Critical requirements for PV cabling in the emerging global market

Cabling | Cable manufacturers are well placed to capitalise on solar's rapid global growth. However, to successfully exploit this continuing development, it is important to understand where growth is focused, why it is focused in these areas and the environmental and legislative challenges that it creates, writes Mark Froggatt

Solar's global growth offers opportunities to cable suppliers

The global market for solar PV energy systems is growing rapidly and, as all solar projects require extensive levels of cabling, represents a considerable opportunity for cable manufacturers. In order to gain a competitive advantage in this market, cable manufacturers must understand which parts of the world are generating the highest demand and develop cable products that meet all the relevant regulations within these locations. Understanding how PV cables perform in comparison to Low Voltage (LV) cables is essential for those seeking to develop products for the PV market, as the applications and conditions these products are specified for will create different requirements. In addition, developing an understanding of the standards to which PV cable products must be approved is of vital importance for manufacturers as the requirements of each standard may render them unsuitable for projects or applications within a specific region. In the case of IEC 62930 and BS EN 50618, these standards vary in their approach to testing and the range of cable products they test for, which means that cable manufacturers should develop their product ranges accordingly.

This paper will discuss the critical requirements of PV cable products, provide guidance on the applicable standards for testing PV cables and examine how manufacturers can produce cable products suitable for this demand, against a backdrop of the emerging global solar market.

Why the solar energy industry is growing?

The solar industry today owes the rapidity of its growth to multiple factors, rather than to one single reason. Fossil fuel pricing is expected to continue to rise over time, so future-proofing – by reducing dependence on such fuels – makes sound economic sense. Of equal importance is the pressure that commercial organisations come under to meet their environmental obligations and build a sustainable, green energy policy. This pressure comes not only from shareholders, employees and trading partners, but also from government and related bodies in the form of mandatory legislation.

Accordingly, the major energy market players are leading the way with large-scale renewable energy projects; household names including Amazon, Apple, BBC, Ikea and Unilever have all invested in major schemes.

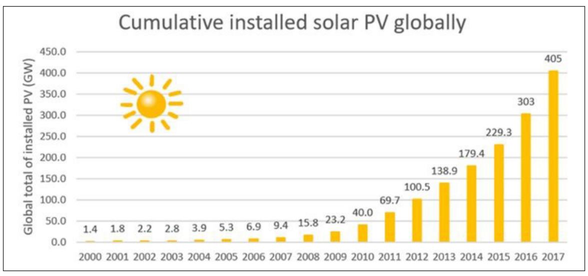
However, governments and individual consumers, as well as many other international businesses, have also contributed to driving the demand for solar energy. This need for solar energy output has been met by a reported steady growth of installed solar energy systems.

Schemes based on renewable energy sources, including solar power, are also providing valuable solutions for remote and developing locations. Providing self-sufficient, renewable energy to rural communities in the developing world helps populations to work their way out of poverty with an ability to power their homes, schools, hospitals, stores and industries.

Overall, the latest figures indicate that the global installed capacity for solar photovoltaic (PV) systems exceeded 400 GW in 2017 (as shown in Figure 1).

These factors are contributing to plenty of business growth opportunities globally. In January 2018, GTM Research reported that 53 countries had set up tendering and auction programmes allowing the supply chain to bid for opportunities to support upcoming solar projects. The research also

Figure 1. Cumulative global growth of solar PV installations. Source: SolarPower Europe



found that an additional 29 countries were planning to set up these programmes to recruit the best suppliers to fulfil their project specifications and requirements.

This statement is also reflected in figures released by the International Renewable Energy Agency (IRENA) relating to employment in the renewable energy sector. In 2017, this reached 10.3 million worldwide. The solar PV industry accounted for close to 3.4 million of those jobs and was highlighted as the largest employer of all renewable energy technologies.

What role do cables play, and what are their critical requirements?

