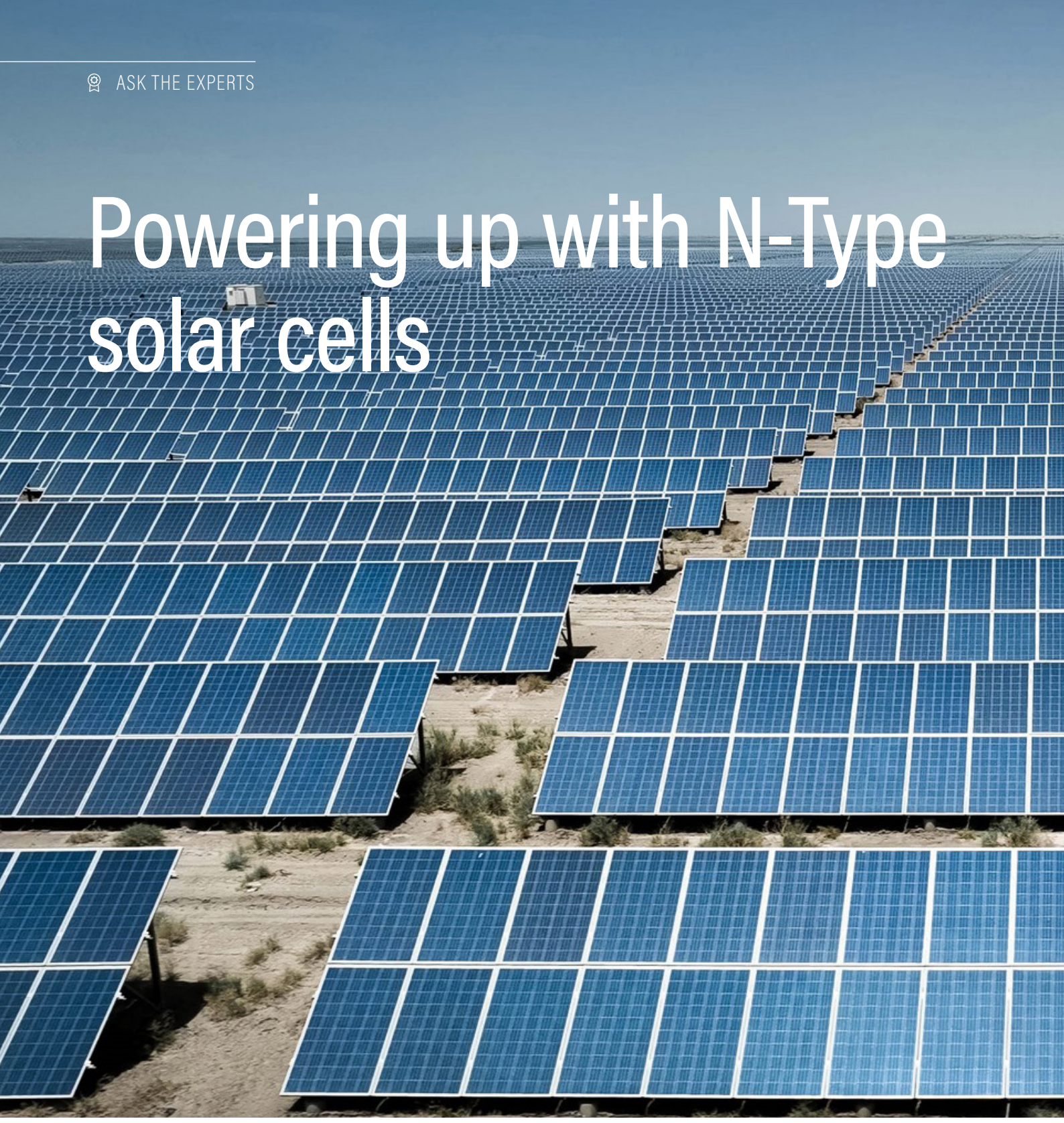
Powering up with N-Type solar cells



Founded in August 2018, DAS Solar aimed to achieve rapid development through innovation. With years of technological accumulation and a keen understanding of future PV technologies, it quickly recognised that N-type is the next generation, establishing a dedicated research and development team to focus on this high-efficiency technology. Vincent Cao, Senior Vice President, explains more to PES.

