Extreme Engineering for Extreme Conditions

10 MW PV Plant at Masdar City
(Inverters: Sunny Central 560HE)

Intensive Testing is Key to High Performance and Reliable Operation

Earth's sunbelt offers unparalleled opportunities for development of photovoltaic technologies

Ample space, extremely high solar irradiation, large areas without reliable energy sources – desert-like regions in the earth's sunbelt offer interesting opportunities for solar power plants. But desert locations also come with huge challenges. Extreme climate conditions make for high demands on solar technologies. Entirely new concepts are needed in order for advanced technology to help reduce the risks of extreme climate conditions. The following examples will help illustrate this principle.

The inverter is the most vital component of any photovoltaic system, converting DC electricity generated by panels into usable AC power.

All components, especially the interior of the inverters, need to be securely sealed to protect them against the damaging effects of sand and dust.

In these locations temperature extremes are coupled with significantly higher inverter loads. The output can quickly double, making components of the highest quality the most important factor for extending the lifetime of the entire installation.

SMA is addressing these challenges through advanced research and development to find solutions for these problems with a broad-based research project that aims to optimize large power stations in sunbelt regions and with innovations such as the SMA OptiCool™ system for high temperatures. SMA engages in increasingly demanding quality tests that simulate the most extreme conditions.

Energy from desert-based solar power stations is a market with considerable potential. As a technology and innovation pioneer, SMA is leading the field and meeting the challenges of these regions.

SMA Quality Tests

All devices subjected to regular stress tests for extreme environmental conditions

Dust, maritime air, sandstorms, heat – these are the kinds of extreme environmental conditions that central inverters can be exposed to, depending on location. Open-air equipment in particular, like the Sunny Central CP series, has to withstand the worst kinds of climate conditions, from desert storms to enormous temperature swings.

SMA regularly conducts demanding stress tests to make sure that the quality of our equipment lives up to their promise. The tests simulate potential climatic scenarios, often times making them even more extreme than is actually encountered in the field. The results are then used to provide definitive statements about inverter performance in a wide variety of environmental conditions, recommendations for optimized installation, and directions for the development of new products to be used in chemically aggressive environments.

Desert-Proof

Sunny Central tested against sand and dust

In addition to extreme fluctuations in temperature, desert locations have another characteristic that directly impacts all the components of a central inverter. Very fine sand can penetrate the smallest openings and settle on sensitive electronics, which puts the operation and life expectancy of the entire PV installation at risk.

The Sunny Central CP integrated OptiCool system eliminates this problem – as proven by SMA's sand and dust tests that simulate desert conditions. A Sunny Central unit was recently sent to an independent testing facility and subjected over an extended length of time to fine dust particles. The facility used pulverized roof tiles whose composition was found to be similar to the sand found in the Arizona desert.

Dust and sand were blown horizontally directly at the unit with wind velocities between 1.5 and 20 meters per second. During the experiment, the ventilators took in and circulated air, as is normal with the OptiCool system.

The test showed that although the exterior of the unit and its seals were covered in dust, none had found its way to the interior. The same was true for the ventilators which, when taken out, were completely dust free. OptiCool's encapsulated design securely protected the units and their electronic components. This is a significant advantage when it comes to functional security, life expectancy and durability.

From One Extreme to Another

SMA inverters in the climate chamber test

In locations like Africa, Asia or North America, inverters are often subjected to extreme temperatures, sometimes combined with high humidity. This results in components under great stress, performance variations, and a high risk of failure, which is why SMA requires all its inverters to pass a climate stress test before going into serial production.

SMA has its own state-of-the-art test center for solar technology where inverters are pushed to the limits of their operational capabilities in temperatures ranging from -40 °C to +90 °C.

The chamber can also create relative humidity of between 10 percent and 95 percent. The inverters are subjected to these kinds of conditions in tests lasting up to 1,000 hours under constant conditions.

The climate chamber test is not only a reliable predictor of the components' durability. It also provides extremely precise values regarding the performance and energy conversion of each Sunny Central, providing engineers with exceptional confidence in the devices' efficiency and reliability.

Experience Meets Expertise: SMA's Design for High Altitudes

Special high-altitude design for Sunny Central CP sets new standards for durability and security

1 MW, Wildkogel, Austria:
Highest PV power plant in Europe at 2,200 m altitude (Inverters: Sunny Mini Central 11000TL)

Some geographic locations, such as altitudes above 2,000 meters, are characterized by challenging atmospheric parameters. Guaranteeing the functionality of PV inverters at these heights requires an especially high level of experience and expertise in solar technology. This is because the added stress on components is highly complex. So is the solution. SMA has developed a number of special design features for the Sunny Central CP series that make these units extremely durable and robust at altitudes greater than 2,000 meters – features that guarantee fully functional security.

For open-air installations at high altitudes in locations such as India or South America, low air pressure has a negative effect on cooling. This is counteracted by the lower temperatures found at higher altitudes. On the other hand, the dielectric strength of air decreases with altitude. The dimensioning and peak voltage of the Sunny Central CP units are designed to compensate for this.

Maximal current and initial output have to be reduced at altitudes above 2,000 meters. Above this threshold, all control voltage circuits are hardened for altitudes up to 4,000 meters and the inverters would then also be designed with a modified DC window. The higher the elevation, the more robust the design – this is the principle that guides the complex model for the Sunny Central CP series at extreme altitudes. This is how SMA can provide PV inverters for all climate conditions, without exception, resulting in another pioneering achievement in the development of solar technology.

When Nominal Power Exceeds All Expectations

Sunny Central CP and HE at their best in ambient temperatures up to 50° C

The demands on solar technology today are enormous, and they keep growing. Operators of utility-scale PV power plants expect significantly reduced, competitive costs of energy. This is possible only if they can offer high availability, minimal system costs, peak efficiency and maximum power. This means that the quality of each individual component has to be well above the norm. And as the heart of every PV system, inverters are expected to provide outstanding performance and outstanding energy yields.

SMA Sunny Central inverters have always been known for providing high power outputs such as producing full nominal power at ambient temperatures up to 50 °C. This record is now being broken by the Sunny Central CP and Sunny Central HE series. In addition to full power at 50 °C, both can deliver 110 percent rated power in continuous operation at ambient temperatures up to 25 °C.

Whether for the outdoor- (CP) or indoor-rated (HE) inverters, SMA offers peak performance at low lifetime system costs. High-tech functionalities such as comprehensive grid management and intelligent power control are critical advantages for plant operators but the greatest advantage is the enormous output: 10 percent overload capability at low temperatures means that considerably more modules can be connected. And with an efficiency of 98.5 percent, combined with a highly productive life cycle, the Sunny Central CP and Sunny Central HE series are at the very top of their class.

With more than 800 high power projects totaling in excess of 4 GW inverter capacity worldwide in 2010, SMA leads the utility-scale market.