Comprehensive PV expertise for a more sustainable future

The power sector is undergoing a global transformation. Over the past decade, the costs of renewables have dropped substantially, solar power by as much as 80 percent. With the comprehensive knowledge and broad experience, Stäubli makes an important contribution to the PV industry and the vision of a more sustainable future.

Renewable energy generation keeps on expanding steadily with increasing capacities of solar, wind and hydro. Whereas solar energy has been proven to be the most economic or cost efficient and effective, it leads with a growth of 135 GW in 2020. The worldwide installed capacity of photovoltaics (PV) runs up to about 755 GW, of which around 50 percent rely on Stäubli's PV connector portfolio. This pioneer and inventor of reliable and powerful PV connectors has been active in the PV industry since 1995 and has launched the first PV connector in 1996 named MC3, after the company name Multi-Contact at that time.

Ever since, the technical experts of the former Multi-Contact, today Stäubli, have invested in research and development to bring the best electrical connectors to the PV industry for safe and long-term operation. In the course, the follow-up model MC4 was introduced to the market in 2002 and has set the benchmark in the PV connector world due to its outstanding characteristics for quality product and dependable performance.

Small components, big impact

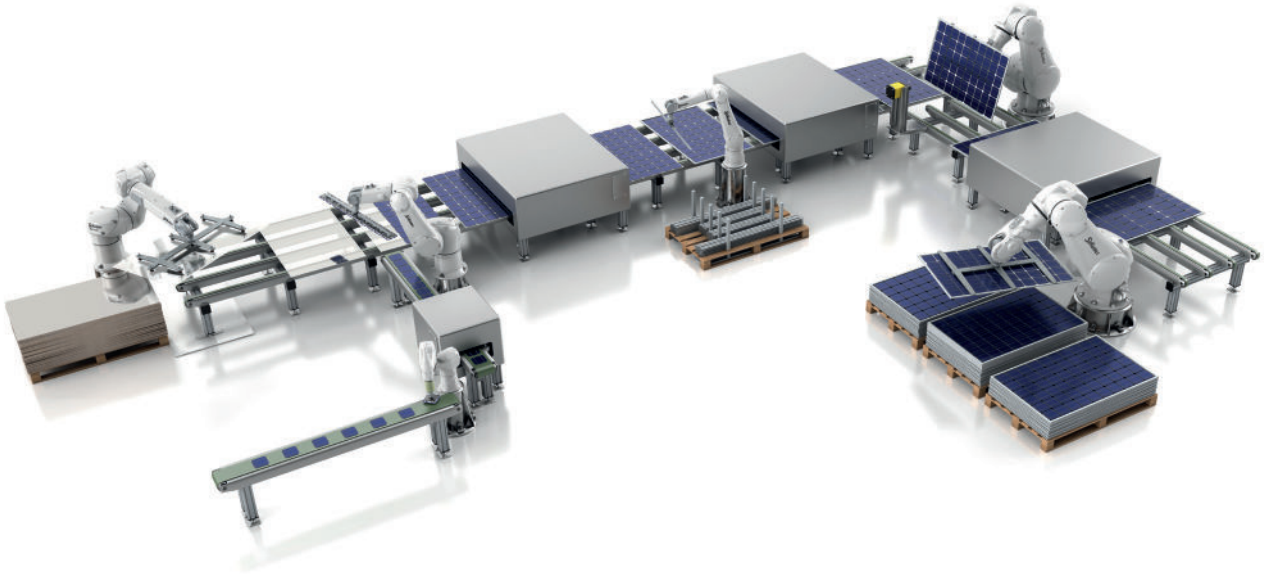
Today, photovoltaic installations have become extremely cost driven. In a tough financial climate, it's quite a challenge to find the optimal balance of CAPEX and OPEX. The PV industry is continuously looking for higher efficiency and lower production costs. Traditionally, this quest has centered on cutting the cost and improving the performance of big-ticket items such as solar panels, inverters and trackers. One area that is commonly overlooked is electrical balance of system (eBoS) components such as connectors and cabling. But the smallest component can be relevant.

Recent studies suggest that it is crucial for project owners to focus on these components and not only on modules and inverters, which represent the largest portion of CAPEX. Many field surveys of research institutes and technical advisers as well the experience of many projects owners all over the globe show that technical failures or issues with eBos components show a high frequency of occurrence and can have the biggest impact for economic losses in PV assets. Root cause for this is either lack of awareness about the importance of these components and/or the attempt to lower CAPEX by reducing asset costs for eBoS components and thus choosing low-quality products or cheap workman.

