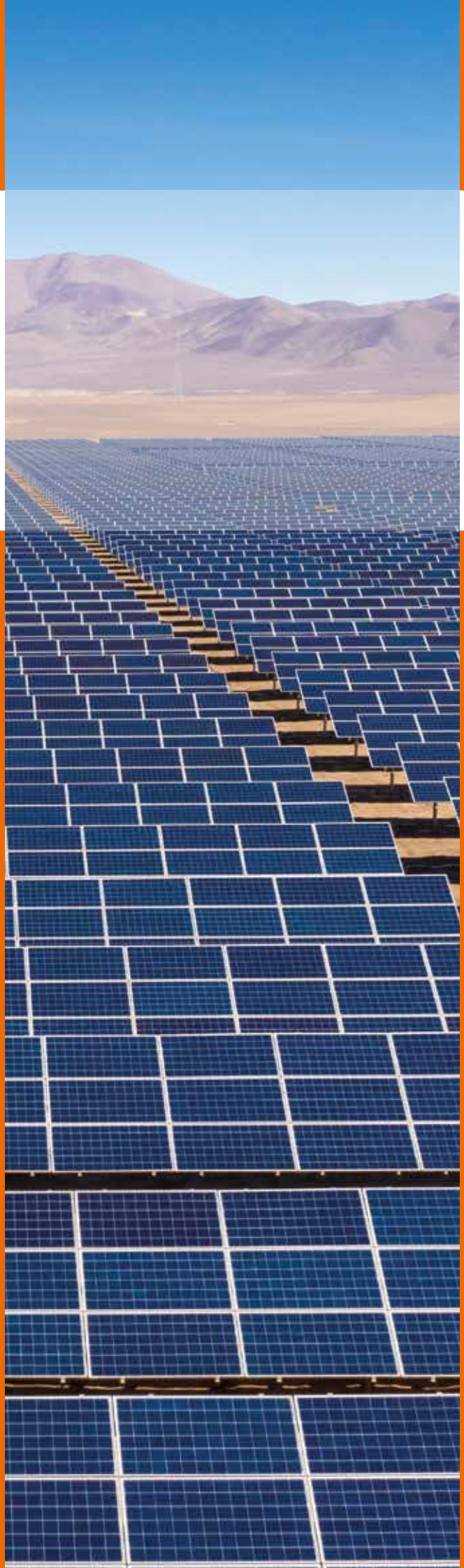
BASEC
BRITISH APPROVALS SERVICE FOR CABLES

Solar Cable Testing

WORLDWIDE CABLE EXPERTS

Your guide to Solar Photovoltaic cable testing and certification



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Contents

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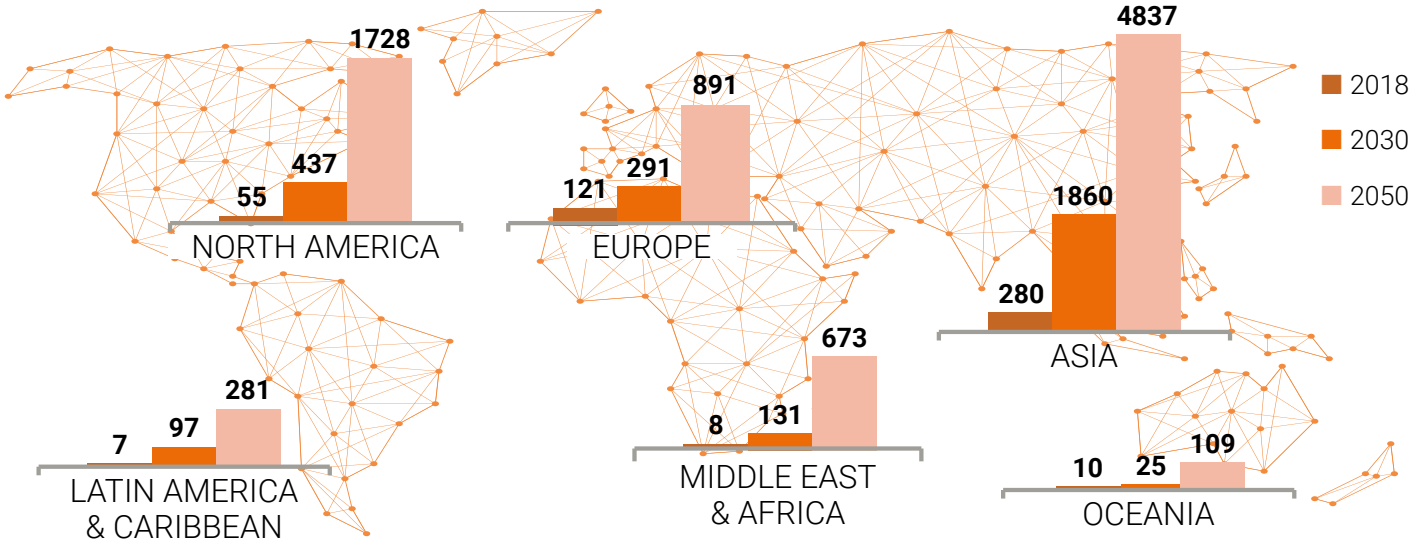
Introduction to solar

