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Floating PV plant in the Swiss Alps operated by local energy service

Safe connections in the harshest environment

The world continues to shift steadily towards renewable energy sources, with solar photovoltaics representing more than one-third of generation growth. And this source will continue to grow at high speed. No doubt too, that more and more PV plants will be installed in areas with special or extreme climate conditions.

In harsh environments, PV installations face several challenges that can affect their performance and reliability. Some of the main hurdles include extreme temperatures, humidity, and high altitudes. Still, in high altitudes PV systems are more efficient, thanks to more direct and less diffuse radiation. That's why Alpine regions, or the high plateaus of the Andes, are very attractive locations to harvest PV energy.

The high altitudes

With increasing altitude, the decreasing air pressure can be a challenge, as the risk of air ionization increases, and with it, voltage flashover. This is an issue for all electrical components in the PV system, such as PV modules, inverters, junction boxes, combiner boxes, and last but not least, PV connectors. The smallest parts in the entire PV system are responsible for the reliable, long-term, and safe transmission of the generated solar power.

In the context of decreasing air pressure, the most important aspect to prevent risks is to consider sufficient dimensioning for the safe insulation of an electrotechnical product. This includes the distance or the shortest air path between two conductors, the so-called clearances.

The world-leading PV connectors of Stäubli have a track record of connecting more than half of the global PV capacity. As an expert in the PV industry for more than 25 years, Guido Volberg, Senior Consultant for Product Regulatory Affairs at Stäubli Renewable Energy, confirms: 'The Original MC4 product portfolio excels with outstanding quality, providing excellent reliability and low contact resistance over the entire service life of more than 25 years.

'Thanks to our exceptional and proven design concept, the Stäubli PV connectors can also be used at altitudes of up to 4000m above sea level (asl). In fact, the MC4 and MC4-Evo 2 cable-connected connectors can even be used at altitudes of up to 5000m asl.

'This was tested and verified by TÜV Rheinland. Therefore, PV installations as they exist, for example in Switzerland at dam walls of reservoirs, on high plateaus in the Andes of South America, or on mountain lakes in the Alps rely on the connectors of the Original MC4 product portfolio.'

The high temperatures

Temperatures at altitudes higher than 2000m asl in alpine regions are in general quite low, but they are interesting, as the efficiency of solar modules increases because the energy yield improves in the cold. This is an additional reason to generate solar energy in such an environment.

The Stäubli PV connectors can operate as low as -40 °C, as the certifications by TÜV Rheinland and UL confirm. Furthermore, extreme heat isn't an issue for the connectors either. The Original MC4 cable

Building integrated PV installation at alpine resort Monte Rosa in Zermatt/Switzerland at 2883 m. asl

coupler portfolio has been designed for use in areas with high ambient temperatures.

Guido Volberg explains: 'After a change in the official PV module IEC standard and the adaptation of the IEC TS 63126, this aspect can now be categorized. So now, the PV modules inclusive of their components must meet the additional requirements of IEC TS 63126 when used in temperatures higher than 70°C (98th percentile operating temperature).

'There are two different levels used; one with an upper limit temperature of 95°C where the PV connectors can be mounted to level 1 modules. This means a 98th percentile module operating temperature of up to 80°C.

'At the second upper limit temperature of 105°C, the connectors can even be connected to level 2 PV modules where we face a 98th percentile module operating temperature of up to 90°C. Here as well, TÜV Rheinland has verified that our connectors are suitable for use on level 2 PV modules.

'To conclude, this means that the Original MC4 and the MC4 Evo-2 connectors can be used both at high altitudes, such as the Alps or the Andes, but also in hot areas like deserts.'

The floating PV

Another special environment for PV connectors regarding technical resistance is floating PV systems, a market that has developed rapidly, too. For several years PV plants have been installed on inland seas, near-shore areas, or even off-shore in the open sea.

Water surfaces like seas, reservoirs, or lagoons make it possible to devote larger areas to energy production even when land is scarce. These plants are also more efficient than traditional systems, thanks to water cooling and the additional sunlight that is reflected off the surface of the water.

The Stäubli PV product portfolio is resistant to water in accordance with IEC 60529 of IP 68 (1m/168h). This means that

Solar power plant in the Atacama Desert, Chile at altitudes from 2.500 m up to 5.000 m asl

they have a degree of protection against the ingress of solid foreign objects and water, as lately been re-confirmed by TÜV Rheinland.

The connectors are successfully tested for situations where they would lie in a water depth of 1m for a period of seven days without water penetration. This characteristic is relevant, for example, when modules would be pressed underwater for a few days by a high load of snow.

In coastal areas, the humidity and above all the saltiness of the air are challenging the material of PV systems. Moisture can cause corrosion and a risk of reduced efficiency or electrical shortcuts resulting in costly repairs or downtimes. The Stäubli MC4 PV connector portfolio is also tested and approved according to IEC 61701, which means they resist salt mist.

The agriphotovoltaics

The dual use of land for photovoltaic power generation and agriculture, known as Agri-PV or agriphotovoltaics, also helps in areas with land shortages. There are various combinations as, for example, installations on animal sheds or greenhouses with PV modules as roofs.

Additionally, outdoor PV installations can be used as shelter to mitigate stress on plants that may be caused by strong wind or provide shading to protect against high temperatures and UV damage.

Guido Volberg outlines: 'The distinctive specifications for the PV systems in Agri-PV are, besides higher temperatures, the humidity in greenhouses or the influence of possible chemicals. This is an area that Stäubli is investigating, in close cooperation with international standardization bodies.

'Furthermore, there is a requirement for increased resistance to ammonia for rooftop installations on animals' stables. The Stäubli PV connectors meet this requirement as likewise certified by TÜV Rheinland.'

Overall, the challenge for PV systems in harsh settings is to select and install high-quality components that are specifically designed to withstand environmental conditions.

Proper installation techniques and regular maintenance are also important, to ensure that the electrical connections remain secure and reliable over the lifespan of the PV plant.

While the PV industry is growing at high speed, the applications are becoming more diverse and so are the requirements for the technical components. Stäubli has always had safety in mind when designing its product solutions.

The reliability, high performance, and solid return of solar power plants are part of the foundation for the successful energy shift.

The company remains committed to investing in a safe PV industry and to keeping up with the innovation pace needed in the renewable energy market.

www.staubli-renewable-energy.com

AlpinSolar photovoltaic plant in the Swiss Alps at 2'446 m asl operated by Swiss energy service providers

Guido Volberg has been working in the photovoltaic industry for more than 25 years.

After graduating in electrical and electronic engineering he started his career with the international standardization organization TÜV Rheinland in Cologne.

Through his work at TÜV Rheinland and his role as Head of the Global Competence Centers for PV modules and PV components, he has been an active member of various committees to define national and international standards that ensure safe PV installations and operations.

For his exceptional contribution in development of IEC standards he has been presented with the 'IEC 1906 Award'.

A proven expert in his field, he joined PV connector market leader Stäubli Electrical Connectors as Senior Consultant Product Regulatory Affairs and is supporting the Renewable Energy business to improve safety in the PV industry.