team, and our masters' ratio on staff reaches more than 70%. The company has invested 4% of annual sales income as R&D funds for new products and technology.

What are the biggest innovations that have come out of TBEA'S R&D efforts?

Major breakthroughs were made in key equipment and technologies such as grid-connected inverters, static reactive power generators, and flexible DC products. The company successfully developed the world's first ± 800kV UHV flexible DC converter. Around the new energy system of 'IoT + the integration of wind, solar, storage and transportation + multi-energy complementation + smart energy platform,' TBEA is promoting a 'Variable Electrical Green Energy Full Ecological Chain Application Solution' in multiple application scenarios, multi-technology scenarios, and multi-operation scenarios. The company is focused on smart products such as inverters, SVG, electrical energy routers, etc. and we are providing services such as TB-eCloud smart energy management platform and smart microgrid solutions.

TBEA became famous for its high-voltage transformer as its fundamental product. How has the company evolved with today's inverter business?

We have more than 10 years' experience in R&D and production of inverters. Through years of effort, we have achieved technical breakthroughs of pivotal equipment and inverter technologies, static VAR generators (SVG), and microgrid products. The company has undertaken a number of Chinese major science and technology projects, which has supported the evolution of renewable energy. Since its establishment in 2000, our company has successively won a series of acclamations, including the United Nations' special award for technological innovation, among many others.

Your 1,500 V inverter has become a mainstream product, with higher requirements placed on the capacity ratio and overload capacity. What has made it to successful?

For international markets, TBEA launched system solutions based on the 1,500 V high-voltage string inverters. Compared with other products, this one has a more concise system structure. There is no AC combiner box, and AC cables are reduced to save costs. The inverter has outstanding technical characteristics – including a high capacity ratio, grid-friendly connection, safety and reliability, and smart O&M capabilities. With higher voltage, higher power, higher capacity ratio, larger sub-arrays and active safety technology, the application reduces overall LCOE by more than 7%. This new generation of high-voltage string inverters, with power as high as 208 kW, is one of the industry's highest-level string inverter models. And with its fair price, the model is a powerful weapon for a grid parity system.

> *"With its fair price, the model is a powerful weapon for a grid parity system"*

What is the process for developing new technologies?

TBEA Sunoasis has established a market-oriented integrated product development (IPD) process. It clarifies the roles and responsibilities of the new product development team, product development stages and tasks, and key review points and their relationships. It also ensures the accurate selection of products, shortens product development cycles, and reduces R&D costs. The IPD process consists of five steps: concept, planning, development, verification and launch. The project team members include cross-functional personnel including marketing, finance, R&D, production, and after-sales service. The team is responsible for the entire control process of product development

Photo: TBEA Xi'an Electric Technology

Hao Xiang is the president of product development at TBEA Electric

from project establishment to market launch. Meanwhile, a management matrix was established to empower project managers with the ability to coordinate between different departments, and to improve the performance assessment of the project team and R&D efficiency. With maturity and improved business capabilities working in conjunction with the current IPD process implementation, we are set for implenting TBEA's future plans. Currently, our company is concentrating in the existing product development process, manufacturing, procurement, after-sales service, logistics, quality control and other business processes, in order to improve the ability of product development, quality management, product delivery and risk control.

What smart technologies does TBEA offer to support intelligent O&M?

We developed the TB-eCloud operations and maintenance (O&M) platform, which is based on IoT technology. Through a 5G communication protocol, it can maximize data transmission and accuracy with AI-supported data mining and analysis, and is accompanied by hybrid cloud computing architecture. The platform provides opportunity for expansion, can reduce failure rates, and improve the overall revenues for power stations. With more than 5 GW of TBEA photovoltaic and wind power plants utilizing this platform for daily O&M, we see this smart technology increasing power output by 3% and reducing frequency of on-site inspections and the total O&M cost – average profit margins are increased by 1% with our solution.

The energy sector is quickly evolving with an uptake in smart microgrids. What has TBEA's role been in this space?

TBEA invented the world's first advanced power router. This power router can integrate different aspects of a micro-grid, connect and distribute power among the grid, power source, power load, and power storage. It can be widely utilized with renewable energy, electric vehicle charging stations, energy storage power stations, etc.

To create a smart microgrid solution, TBEA takes the power router as the core product, surrounded with an energy management system, central controller, energy storage system, and other key products. Our solution is suitable for different scenarios including industrial and commercial zoned projects, data centers, islanded systems, and districts without power supply, and so on.