Renewable energies are at the forefront of a sustainable power supply. Solar is the world's fastest growing energy technology, and ambitious growth projections continue to be highlighted as key targets for all major regions around the globe.

Solar photovoltaic systems are made up of a system of equipment and technology, which has seen significant refinement since they were first invented as a potential energy source. It was only in the 2000s that a substantial impact and momentum started to gather, which identified solar as one of the most reliable alternatives to conventional power sources such as coal, oil and gas.



Data source: IRENA

Installed solar and future growth capacity (GW)

Renewable energy sources have been deployed at a rapid and growing rates over recent years. The growth has been phenomenal, in that it has reached record levels and, is set to exceed the annual capacities generated by traditional sources, as mentioned above. This trend is common across all major regions worldwide.

As such, solar PV installations have been dominating the renewable technology sector, so much so that in 2018 global capacity of grid-connected Solar PV totalled 480 GW, which represents over 20% growth on 2017's 386 GW. Since the early 2000s the compounded annual growth is even more impressive, currently sitting at 43%.

Introduction

How solar works

The sun's energy is captured by the solar panel and turned into electricity. Energy emitted from the sun is known as photons. Photons travel to the earth in around 8.5 minutes from a distance of 93 million miles. PV panels collect the photons radiated from the sun, the panels of course are central to converting the energy into electricity.