The lifelines

In order to guarantee consistently high yields from PV plants on the long-term, reliable and high-quality components are required in addition to experienced project partners. In the complete PV energy system, the eBos can be considered as the subsystem between the power generation part and the power use. The smallest components in eBos are the PV connectors. Their quality in terms of contact technology, design, material and manufacturing are key for the profitability of a PV plant.

Matthias Mack, Director Global Alternative Energies and member of the Management Board at Stäubli outlines: 'Quality and reliability of photovoltaic connectors are essential for the economic efficiency and safety of a PV plant, because they are the lifelines of a PV system. Our 25 years of experience in the PV industry is the



Automation solution c-Si module production line

foundation for the expertise in product design, the technology know-how, the competence in manufacturing methods as well as the alignment of processes and services for the customer's benefit.'

Contact quality

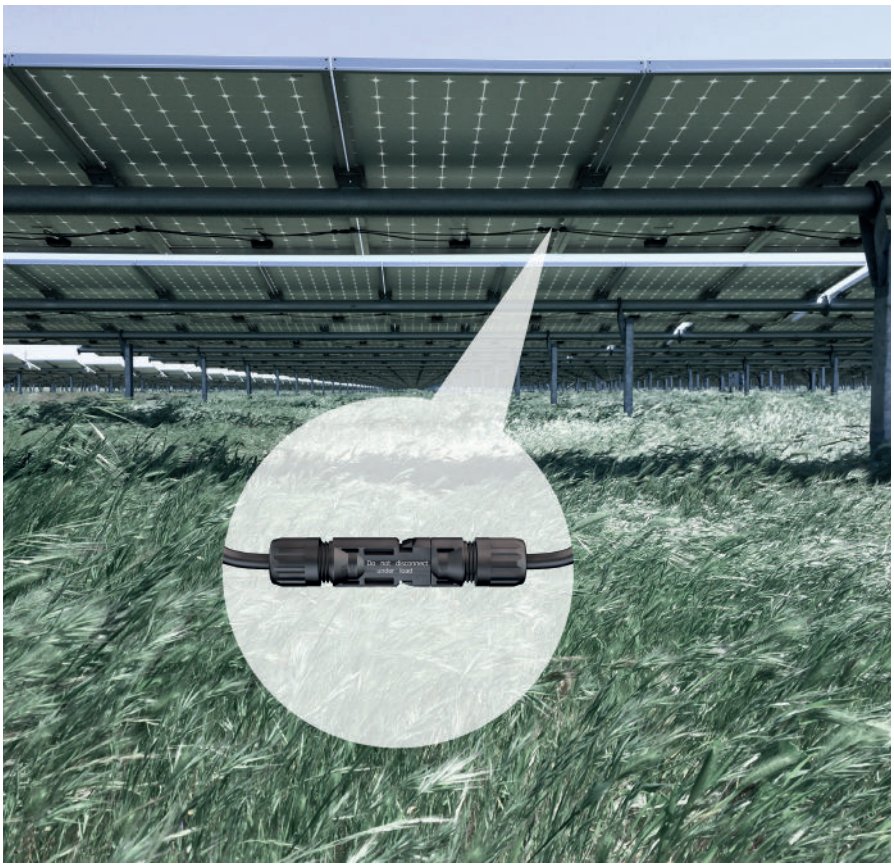
Constantly low contact resistance of the PV connectors is key for efficient operation and safe energy feed-in. Increasing contact resistance, e.g., due to deficient material characteristics, can weaken the efficiency of the entire PV system. The core of the Stäubli PV connectors is the innovative MULTILAM contact technology. This unique contact principle stands out due to multiple contact points that improve connection quality and energy transfer thanks to its constant spring pressure and the unique design.

This results in a constantly low contact resistance, ensuring safe and long-life operation and reduces downtime and service cost significantly. Furthermore, by means of this differentiating contact technology risks for power loss, hotspots or even fire that would lead to enormous reconstruction costs, are reduced to a minimum. The original Stäubli PV connectors from the MC4 connector portfolio are very stable in terms of temperature and show no heat accumulation.