"PV inverters will shift from passive devices to active devices in a comprehensive manner toward digitalization and intelligence – extending to smart O&M, solar+storage, grid support, and active safety"

Looking ahead, what are the technological innovations on the forefront for the industry and how is TBEA adapting?

With the increasing proportion of solar PV in the mix, and the diversification of power generation scenarios, PV inverters will shift from passive devices to active devices in a comprehensive manner towards digitalization and intelligence - extending to smart O&M, solar+storage, grid support, and active safety.

The PV system has already changed with voltages moving from 1,000 to 1,500 – and will be higher in future. Inverters will change to support the grid, rather than adapting to it. Highly integrated designs of inverters, transformers, and switch cabinets will provide for strong active safety. Based on big data, cloud computing, and AI technology, our TB-eCloud platform will provide customers with a digitalized, intelligent full lifecycle power plant operational solution to effectively increase power generation, improve O&M efficiency, and reduce electricity costs.

Delivering excellence in demanding timelines

Today's solar market offers a wide range of options for modules, inverters, balance of systems, inverters, and intelligent software for developers to choose from. Enrich Energy, a large PV plant developer based out of India, has commissioned more than 400 MW of solar capacity since its inception in September 2011. The company says that TBEA has been its inverter partner of choice – and it is already exceeding expectations for three projects.

India has a set an ambitious target of integrating 175 GW of renewable energy capacity onto its grid by 2022, but has met with hiccups along the way. Achieving the milestone came under scrutiny starting in 2018, when an introduction of tariff caps and import duties on PV modules and cells added up to increase the cost of solar power generation. This is when developer Enrich Energy was looking to move forward with its 20 MW project for Shri Keshav Cement in Karnataka, India.

Faced with the challenge of meeting a tight deadline to have the project completed by November 2018, Enrich Energy chose TBEA as the inverter partner to meet its complex project requirements and schedules.

"That was the time when there was a fair bit of uncertainty as module prices were fluctuating and there were issues related to cell availability. So we had to move in quickly for the project as we had hardly 4.5 months to have it installed," Vinayak Deshpande, general manager-supply chain management at Enrich Energy told **pv magazine**. "We chose TBEA because we felt it could deliver the project in time."

According to Deshpande, with a wide range of modules and intelligent software technologies available, TBEA inverters have been able to continuously meet their project expectations and crunched installation timelines in the Indian market. With an aggregate capacity of 400 MW commissioned so far, Enrich Energy now has three projects with TBEA inverters – two in Maharashtra and one in Karnataka.

Aside from the Karnataka project, which specified eight central TBEA containerized inverters for each 2.5 MW array, Enrich Energy has moved forward with two additional projects in the Indian state of Maharashtra. Enrich Energy's 3.75 MW plant in the Mandrup Solar Park in the district of Solapur for a pharmaceutical company, CleanScience, used TBEA's TC3750KF inverters. The power generation from this plant will be consumed entirely by CleanScience. And now the developer is executing its third project in partnership with TBEA, for independent power producer AMP Energy. The latest 20 MW Enrich Energy project is the first installation to fall under India's group captive scheme, wherein solar projects are set up for the collective use of multiple industrial or commercial consumers who have 26% equity in the project and must consume 51% of the power produced. The installation uses four 1,500 V outdoor inverters for each of the two 10 MW arrays.

Mandrup Solar Park, the first private solar park in India.

Photo: Enrich Energy

Perfect match

Modules produce different power outputs with different inverters. To obtain higher yields in power generation, the I-V curve input of an inverter must match with the modules' I-V curve for generation. Enrich Energy follows a rigorous process to find the perfect match.

"Looking ahead, people will move to string inverters as these are preferred in terms of availability and reduced failures"

"We keep a watch on what is happening in the market and what technology is being adopted by other players, not just locally but also globally. We operate with a restricted vendor list, which includes four to five top vendors," explained Deshpande. "We run analysis on the different combinations of chosen inverters and modules to discover whether a certain inverter provides a pretty stable output irrespective of which module manufacturer we source from."

The next step is analyzing costs for the various vendor combinations. "TBEA inverters give a consistent amount of generation for different types of modules. That's one of the reasons why we have preferred TBEA inverters," stated Deshpande.