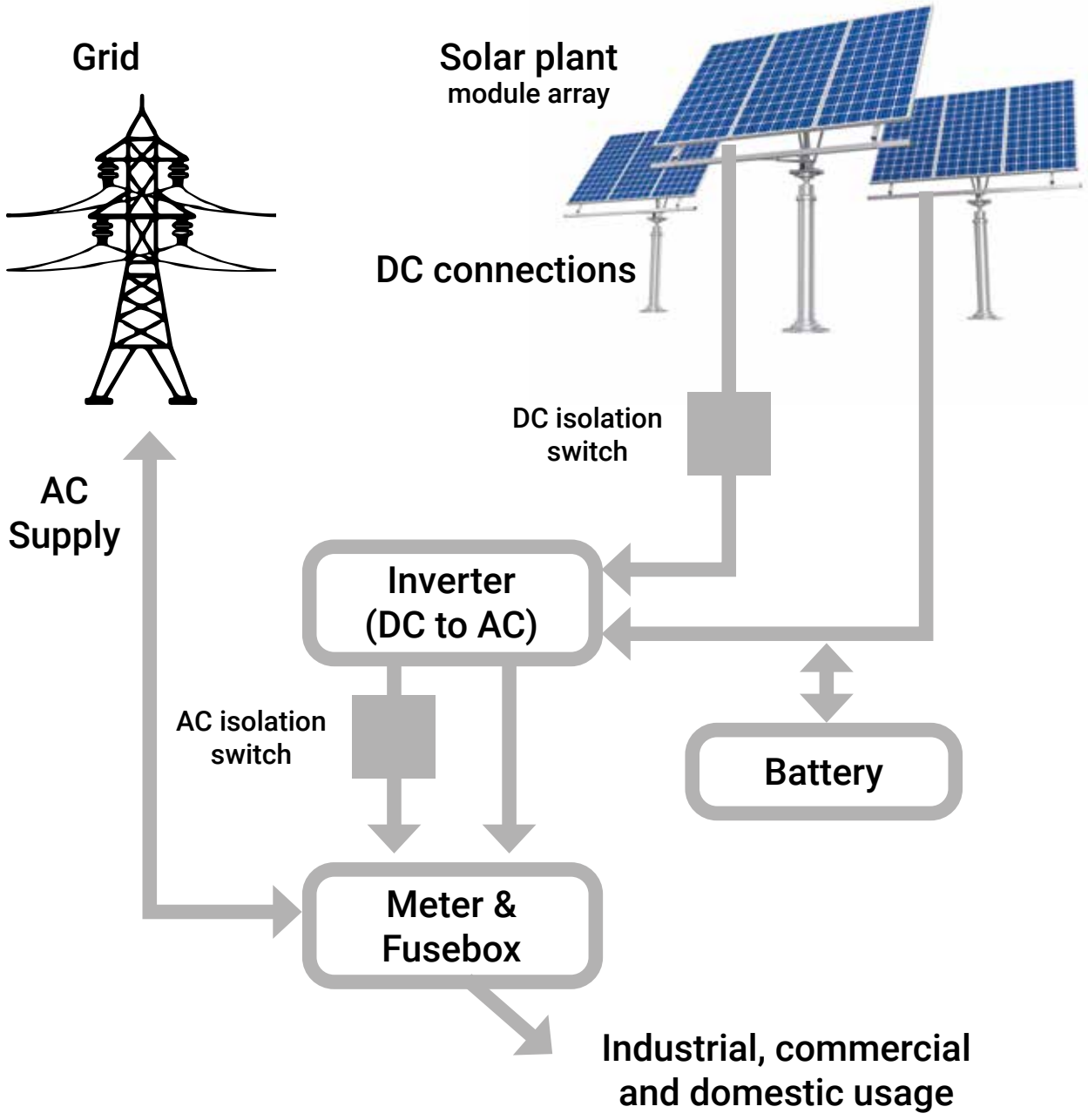
Solar cables are used to interconnect PV panels. The circuit includes an inverter which plays the role of converting direct current (DC) to alternating current (AC).

Solar cable is a DC cable with rated voltage of 1.5 kV DC, the conductor is tin coated copper with cross linked insulation and sheath.

As a vital component in the solar system, the DC cabling structure must meet the required quality levels otherwise plant owners risk impacting their operational efficiency. Failing to meet recognised industry standards sits at the heart of this. The use of poor quality, or non-approved cable could lead to decreased conversion efficiency, further impacting the plant's ability to generate planned production outputs.

Introduction

The solar connection



Cables, supporting equipment, systems and auxiliaries are central to the transportation of energy generated at any power station. Delivering it to the end application.

If all of equipment is compliant, then the glue that connects your system together: the cabling should also adhere to the internationally recognised standards to prove quality.

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Standards

In-depth cable testing

> *BASEC provoides certifications and approvals to all global cable standards*

There are two cable specific standards available that the industry must comply to, including:

EN 50618

This European standard is most established in the market and applies to all low smoke halogen-free, flexible, single-core power cables with crosslinked insulation and sheath. The standard is relevant to cables installed for use at the direct current side of photovoltaic system, where there is a nominal direct current voltage of 1,5 kV between conductors and between conductor and earth. Typically cables which comply to this standard are suitable for use with Class II equipment.

IEC 62930

This International standard was issued in 2017. It is applicable to single-core cross-linked insulated power cables with cross-linked sheath. Cables approved to this standard are also often used at the direct current side of photovoltaic systems, with a rated direct current voltage up to 1,5 kV between conductors and between conductor and earth. The standard includes low smoke halogen-free cables and any other cable products that can contain halogens. Again, products compliant with this standard are suitable for use with Class II equipment, defined in IEC 61140.