PES: Thanks for taking the time to speak to PES. Can we start perhaps with an introduction to DAS-Solar?

Vincent Cao: Founded in August 2018, we are a national high-tech enterprise specialising in the research and development, manufacturing, and sales of high-efficiency solar cells, photovoltaic modules, and system applications. Additionally, we are involved in the investment, construction, and operation of power stations. DAS Solar is also a strategic investment enterprise of state-owned companies.

With a big focus on industry-university-research cooperation, our R&D team makes up 20% of our total employees, and our annual research and investment accounts for approximately 5% of our sales revenue.

As a leader in N-type photovoltaic technology, we boast two key products; N-type modules and lightweight modules, and three series of full-scenario PV system solutions; ecological PV, urban PV, and offshore PV. We have also established a comprehensive sales network at home and abroad. With a production capacity of 30 GW for high-efficiency cells and 30 GW for high-efficiency modules set for 2023, we have become a leading top-tier brand in the photovoltaic industry.

PES: A focus for you is on N-Type solar cells, correct?

VC: Yes, that's correct. We were the first to commercialise a TOPCon production line to gigawatt scale in China.

PES: As a pioneer in the field of N-type technology in the solar market, what are your reasons behind this as a primary direction for research and development?

VC: The crystalline silicon photovoltaic industry has undergone over 20 years of

development. The efficiency of traditional p-type cells has reached a bottleneck. Currently, mainstream p-type PERC cells have achieved an industrial efficiency of 23.5%, which is close to the laboratory efficiency bottleneck of 24%. There is therefore a need to develop more advanced technologies.

N-type PV technology has the potential to exceed 28% of efficiency theoretically. It offers higher efficiency, lower degradation, excellent performance in low-light conditions during mornings and evenings, high power generation on both sides and a low-temperature coefficient. This technology can significantly reduce the cost of PV power generation.

At its inception, DAS Solar aimed to achieve rapid development through innovation. With years of technological accumulation and a keen understanding of future PV technologies, we recognised that N-type is the next generation. Our CTO, Dr. Song Dengyuan, was a PhD student under the supervision of Professor Martin Green at UNSW and a researcher there for 10 years. He works on both cells and modules and under his leadership, we established a dedicated research and development team to focus on high-efficiency N-type TOPCon solar cells.

PES: What are the main advantages of N-type product?

VC: Our N-Type module delivers exceptional performance and offers cost-effective advantages. With 80% bifaciality, it generates up to 30% more energy yield. It has a '0' LID, 1.00% first-year power degradation, and 0.40% annual degradation, ensuring reliable performance. Certified for durability and resistance, it can withstand extended PID, sand and dust, salt mist, and ammonia. Its lower temperature coefficient minimises power loss in high temperatures.

The N-Type Pro module also excels in low-irradiance conditions, delivering higher power output even on cloudy or foggy days. Compared to the PERC module, the extra power yield of DAS Solar N-type modules will top out at 5% in the same capacity. Right now, our N-type products have obtained the UK Conformity Assessed (UKCA) and Microgeneration Certification Scheme (MCS).

PES: Is demand for this technology growing and how are you meeting that demand?

VC: The current market penetration level for TOPCon products is around 20%, but in 2024 this will increase to 65% or maybe higher, meaning we have a huge opportunity. By the end of this year, we will have around 30 GW each of capacity for cells and modules, with 90% of N-type products. During 2024, the capacity for each will increase to 40 to 45 GW.

We are thrilled about our rapid capacity expansion, and our confidence is unwavering. DAS Solar has implemented a decentralised manufacturing strategy in China, having established over 10 major production bases domestically. This approach offers several advantages, including fast delivery, prioritising local demand, and significantly reduced transportation costs.

Additionally, we are actively researching and evaluating the advantages and disadvantages of decentralised manufacturing overseas. In 2022, to better serve local customers in Europe, we announced the official establishment of a German subsidiary. Also, a well-established supply chain and warehousing system in Europe is being established, which will become the center of its European operations and form an important part of its global expansion strategy.

Vincent Cao

PES: As a frontrunner in the N-type domain, could you please outline the achievements your organisation has made thus far through approximately four years in the PV field?