Cables are essential to the transmission of the power generated by the solar panels. Whether they are installed indoors or outdoors, each application will call for greater emphasis on different characteristics for performance, which impacts on material requirements.

Figure 2 shows a simple domestic PV system, but the same principles equally apply to larger installations. Note in particular the use of DC cabling to interconnect the modules to one another, and to the inverter that converts their DC output to a usable AC supply. While the AC cables downstream of the inverter are usually within a building's indoor, protected environment, the DC cables are typically outside, where they are exposed to environmental stresses and, potentially, human interference.

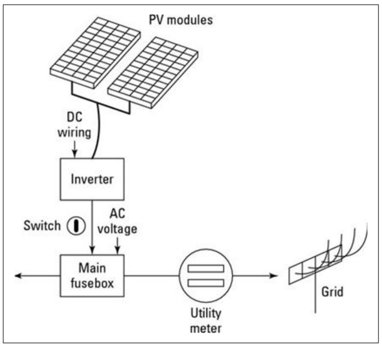


Figure 2. Simple PV system block diagram

While the technical and legislative challenges associated with overcoming these issues are significant, the opportunities they represent to those cable manufacturers that can overcome them are correspondingly impressive.

How are PV cables different to LV cables?

When a PV system is installed, both low voltage (LV) and PV cables may be specified. As these cables are designed for different applications, the performance characteristics may also differ. For example, while LV cables are suitable for indoor use and in conditions where they are protected from the elements, they are typically unsuitable for outdoor applications. An exception to the rule would be when a cable is buried, as PV cables are not designed for applications where this is a requirement. PV cables, however, are suitable for installation in trays, in applications where the cable used does not touch the ground. This can be particularly useful if rodents are a problem in the environments in which the cable is being used.

PV cabling must be able to withstand harsh conditions, for example found in the desert

LV and PV cable products also differ in the maximum temperatures in which they should be operating. This aspect should be considered at specification stage when determining if the product selected will be suitable for the specific application. Under the IEC 62930 and BS EN 50618 standards, LV cable products only need to operate continuously at temperatures of up to 90 degrees, whereas PV cable products need to be able to operate at a temperature of up to 120 degrees to ensure continued functionality if, in operation during their lifecycle, they were to reach this temperature. Ozone resistance is also mandatory for PV cables, although it is not usually required for LV cables. While LV and PV cables may perform the same essential functions of power transmission, the response to environmental conditions will be different based upon how the cable has been designed.

Which regulations apply to PV cables?

PV cable technology is still relatively new, which means that most applications will follow established international standards to ensure cable products meet high levels of quality and safety.

The industry standard warranty period provided by solar panel manufacturers is 25 years. As a result, this is sometimes also recommended as the lifecycle for solar cables. However, a set time indicative of how long a cable will last cannot be accurately given without understanding the operating temperatures and conditions. The results from a thermal endurance test, as specified in PV standards, can be used to predict life expectancy of cable products.

The location of solar projects necessitates longevity and low maintenance, particularly in the remote applications in which they are used. As such, the solar industry is heavily regulated to ensure products will be reliable and fit for purpose. As a minimum requirement, products must meet building regulations for the region in which they are being installed.

Simply performing a thermal endurance test on a PV cable product does not guarantee it will meet the required levels of quality and safety. However, independent testing and approval of products provides specifiers and end users with confidence through evidenced compliance to the applicable standards.

Following discussions with a number of firms involved in solar technology,

Abrasion resistance	Ozone resistance
Flame retardance	Proofed against chemical stresses – acids and alkalis
Halogen-free (where appropriate)	UV resistance
Humidity and water resistance	Withstanding large temperature ranges (-40°C to 90°C)
Low smoke emission	Withstanding mechanical stress: compression, tension, bending and shear load

Table 1. Attributes for which DC cabling should be tested, according to industry standards

standards have been developed which recommend the list of features shown in Table 1 that DC cables should be tested for, to maximise the potential opportunity.