The IEC standard is however significantly more flexible, in that it can be applied to a broader range of cable products as it offers:

- A class 2 conduction option
- Extended size ranges up to 400m²
- Multi-core options
- Assessment of halogen free and halogen containing
- Increased storage temperature up to +45°C
- International recognition and easier localisation

BASEC is working with cable manufacturers around the world to increase compliance to cable standards. The driving force central to solar cable product approvals is the demand and need to ensure that products are fit for purpose, and that they will deliver electricity with the highest efficiency in line with the essential requirements of consistency and reliability of the growing number of solar power operations.

Cable testing

Complete cable assessment

As with all recognised standards, for cable a collective standard is referenced for the approval, such as the two outlined above.

It is, however, the detail behind all of the other standards which come together to provide a holistic and representative assessment of the cable, as individually layered components, from the sheath to the conductors to all of the components in-between, to how that cable performs as a full product unit, which ultimately provides greater perspective on how the cable will perform in service.

Including the identification of early indicators of cable quality, which could in turn lead to a failure later down the line.

Thermal endurance properties

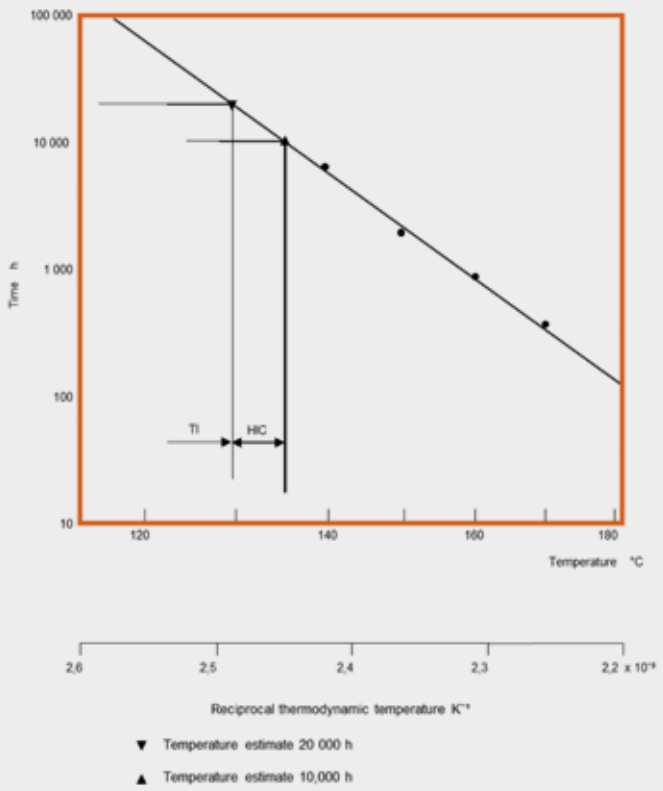
Due to the rapid development of polymer and insulation technologies the IEC / EN 60216 series were developed to assess thermal capabilities of the electrical insulation materials, used on cables, in order to understand service experiences. The series includes:

- ✔ IEC / EN 60216-1 – Ageing procedures and evaluation of tests
- ✔ IEC / EN 60216-2 – Determination of thermal endurance properties

Accelerated ageing tests are completed to provide an understanding of how the materials will perform in extreme operating conditions.

The rate of ageing is calculated through physico-chemical models, specifically through the Arrhenius equation. It is assumed there is a linear relationship between the reaction rate constant and the thermodynamic temperature; the time required to cause a predetermined property change and the temperature correlations. One key factor that should be considered is that deterioration, across all parts of the material being tested, may not take place simultaneously.

This test is conducted as a long-term assessment to provide adequate understanding of the insulation's lifetime performance.



Thermal endurance graph

Vertical flame propagation

The IEC / EN 60332-1-2 specifies the use of a 1 kW pre-mixed flame, which is used to test resistance to vertical flame propagation. Prior to testing the samples must be conditioned at a relative humidity value specific to the sample being tested.

As the burner is ignited the gas and air flow rates must also be adjusted meet the test parameters. The timing of flame application to the sample is measured from a nominal of 60 to 480 seconds, this is in direct correlation to the overall diameter.

