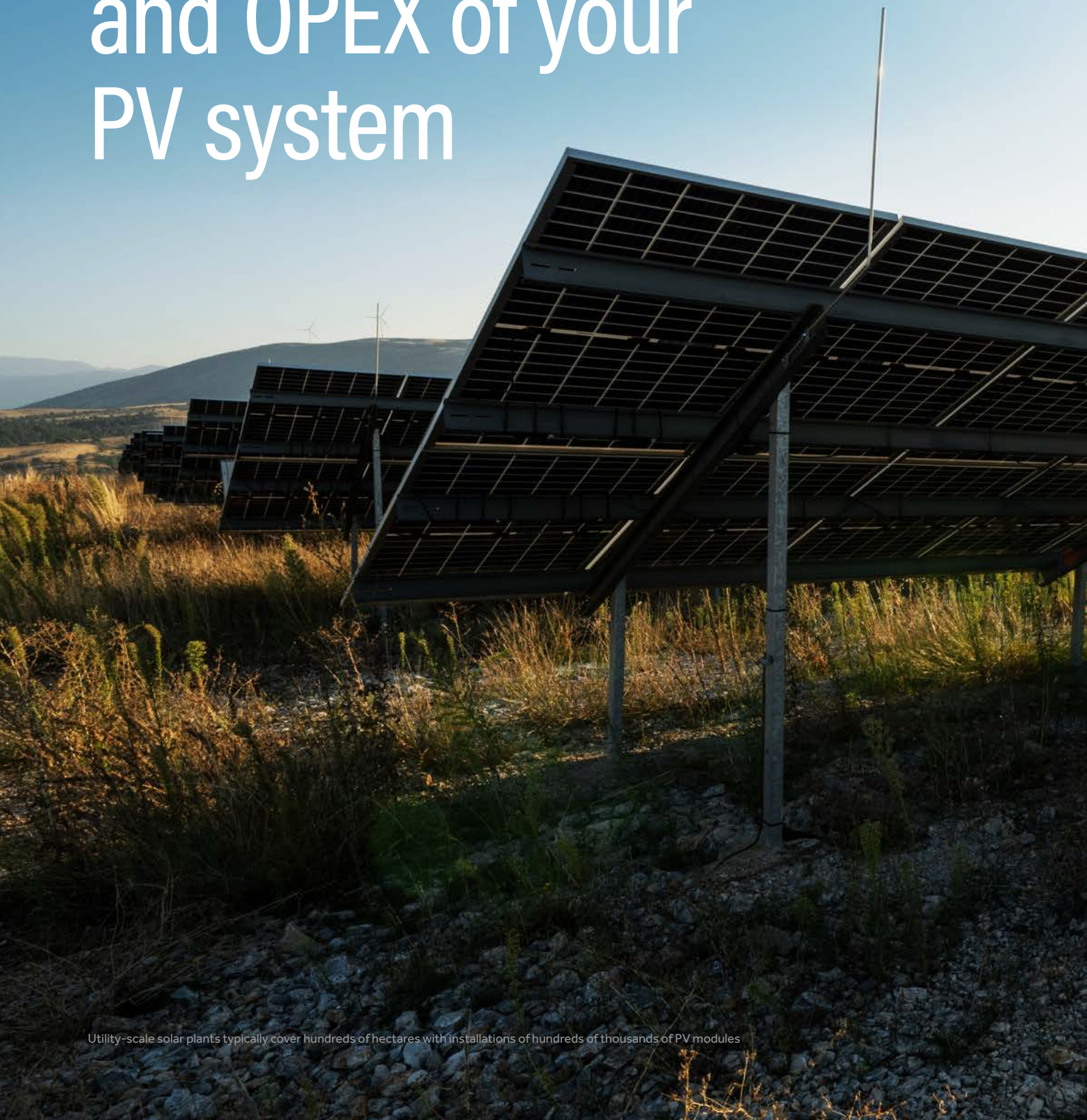


Effective DC wiring optimizes CAPEX and OPEX of your PV system



In this exclusive PES interview, Andrea Viaro, Global Head of large-scale systems at PV connector market leader Stäubli Renewable Energy, provides valuable insights into development since he joined the company, as well as wider trends in the field of photovoltaics. The company is famous for its Original MC4 electrical connectors, a staple in the solar sector, and plays a crucial role in the rapidly growing PV market.