A declaration from cable manufacturers that their cabling has undergone their own in-house testing is not enough – they must be able to prove to the industry that their solar products have met the pass requirements related to each of the specific tests involved in verifying the above product features. Using a testing and certification partner provides reassurance that operators and stakeholders require.

Using inappropriate cable shortens a project's lifespan and many solar projects are being supported by local governments and, as such, can be accountable to public stakeholders for the return on financial investment.

While some certification bodies have developed their own standards for testing PV cable products, the main standards recognised internationally and specifically relevant to solar cable products used in DC apparatus are IEC 62930: ed 1.0:2017 and BS EN 50618:2014.

EN 50618 only applies to cable products that use flexible tin-coated copper conductors with a single core and cross-linked insulation and sheath produced with low smoke, halogen free (LSHF) materials, while IEC 62930 has extended this scope to cover single-core cross-linked insulated power cable products manufactured with or without LSHF materials. Both standards set out exacting requirements for testing PV cable products in reflection of the challenging conditions the cable products will be specified for.

While these standards have similar critical requirements, there are significant differences in the materials permitted and the range of the conductor size that can be tested, which we will discuss in the next section.

How can I produce cables that meet solar PV system requirements?

At a technical level, innovations in compounds and extrusion technology are now available to help cable manufacturers meet the solar industry's unique specifications. Many cable manufacturers are working closely with project specifiers to manufacture cables that meet the design and local manufacturing standards' requirements.

In order to produce cable products that will meet solar PV system requirements, cable products should be designed to meet the requirements of IEC 62930: ed 1.0:2017 and BS EN 50618:2014. These specific requirements will now be explored in more detail, where each standard's emphasis on the use of some materials over others differs.

The first requirement is for cable products that are used with Class II equipment. Defined in IEC 61140 as equipment with double insulation that does not require a safety connection to the electrical earth, Class II equipment typically applies to appliances including televisions, DVD players and power tools. BS EN 50618 is suitable for testing these types of cable products; however, IEC 62930 does not make provision for this. Any appliances using PV cable products with Class II equipment should therefore be tested to BS EN 50618.

A further consideration when seeking to understand specific characteristics and the different emphasis each standard places on them is the size of the cable conductor. Where BS EN 50618 only specifies a conductor size range of between 1.5 and 240m², IEC 62930 allows for a wider range of 1.5 and 400m². It is worth noting that even if a cable product has a large diameter, the conductor size may be small due to being surrounded by insulation, bedding and wire armour. The decision as to which standard cable products should be tested to, therefore, should not only be based on conductor size alone.

Solar cable installation

The main difference between the standards is the materials permitted for testing, as BS EN 50618 only permits testing of cable products manufactured with LSHF materials. These types of cable products are designed to give off low emissions of smoke and corrosive gas when they come into contact with fire. They are often specified for public buildings as they reduce the risk posed to public safety, in the event of an emergency. By comparison, IEC 62930 permits materials with or without LSHF materials to be tested, including PVC cable products. While this material gives off thick smoke and toxic fumes when burned, PVC, or a modified form of PVC, may be more appropriate for customer requirements. For example, PVC cable products may be better suited to carry power from solar panels to a water treatment facility, as they provide greater chemical resistance than their LSHF counterparts to the chemicals used in the water treatment.

Thermal endurance testing is mandatory as part of IEC 62930 and BS EN 50618. This test is designed to determine a cable's lifetime and involves testing any PV cable product up to 120°C for 20,000 hours, to simulate how the product will perform in operation. When these standards were initially being developed, the thermal endurance test generated some controversy as its main measure is to demonstrate how long the cable will operate for before it reaches the defined threshold; all within controlled conditions. As many PV cable products are usually installed in extreme conditions, the results of this test may be less conclusive than more established tests such as the hot pressure test, which is used to check that sheathing and insulation materials are resistant to indentation at elevated temperatures. Nevertheless, submitting cable products for a thermal endurance test can further aid in evidencing cable quality.