This test measures how far the charring spreads from the flame application up the cable sample itself, to the nearest millimetre. In a controlled test environment, this test provides an indicator of how the cable may perform if it were to catch fire.

Weathering & ultraviolet resistance

Due to the very nature of how solar power systems operate, the systems are subject to hours of outdoor weathering and ultraviolet light exposure. It is with these environmental factors in mind, why the solar standards require assessment of how resistant and durable cables are when subjected to these conditions.

The testing undertaken is designed to assess the sheathing material's UV stability, in the condition as manufactured. A sample of the sheathing material is placed in a high-pressure ultraviolet chamber on a rotating platform for 720 hours, simulating accelerated conditions. The humidity and temperature can also be adjusted depending on the test requirements. Cable elongation at break in the condition as manufactured is measured first and again after exposure to the ultraviolet light and water. The results in turn provide an indication of how a cable will react in prolonged or extreme conditions. Typically, non-resistant materials will start to discolour, which is an early indicator signalling change in the cable's ability to perform and could lead to further damage or risk factors.

If you manufacture, supply or use cables that do not comply to a recognised solar photovoltaic cable standard, the effects of weathering coupled with exposure to consistently high temperatures will start to compromise the quality and integrity of the cable's electrical and mechanical properties.

In time, the insulation materials may harden due to the lack of resistance, becoming brittle and therefore causing the protective layers of insultation and sheathing to crack. This in turn would create exposed conductors, if they were to make contact with a surrounding metal component or another circuit a serious electrical flash-over could occur.

The volumes in which they are present forms a key indicator of their suitability for the end environment. The high presence of these gases in the insultation and sheath can be problematic in the event of a fire.

- The BS EN 50525-1 assesses the complete cable construction of low voltage energy cables applicable to both rigid and flexible products.

The standard also specifies design requirements in order that the cable is compatible, and that the requirements for marking, electrical, dimensional and mechanical properties.

Electrical voltage

Cables are responsible for the transfer of energy in solar photovoltaic systems, their safe and reliable operation therefore is key as the very nature of the systems is to produce, collect, in some cases store and successfully transfer energy to its end destination.

The BS EN 50395 specifically relates to low voltage energy cables. The standard includes a full range of tests to assess the cable's electrical design:

- Electrical resistance
- Voltage testing on complete cable
- Insulation resistance at 20°C and 90°C
- Long term resistance to DC
- Surface resistance of sheath

Should the electrical performance of the cables be poor to begin with or become compromised in service, this poses a significant impact and risk on the solar plant's ability to generate the planned production outputs

Gas and halogen assessments

The IEC / EN 60754 standard is comprised of two parts and is used to assess the **gases released** during combustion of materials in cables:

- 60754-1 is designed to determine the halogen acid gas content and is particularly important because it was developed as a result of concerns raised by cable users over the amount of acid gas released when insulating, sheathing and other materials catch fire.

  The acid gases can cause more damage to the surrounding systems and equipment as they are released into the local atmosphere, more so than the fire itself.

  All non-metallic cable components are burned so limits can be agreed for cable specifications. The actual material volumes are central to the testing as the complete cable is not assessed.

- 60754-2 is designed to determine acidity by pH measurement and conductivity and assesses the potential corrosivity of gases released during the combustion of materials, which is indicated in the pH value recorded. Conductivity of the gas is measured by submerging it into an aqueous solution, high conductivity signals the presence of ions which is often an indicator of a highly acidic gas properties.

  In extreme environments halogenated acid gases can contribute to risk of seriously harmful and unbearable conditions for those installing, commissioning or installing the systems.

- Linked closely to the EN IEC 60754, the **assessment of halogens** features in this standard where the pH and conductivity testing offers parameters that the test results must fall within in order to comply with the standard.