"A smart developer will always look at the balance between cost, availability, and quality of power generation"

"Our experience with TBEA has had them delivering beyond our expectations. For example, in Karnataka project, our design predicted that we could generate 6,800-6,900 kWh at peak time under the best ambient temperature and irradiance conditions. To our pleasant surprise, the generation is 7,400-7,500 kWh/day per MW – which is 15% higher than what we get on good days," he added.

Special features

Deshpande says that in addition to meeting Enrich Energy's condensed timelines and output needs, TBEA is providing a host of special features in its inverters.

"TBEA inverters offer automatic power factor correction limit of up to 30 kVA/MW, which is higher than other inverters," says Vinayak. "Power factor delivery of almost 1, guaranteed uptime of 99% for central inverters and 99.5% for string inverters irrespective of project size, compliance to all IS and CE codes, software for power plant control, all types of solutions including outdoor and containerized, customization, and safety features including AC and DC isolation are the other features available."

Additionally, there are eight to 10 built-in intelligence features, which are becoming more important than ever before in today's increasingly digitalized smart energy environment. The smart features include soft start, Low Voltage Ride Through (LVRT) protection, power factor correction, intelligent load management capability, automated grid synchronization, and reactive power compensation.

Payback period

Enrich Energy is looking to save costs to bring down tariffs for winning their next bid. "If you buy an outdoor solution from TBEA, you get an IP 50/65 container, so you save on the control room cost directly," said Deshpande. "Additionally, you can select a larger size of container wherein you can mount your fire alarm system and SCADA" for increased security and remote plant management.

Based on daily generation capacity, he estimates the payback period to be seven to eight years with Enrich Energy's installations specifying quality modules, TBEA inverters, and good O&M practices.

Looking ahead

The partnership continues to shine between the two companies. At some point in the near future, Enrich Energy will start working with TBEA on a mass-scale solar PV project featuring string inverters. "Looking ahead, people will move to string inverters as these are preferred in terms of availability and reduced failures, whereas central inverters have their advantages in terms of cost," explained Deshpande. "A smart developer will always look at the balance between cost, availability, and quality of power generation."

Saudi Arabia's crowning PV plant

The 300 MW Sakaka solar project in Saudi Arabia is the Kingdom's first utility-scale PV power plant and the poster child of the Saudi Arabia's Vision 2030 renewable energy plan. Under this program, the country aims to reduce dependence on oil and diversify its economy into new economic sectors, such as the market for renewable energy. The Sakaka plant has attracted much attention and publicity around the world – and incorporated technology to meet considerable conditions.

The 300 MW project was tendered by Saudi Arabia's Renewable Energy Development Office (REPDO), which is part of the country's Ministry of Energy. A competitive tender process started in 2017 and ACWA Power – the country's leading developer, owner, operator and investor for power generation and water desalination plants – was prequalified together with other international investors. Following the commercial evaluation stage of the tender's process, ACWA Power became the preferred bidder, securing a SAR 0.08872 ($0.024)/kWh tariff. Sakaka Solar Energy Co., a joint venture that is 70% controlled by ACWA and 30% owned by Al Gihaz Holding, is the owner and developer of the project. The generated electricity is sold to Saudi Power Procurement Co. (SPPC) under a 25-year power purchase contract.

ACWA Power launched the first solar project under the Kingdom's ambitious Vision 2030 program, which will set the scene for Saudi Arabia's renewable plans. Project development moved quickly, with construction starting in November 2018 and panels that began generating electricity in November 2019. ACWA Power is committed to developing PV capacity in its home base of Saudi Arabia with a goal to develop PV at the lowest possible cost.

Photos: Sakaka Solar Energy Co.

Tech considerations

According to the tender rules, Saudi Arabia's first large-scale PV plant came with a 30% quota of locally manufactured PV components. Sakaka Solar Energy Co. explained that this meant that 30% of a project's budget needed to be spent on local contractors and domestically manufactured PV components, while employing Saudi nationals. The groundbreaking $320 million (SAR 1.2 billion), 300 MW Sakaka project featured around 1.2 million modules supplied by Astronergy.

SVG support

While most people initially think of modules and inverters when discussing solar PV installation components, Static VAR Generators (SVGs) are a more frequently used apparatus for developing massive energy plants of Sakaka's scale to support efficiency and interaction with the utility grid. SVGs can provide rapid, continuous capacitive and inductive reactive power to realize reactive power and voltage control. This helps to ensure the stability, safety and economic operation of power grids, while also improving the connection point between load and the public power grid.