While cable products may be successful in passing a thermal endurance test, consideration should also be given to how other characteristics will be impacted by the conditions they are operating in. For example, solar panels are often installed in coastal or desert locations where the temperature may rapidly drop, which could cause cables to crack or bend as


Electrical engineer inspecting photovoltaic cables connected to solar panels

temperatures drop below those in which the cable products have been designed to operate. If cable products have been produced using poor-quality materials, they may absorb significant amounts of moisture, dulling the performance of the cable products by reducing the current they can carry. These examples demonstrate the need for PV cables to be suitably tested for performance across a wide range of characteristics to verify quality and suitability for installation in the specified conditions.

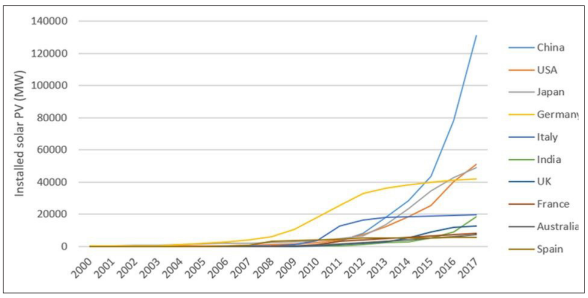
How is demand distributed globally?

As early adopters of solar PV systems, Germany was recognised as a leader in solar installations for a decade up until 2015, after which it was overtaken by China (see Figure 3). China's solar installation started to take off sharply in 2012, and in 2017 their newly installed base totalled significantly more solar capacity than the past top nine leading countries combined. Relative newcomers Japan and the USA have also overtaken Germany and have been tracking at a higher rate of installation. The data demonstrates that the race to produce renewable energy-driven initiatives, is truly a global one. It is therefore essential that specifiers, buyers, cable distributors and manufacturers take note to use product that is compliant with the international and local standards, to ensure that the product supplied is commercially fit for purpose.

Cable manufacturers looking to break into the solar market should carefully consider the end-user requirements when designing their cables, as the standards used to verify cable quality are specific to different types of materials. As mentioned above, BS EN 50618 is only applicable to LSHF cable products, while IEC 62930 permits materials that are not produced using these materials, which could provide a manufacturer with an indication of which of their existing product variants may be best suited to specific markets. Depending on the specification that cable products need to meet and which of the standards are favoured in the market, this should inform design and production decisions.

For example, if buildings in the selected market have a high fire risk or cable products will be installed in enclosed spaces, LSHF cable products should be used to minimise the risk of building inhabitants being exposed to toxic fumes and gases during a fire. However, if cable products are designed to be used on the exterior of a building, as many PV cable products are, this would create different requirements for the cable product. In this case, PVC may be deemed a more suitable material to use as it demonstrates greater abrasion resistance and durability than its LSHF counterpart.

Figure 3. Cumulative installed solar PV, top 10 countries, 2000-2017. Source: SolarPower Europe

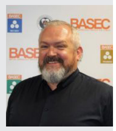


Conclusion

This article has shown how multiple factors are contributing to the solar PV market's rapid growth. Over time, and as knowledge is rapidly developing, we are seeing a vast improvement in the quality and performance of the cables used in the solar industry. In years gone by these aspects have not fared as well as anticipated, therefore as the industry continually grows, we can also expect to see the technologies used to manufacture cables advance, to ensure reliable product enters the market. This growth is creating a healthy demand for external DC cabling, and a great opportunity for cable manufacturers that can overcome the challenges associated with meeting the market's requirements. These manufacturers can obtain a competitive edge in this process by working with BASEC to gain independent product certification and approvals to demonstrate that the products supplied into the market are compliant with all of the necessary regulations.

The potential rewards for cable manufacturers who make this investment are considerable; as Walid Halty (Dvinci Energy, Forbes, May 2018) comments: "Today, Solar is the #1 most bankable sustainable technology, which has turned the industry into a gold rush." ■

Author



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