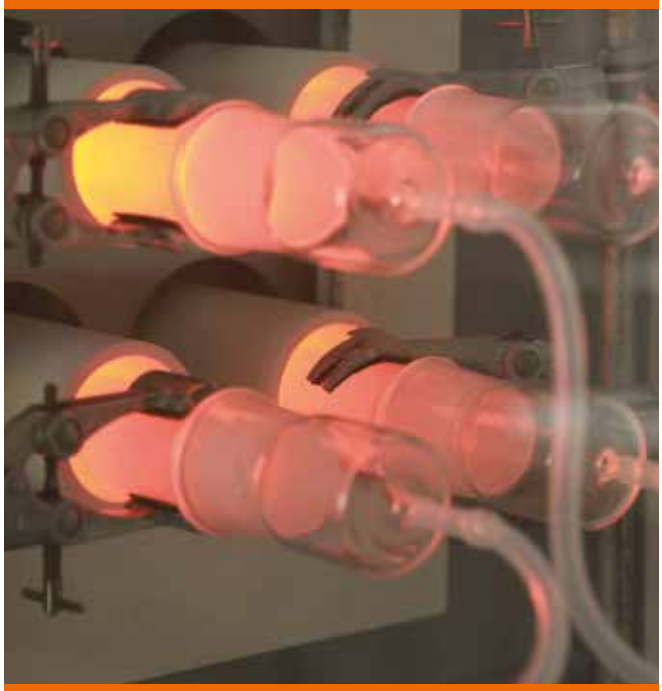
  The suite of related tests provides a measure of the levels of hydrochloric, bromine and fluorine acid gases.

Smoke emission assessments

- The IEC / EN 61034-2 measures **smoke density** of cables burning under defined conditions. This standard is particularly relevant to assessing visibility in and around areas where smoke is released into the air as a result of the cables igniting in a fire scenario.

  The measurement of smoke density is recording visibility of a light transmitter whilst the cable product is under flaming combustion and smouldering conditions.

Safeguard your solar operations with thoroughly tested, quality BASEC approved cable



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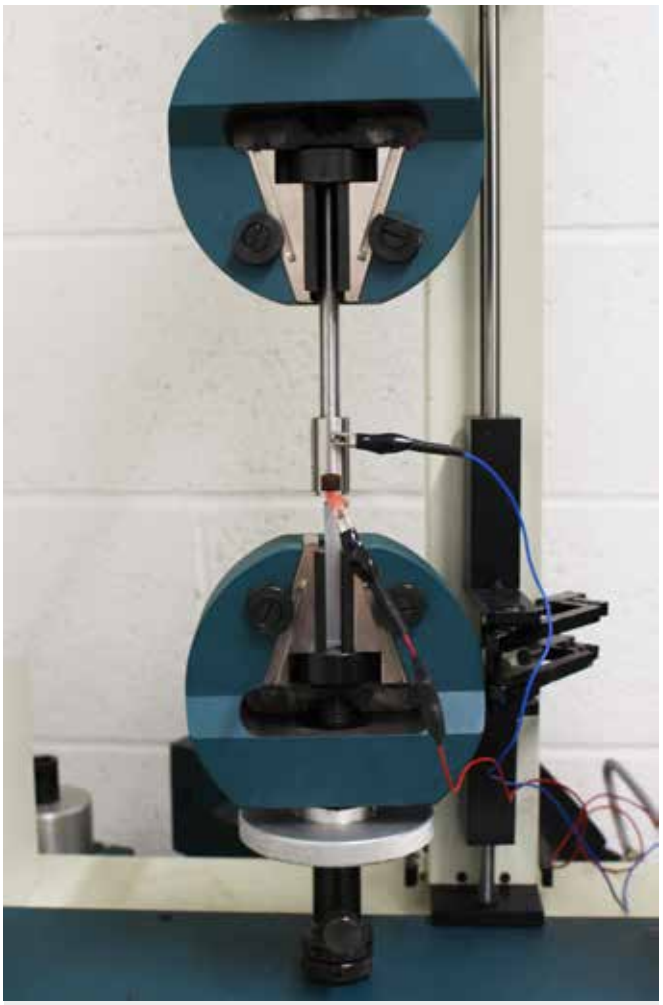
Cable testing

BASEC provoides certifications and approvals to all global cable standards



Ozone

Assesses a material's resistance to ozone degradation. The test methodology outlines that the samples must be subjected to circulating air, under controlled temperature and ozone concentration conditions. On visual inspection post testing, the sample should be free from cracks – this test can be performed as per IEC / EN 60811-403 or EN 50396.