Comprehensive expertise

Paying attention to the smallest detail and being committed to quality pays off for the Stäubli PV business, as its track record of cumulated more than 385 GW PV capacity proves. But also, for EPCs, asset owners and investors it is indispensable to consider all details and rely on expertise and quality, when approaching new PV plant projects. The company owns the know-how of the entire design and manufacturing processes, combining technical expertise with control of production and supply to guarantee quality in terms of functionality, safety and material characteristics. After the in-depth evaluation of all applied material, the definite design and construction as well as the control of all assembly steps, the final products are tested beyond the norm.

An important phase in the development process is the comprehensive and structured test procedures we follow, to guarantee resistance to the harshest climate and weather conditions ensuring continuous operation. Furthermore, we place great emphasis on advanced services related to the connector as a product. Based on the findings of research and examinations, it is our concern to increase the knowledge in the industry about the importance of PV connector components through training and education as well as consulting support of our partners. We care for the best solution



Small components. Big impact. PV connectors are the lifelines of the PV system

All PV plants around the world produce globally 740 GW, whereof more than 385 GW are connected with Stäubli PV connectors

and therefore share our expertise for planning as well as for operation and maintenance (O&M) to mitigate risk and secure higher return on the PV systems.

Competence along the photovoltaics upstream production segment

Creating values in the PV industry, Stäubli also owns extensive expertise in the efficient PV cell and module production. As a partner in PV industrial production processes since the very beginning, the Robotics division has been developing automation solutions for all process steps within the complex production chain for decades cooperatively with its customers. Stäubli robots provide the perfect solution to boost production, offering extremely high speed but smooth motion, high accuracy, and proven reliability with limited maintenance.

'Stäubli robots make the production of PV cells and modules safer, more efficient and more economical,' explains Christophe Coulongeat, Group Division Manager Robotics, 'whether in the solar cell production or in the C-Si module manufacturing, our complete range of four and six-axis robots provide the perfect solution for every automation task in the PV industry combining reliability, precision and dexterity to improve customer's productivity.'

Precision and speed

The requirements for automated handling in solar cell production push conventional automation solutions to their limits: as in the cell manufacturing process such as diffusion or PECVD, the silicon wafers have to be handled at high speed as well as with finesse. Any irregularity in the motion sequence of the robots would inevitably lead to breakage. The Stäubli robots' portfolio offers models for all wafer formats and handling processes. The four-axis and six-axis robots of the TS2 and TX2 series are world leaders in the disciplines of dynamics, precision and reliability, standing out with their superior drive technology. At the same time, the robots handle the valuable load with extreme care, so that wafer breakage or other damage can almost be excluded and the encapsulated design of the machines ensures long-term reliability.

In the crystalline silicon (c-Si) module production, the Stäubli robots facilitate every step. The precise and ultra-fast four-axis TS2 SCARA robots are the best on the market at delivering the shortest cycle times and managing high-speed tasks inside stringer, or shingling machines. The prerequisites for this are the combination of a light and rigid structure, patented JCS drive technology and the ultra-flexible CS9 control system. In backend processes such as string layup and module handling for assembly and test, six-axis robots of the Stäubli TX2 generation are used. As trends are towards longer strings and larger modules, the speed and reach of the robots, with high positioning accuracy, are decisive factors.

Creating the future

Stäubli robots facilitate the cost-efficient and reliable manufacture of all string systems currently available on the market as well as those planned for the future. The original Stäubli PV connectors of the MC4 product portfolio are the key element for safe and profitable operation in PV plants. With its longstanding experience in the PV industry for more than 25 years, the passion for quality solutions and the attention to the detail, Stäubli is investing to support the development of an efficient and safe PV industry for the future and to partner with its customers sharing its expertise.

About Stäubli

Stäubli offers innovative mechatronic solutions in three core areas including Connectors, Robotics and Textile. Founded in 1892, today Stäubli is an international group headquartered in Pfäffikon, Switzerland with more than 5,500 employees worldwide. The company has a presence in 29 countries with production companies, sales and service subsidiaries and is supplemented by agents in 50 countries.

As a world market leader in the field of connectors, Stäubli manufactures quick connector systems for all types of fluids, gases and electrical energy. The Electrical Connectors product portfolio ranges from miniature connectors to high-performance connectors for power transmission, industrial automation, transportation, test and measurement. In Photovoltaics, Stäubli is the global market leader with its MC4 connector components. The core of all Stäubli electrical connectors is the unique MULTILAM technology.

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