PES: Thank you Andrea, for taking the time to speak with us. We first spoke after you joined Stäubli in 2020. How have things been progressing for you in the company since then?

Andrea Viaro: I have been part of the solar industry for over 15 years, and I am delighted to see the consistent and rapid growth of photovoltaics worldwide year after year. Stäubli Renewable Energy is more committed than ever to keeping up with this dynamic and is motivated to be a forward-thinking partner.

Personally, I am also highly committed and thrilled to develop and strengthen customer relationships for Stäubli. I am proud to be part of this enthusiasm, and to contribute with my experience and work to increase the reliability and safety in the PV industry.

PES: Stäubli is well-known for its electrical connectors for the solar industry, the Original MC4 product portfolio. As the PV market grows, what is Stäubli's position in this market?

AV: The Stäubli MC4 PV connector holds the distinction of being the most widely installed

worldwide, connecting over 50% of the global photovoltaic capacity.

We have adapted our organization to fit the speed and growth of the market and also to better support the different customer groups that we supply with our products.

We closely observe the industry's needs and evolution and plan proactively in accordance with the developments of our clients. We also bring up new product and service solutions, always aiming to increase the performance and safety of our customers' PV systems.

Several international studies examined and prioritized the potential failure risks in solar power plants. These studies have consistently shown that quality connectors with low contact resistance, correct assembly and installation, as well as appropriate and well-designed eBOS applications, are crucial in mitigating risks and improving the reliability of PV systems for safe performance.

That's why we believe that our contribution can make a significant and positive difference in the industry. It's just a relatively small component that nonetheless can have a very

strong impact on the safety, reliability, and overall performance of the PV system.

PES: An interesting, not to be neglected, aspect. You mentioned the eBOS application. What do you mean by that?

AV: That's a good question, which I'm pleased to answer. Indeed, the terminology may not be widely recognized yet, which further highlights the need for greater awareness about this crucial component of PV installations. eBOS is a technical term, that stands for 'electrical Balance Of System'. It encompasses all electrical components that combine the individual PV module outputs, to match the electrical input requirements of the inverter. So basically, all electrical parts from the backside of the modules to the DC input of the inverter. The expression eBOS is well known in the US market and in the English-speaking regions, whereas in Europe it is known as DC cabling.

PES: Thank you for the explanation and definition. And why is the eBOS application so important?

AV: Let's take a closer look at utility-scale solar plants, which typically cover hundreds



Stäubli offers complete and high quality eBOS products. For example, the MC4-Evo 2 Y-Splitter combined with the MC4-Evo 2 In-line Fuse 3 provide tailor-made cable harness assembly



The MC4-Evo 2 branch connector

of hectares. These installations consist of hundreds of thousands of PV modules that need to be connected to the system. The eBOS components collect the outputs from all the solar panels and combine them to match the electrical input parameters of the inverter.

Now, we are faced with the question of finding the best fitting DC wiring design solution that optimizes the combination of DC strings and the selection of the right products within this eBOS application. This solution can not only minimize losses and achieve the highest performance but also facilitate O&M activities and minimize related costs.

We can also equate the eBOS to the lifelines of a PV system. It ensures that the power generated by the modules is gathered and transferred efficiently, reliably, and safely. If the PV components are not performing effectively, the energy yield of the whole solar system might not be adequate.

The components of the eBOS application can therefore significantly make the difference between success or failure of a solar project. They can impact the initial costs (CAPEX) and installation efficiency during the conception and construction phases. They can as well prevent potential maintenance issues in the operational phase - which still today happen too frequently, unfortunately - that cause higher operational costs (OPEX).

PES: Where do you see the challenges for the eBOS?

AV: The eBOS can directly influence the performance of the PV system, simply through the electrical resistance, which is related primarily to the quality of the materials/components used and their assembly procedure, as well as to the solution design and construction.