Sheath resistance against acid & alkaline

Assesses a material's resistance to acid and alkaline degradation. The test methodology outlines that samples must be immersed in acid and alkaline solutions for 7 days within controlled temperatures. Then tensile strength should be measured to assess variation and impact of the acid and alkaline solution - IEC / EN 60811-404

Cold impact

Assesses the performance of cables at low temperatures. The sample to be tested is fixed in a low temperature chamber (−40 °C), methodology as per IEC / EN 60811-506.

The test parameters, including the hammer and steel intermediate piece masses and heights are specified in Annex C IEC 62930 and EN 50618.

The impact test is designed to ensure that in the event of a heavy object falling on the cable, that the cable will not become damaged and result in the materials cracking or breaking – IEC / EN 50618:506

Dynamic penetration

Is performed at room temperature and force is continuously applied at 1 N per second on a needle to measure how much force must be applied to the needle apparatus before it meets the conductor. A circuit of low voltage runs through the cable which is interrupted as soon as contact is made.

This test is designed to record how much force is needed to break through the insulation and expose the conductors – part of the IEC 62930 / EN 50618 standard

Non-metallic materials & components

Understanding the performance of materials such as polymers, plastics, rubbers, tapes, adhesives, which are used as part of design constructions or as fillers, is central to the assessment and certification of cables.

The following tests are used to measure and predict how the cable in question will perform over time:

Hot set tests

Mechanical hot set testing for cross-linked materials involves sections of the sample sheath or insultation material compounds to be placed in an oven with a weight attached. The test assesses the extent of material elongation and tensile strength to measure that the material has been adequately cross-linked.

Cross-linking is undertaken to create materials with specific properties, a mixture of compounds therefore can be combined which alters or creates a new chemical structure. If the degree of cross-linking is low, the material is more likely to stretch or shrink more and limit flow – IEC / EN 60811:507

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Product approval

Certification & reporting

BASEC certification is amongst the most rigorous in the world. As the cable experts, BASEC employs a team of specialists who apply their detailed technical knowledge to all aspects of the testing and certification processes.

Cable manufacturers of solar photovoltaic cables are partnering with BASEC more and more to obtain product approvals to evidence that their cables meet the industry standards.

In addition to the testing of cable samples, product certification includes in-depth product certification requirement (PCR) auditing of the manufacturers facilities, equipment, systems and processes. Auditing and product quality surveillance through sample testing is conducted several times a year, over a three-year product certification cycle.

Step 1
Planning & prepartion

Step 2
Initial audit & audit report issued

Step 3
Samples sent to BASEC for testing

Step 4
Certificates awarded

Step 5
Use the BASEC mark to differentiate

Step 6
Ongoing testing & surveillance audits

Manufacturers of BASEC approved product certifications are issued with a full report which outlines all of the testing outcomes and a product certificate which can be used to evidence cable quality and is publicly listed on the BASEC website to enable independent compliance.

End users of the cable can therefore check for the BASEC mark on the cable itself and download copies of the product certificate for use in their tendering applications and project documentation


Ensure your future is as bright as the solar industry's!
Contact BASEC to strengthen your impact with independent cable product certifications
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Product approval

Benefits of approved cable in solar

There is an increasing need for solar systems to be able to perform under extreme weather conditions and events. The International Renewable Energy Agency (IRENA) issued a report in 2019 which outlined arc faults as the common cause of fire-related incidents.

A cable arc fault is most often caused by damage, breakdown or contaminants in the dielectric (insulation). Generally an arc fault occurs when the voltage on the conductor is high enough to enable electrons (current) to flow across a surface, or to ionise the air which enables electrons to flow to a point of lower potential. These electric arcs are very hot, ranging from 3,000°C to 35,000°C and have frequently started fires.

The electrical current therefore jumps out of the cable through to air to another nearby conductor or in an arc to a grounded object. It is at the point where the current ionizes the surrounding air is what causes the arcing.

Electrical safety, material assessments and reliable performance of the complete cable design become central to addressing and minimising the risks of occurrence.