VC: The company achieved remarkable growth with its revenue nearly a hundredfold compared to 2019. It ranked among the top three globally in N-type module shipments and eighth worldwide in overall module shipments. The company's innovation led to 171 granted patents, with almost 40% being inventions. It filed over 450 patent applications and played a key role in developing ten industry standards. DAS Solar's future prospects in the photovoltaic market are promising.

PES: The most recent upgrade to the N-type technology innovation development is the N-type 3.0 series products. What are the main advancements from earlier products?

VC: Our N-type 3.0 series contains bifacial double-glass module, ultra-thin

double-glass module, and lightweight half-cut module, covering the power output of 430 to 640 w, with highest conversion efficiency up to 22.9%. Equipped with our cutting-edge TOPCon 3.0 plus cell technology, the cell achieved an impressive cell laboratory efficiency of up to 26.24% and the open circuit voltage of 730 mV, a world record.

Leveraging advanced technologies such as high-energy laser-induced selective emitter (i-SE), ultra-thin polycrystalline silicon with micro-doped ut-polySi, and passivated emitter rear contact (PERC) with multilayer surface passivation (mt-Pass), the N-type 3.0 series modules boasted exceptional performance and reliability. They offered advantages such as zero light-induced degradation (LID), higher bifaciality, lower temperature coefficient, and superior performance under weak light conditions, meeting the diverse requirements of various application scenarios.

PES: Could you give me a detailed introduction to the technological highlights outlined in the recent release of your latest technology development roadmap?

VC: Based on market research and trend analysis, we have strategically pursued five groundbreaking technological pathways: TOPCon 4.0, TBC, CSPC, TSiP, and SFOS, comprising these next-generation solar cells. These cells are designed with innovative cell structures and utilise cutting-edge materials, enabling both improved power generation efficiency and cost reduction. Moreover, they are tailored to various photovoltaic application markets, boasting cell efficiencies exceeding 35% and even surpassing 40%, a remarkable enhancement from the current 27%.

In terms of each specific technological pathway, TBC technology is a new

high-efficiency cell technology that combines high-efficiency TOPCon technology with black to back contact technology. By leveraging the exceptional passivation contact structure of TOPCon cells, TBC technology places all electrodes on the backside of the cell, eliminating the light shading loss of approximately 3.5% caused by conventional front-side grid lines.

This approach not only enhances the cell's appearance but also significantly boosts current output. Our research and development efforts on TBC 1.0 high-efficiency cells began in 2020, and we have successfully achieved the development of TBC 3.0. The next-generation TBC module products will be introduced to the market in the second half of 2023. The efficiency of TOPCon and TBC cells will surpass 27%.

The CSPC cell is based on the TOPCon cell structure with an efficiency of 26%. It employs a novel selective carrier contact passivation material to reduce recombination current, thereby increasing the conversion efficiency of crystalline silicon cells to approach their theoretical limits. In order to further enhance cell efficiency, the TSiP cell represents an innovative silicon-based stacked cell technology that extends solar spectrum utilisation into the infrared range.

The stacked cell design significantly boosts the open-circuit voltage of the cell. Currently, we are collaborating with renowned universities and research institutions, both domestically and internationally, on the development of TSiP cells. The core technologies for TSiP cell research and development include low-resistance tunneling layer technology in the intermediate layer between the top and bottom cells, corner-preserving deposition technology for the top cell on the textured surface of crystalline silicon, spectral distribution technology for both the top and bottom cells, as well as metallisation technology. The industrial efficiency of TSiP cells is projected to surpass 30%.

The solar cell with Singlet Fission on Silicon (SFOS) can have a theoretical maximum efficiency of more than 40% because the SF layer on silicon PV devices can double the EQE over the wavelength range over which it absorbs. The Photovoltaic Research Center at UNSW is a global photovoltaic innovation highland, through high-end talents and advanced R&D equipment, focusing on the basic SF material and mechanism research of SFOS cells.

DAS solar has the rich research accumulation, industrialisation experience and advanced laboratory facilities in TOPCon cells, focusing on the research of SFOS cell's industrialisation integration technology and large-scale mass production technology. Through the efforts of both parties, it is expected that the new generation of solar cell technology revolution will be promoted, just as UNSW invented the PERC solar cell 40 years ago.

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