However, the main challenge at present remains the underestimation of the impact that the eBOS can have on multiple levels (technical, financial, warranty/safety-related, legal), especially in the long run during the PV project lifetime. In general, there is not enough attention given to the potential of optimized eBOS, even when it comes to the most obvious details.

For instance, at the very beginning of your PV project you should also be aware of the length of the cable leads delivered with the pre-mounted connectors on the modules. You might consider this a small detail at the conception phase, but it will have an impact on the overall design, construction, and performance of the DC wiring system. In fact, the less material used for the eBOS, the lower the CAPEX. The less components installed in the eBOS, the less potential points of failures.

PES: Can you tell us Stäubli's role in addressing the challenges in this area and what innovations will help to solve them?

AV: Ultimately, what every customer wants is a quality solution that can live up to its promised lifetime and guarantee the return of investment. Coming back to the mentioned international studies based on field data, we learn that more than two thirds of issues are related to eBOS



The Stäubli PV connectors with low contact resistance, correct assembly and installation can help to mitigate risks and improve the reliability of PV systems



The Stäubli MC4-Evo 2 Y-Splitter

application errors. The Stäubli product solutions have a proven track record and are known for their reliability.

In addition to providing the most installed and trusted PV connector, our product portfolio also offers a variety of customized or off-the-shelf products for various harness concepts. With our extensive experience and expert knowledge gained from numerous customer projects, we can share our know-how for best practices in eBOS application design and installations.

We work closely with EPC and installation companies to train their staff and prevent assembly errors. In addition to offering high-quality products and certified assembly tools, we also provide installation training and necessary services for best practice assembly.

It's important to note that our cabling design optimization service, which we offer during the conception phase of the project, is the starting point to ensure that the eBOS concept is defined in the most suitable and advantageous way for the specific application. Our objective is to maximize performance, safety, and minimize costs and risks.

Another quite important element in defining the wiring concept also covers the aspect of maintenance in case of a breakdown in a specific area. The more

modular the wiring concept of the eBOS is set-up, the more flexible, easier, and faster replacement parts can be ordered and installed during the operation.

An eBOS solution offers numerous advantages. Firstly, it enables faster delivery times, reducing the likelihood of project delays. Secondly, it simplifies the supply chain complexity, streamlining procurement processes. Additionally, this approach shortens installation times, enhancing overall project efficiency.

Moreover, the modular nature of the solution increases flexibility for on-site adaptations, allowing for easier adjustments during installation or maintenance. This culminates in reduced efforts and costs for the replacement of damaged parts during O&M.

In summary, the comprehensive and high-quality range of eBOS products and services provided by Stäubli offers customers a reliable solution to maximize the performance of their PV assets. By utilizing Stäubli's offerings, customers can optimize both their capital expenditure (CAPEX) and operational expenditure (OPEX), resulting in enhanced efficiency and long-term benefits for their solar power systems.

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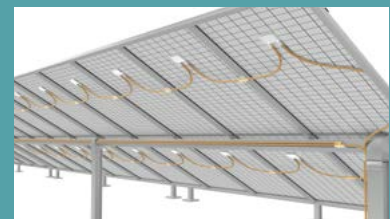
Andrea Viaro

For 15 years, Andrea has been committed to the purpose of the transition towards sustainable energy generation.

He has gained professional experience in the photovoltaic business, working internationally for different tier-one manufacturers and consultancy firms in the PV industry.

He holds a master's degree in Materials Engineering from the University of Padova and has thorough know-how about the PV market, technology, and quality aspects.

Pursuing his way in the solar industry, he participates regularly in roundtable discussions and various public events, sharing his knowledge with the objective of supporting the safe development of the solar PV industry.



eBOS

The term eBOS stands for Electrical Balance Of System. It encompasses all the DC (direct current) electrical components within a photovoltaic (PV) system that are situated between the solar modules and the inverter.

This includes various components connected via strings, which form the electrical infrastructure of a solar system on the DC side.

Essentially, eBOS encompasses everything except the solar modules themselves and the inverter within a solar power setup.