The report also highlights that the total generation value has potential, on a worldwide scale, of equating to over 13 trillion USD if it continues on the trajectory it has been on since 2016 through to 2050. Asia is set to feature as the largest region in terms of total installed capacity, as it is estimated to hold a share of more than 50% by 2050, followed by North America and Europe.

With industry demands and technology evolving at record speeds there is request from users for clear standardisation of cables. Not only will this ensure that the cables installed are compliant, safe and fit for purpose, but the adherence to standards will to drive consistency and support the ability to scale up to meet these ambitious production targets.

In demanding and using cables approved for solar applications you can safeguard your projects; in the same way that many of the wider solar photovoltaic systems components must comply to internationally recognised standards.

When quality matters.

About us

BASEC is the **expert in cable** certification, testing and the awarding of triple standard accredited management systems approvals: ISO 9001 for quality, ISO 14001 for environment and ISO 45001 for health & safety. Established in 1971, BASEC works in partnership with cable manufacturers around the world and their end users, as the preferred testing and certification provider.

To evidence the highest levels of quality and safety, BASEC delivers certification to industry recognised standards and specifications, including International IEC, European EN, British BS and local requirements. BASEC offers a range of services from **full certification** of single or full product ranges, to **one-off** and **type testing** of LV, MV and speciality cables. Recognised in both the UK via UKAS NB 2661 & Europe via INAB NB 2851, for accredited CPR fire testing.

BASEC supports you across all major sectors, including: construction & electrical installation, utilities, transportation: rail, power distribution, renewable energy: solar, nuclear, oil, gas and petrochemical, fire and security and infrastructure.

BASEC continues to invest in increased regional presence and laboratory equipment to support the industry faster and better. When quality matters, choose BASEC as your trusted partner.

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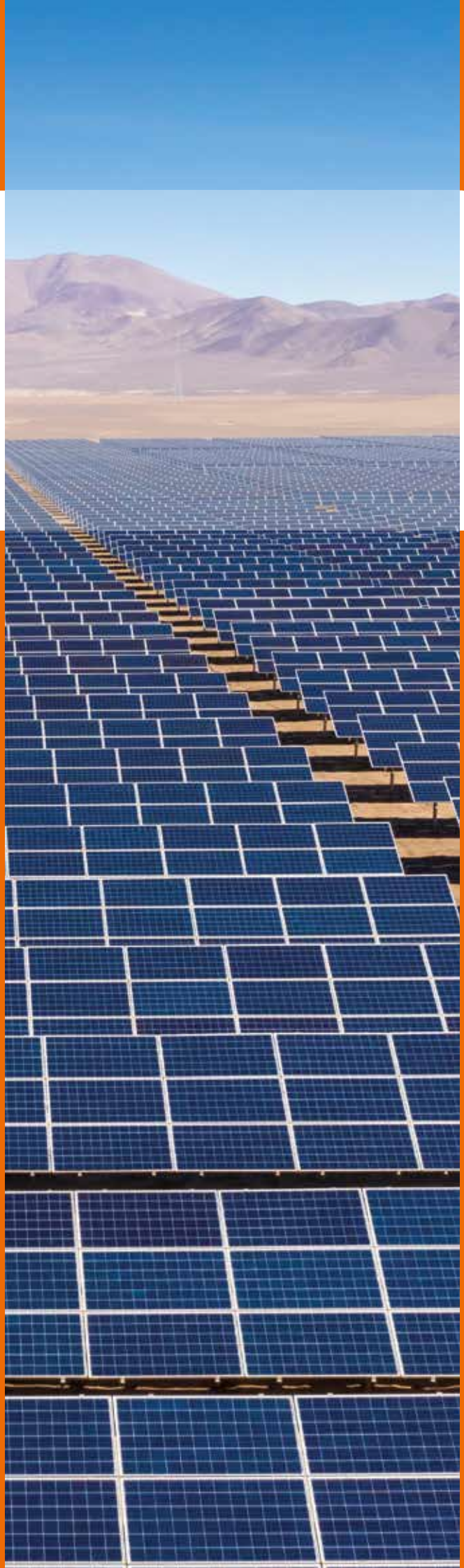

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