In the case of the Sakaka project, the contractor selected China's TBEA to supply the PV park with 75MVar (40MVar+35MVar) water-cooling SVG, to be utilized for reactive power compen-

"The KSA transmission network has requirements on the additional reactive power within 20ms control response time"

The 300 MW Sakaka Solar Plant incorporated TBEA's Static VAR Generators to support the grid, improve power quality, and save power.

> *"The fast response ability can comprehensively improve the power output for the Sakaka project"*

sation. The high-voltage SVG is a static synchronous compensator based on an IGBT chain converter that develops the direction of reactive power compensation technology in an AC power network. This has provided two major benefits to Saudi Arabia's famed PV installation. First, water cooling cools the power electronics within the SVG container. Second, the TBEA equipment meets the solar farm's reactive power compensation requirements. The solar plant equipment absorbs and generates reactive power to stabilize voltage and comply with the voltage limitations defined by the country's grid code.

"The KSA transmission network has requirements on the additional reactive power within 20ms control response time," explained Mr. Yang, a product solution manager for TBEA. "The fast response ability can comprehensively improve the power output quality for the Sakaka project."

When selecting suppliers for the Sakaka PV farm, the contractor weighted in several parameters prior to selecting TBEA as its SVG solution provider, in line with the rules applying to all projects. These included having previous project experience of a specific capacity, compliance with international safety and quality standards, and cost-competitiveness, of course. But what made the difference was the company's delivery times and adherence to deadlines, despite the challenging timeline for the Sakaka project.

So far, the decision has paid off. Since the solar farm came online, ACWA Power has experienced smooth operation and has not faced any major issues with TBEA's cooling process. ACWA Power says that following the project's commissioning, the TBEA team has constantly been available for questions and inquiries, with the after-sales service running smoothly.

ACWA Power's senior management team was particularly happy with TBEA's installation services. He says that the TBEA team came at the end of the construction period, when most projects tend to be at a very busy phase and there are usually many challenges to deal with. But TBEA's employees were fully collaborative, supportive and adaptive to the Sakaka project.

Lay of the land

Sakaka Solar Energy noted that one of the smoothest aspects of the project was logistics. Saudi Arabia's good infrastructure – including ports and roads – aided the project's rapid development. This is a crucial factor when considering the country's future PV development.

ACWA Power stated that the environmental considerations for Saudi Arabia's first utility-scale solar PV plant were the same as most outdoor construction sites in the country. But the environmental variance in Saudi Arabia is similar to many parts of the world. The most specific factor for the PV farm was the design temperature, as there was a requirement for the project's temperature to vary from 50 C to -5 C. The project also needed to be able to withstand the dusty conditions of the region.

The new PV power plant came online in November 2019, with the TBEA SVG commissioned in December. Performance during the first few months of operation have been smooth and have met expectations, making for a crowning project in the Kingdom, indeed.

Photo: TBEA Xi'an Electric Technology

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TBEA 特变电工

pv magazine group

TBEA

AC/DC hybrid micro-grid solution

Multi-ports for Source & Grid & Load & Storage

Energy Router

10kV/0.5~3MW

Characteristics

Advanced Technology

Higher and Smarter

- 98% High efficiency
- AI Optimization
- High integration
- N+1 High reliability

Economic benefits

More Reduction and Promotion

- -2.5% Reducing energy consumption
- +1% Increasing IRR
- -10% Reducing initial investment
- Reducing construction period

Application scenarios

Various

- Industrial and commercial parks, campuses
- Green towns
- Data centers
- Other Energy Internet, like dc or dc/ac hybrid distribution network application scenarios

TSVG / STATCOM

3.3~35kV/1~100MVar

Characteristics

Combined with FACTS and latest power electronic technology, developed SVG / STATCOM with high reliability, low power loss, fast response speed and grid friendly

High reliability

- IGBT temperature monitoring and protection technology
- Power Unit automatic bypass technology
- Valve section parallel technology
- Commissioning online rate up to 99.9%

Low loss

- Switching frequency optimization technology
- Cooling system optimization technology
- Reduce power loss up to 20%

Fast response speed

- DSP+FPGA control typology
- Reactive power response time <5ms
- Voltage control response time <30ms

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