Решения по обеспечению качества для преобразования энергии Power & Energy в ветровых турбинах, газовых и паровых турбинах, в производстве энергии на основе водорода, в фотоэлектрических системах

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INDUSTRY SOLUTIONS

Quality Assurance for Energy Transformation

ZEISS Power & Energy Solutions

Wind energyGas & steam turbinesHydrogen powerPhotovoltaics

Quality solutions for the energy sector

The Power & Energy sector plays a crucial role in achieving a successful decarbonization strategy as part of the global energy transition. It enables a shift in the energy mix from fossil fuels to zero-emission energy and the required storage solution such as hydrogen. New technologies and processes must be developed in energy generation, storage, and infrastructure, which involves establishing new quality processes to meet manufacturers' specific needs and challenges of for example wind energy, photovoltaic systems, gas & steam turbines, electrolyzers, and energy storage. The broad product portfolio of ZEISS provides integrated hardware and software solutions to ensure consistent and high quality in energy generation, storage, and infrastructure.

Wind turbines

Discover ZEISS's high-precision metrology for bearings, gearbox housings, hubs, shafts, rotor blade forms and sections, as well as weld seam inspection of steel towers. Find out more about our advanced metrology solutions.

- **Gas & steam turbines**

  The smallest details matter from design to operation of a gas & steam power turbine. Investigate how ZEISS solutions support all industry standards.

Hydrogen-based energy production
Accelerate your electrolyzer R&D with the ZEISS portfolio of microscopy solutions, which include deformation tests, full surface analysis of freeform surfaces, complex geometries, and leakages.

- **Photovoltaics**
  Explore how ZEISS metrology solutions ensure the high efficiency and service life of photovoltaic products by analyzing defects, characterizing layer thickness, and much more.

Quality Assurance for the Wind Sector

ZEISS Power & Energy Solutions

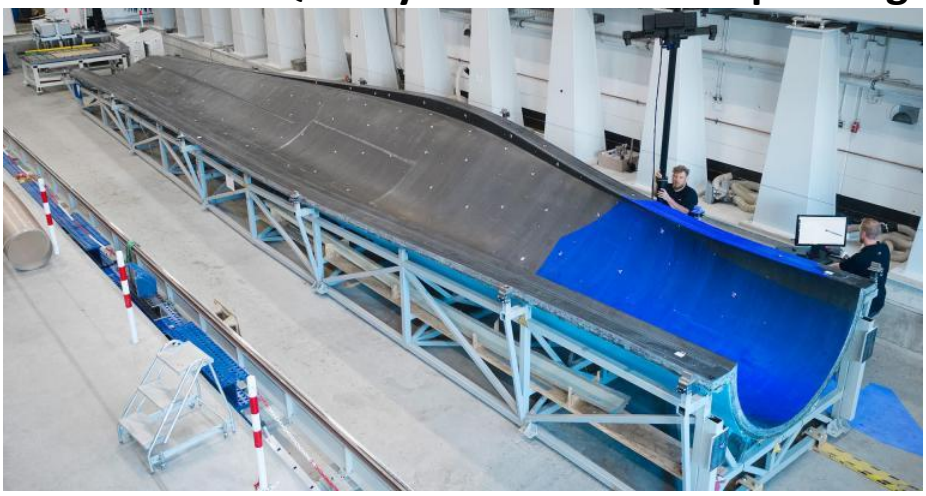
Ensuring excellence in wind energyZEISS Solutions for Power & EnergyRelated products

Ensuring excellence in wind energy

Longevity assurance for wind turbines

Wind energy is crucial to meeting the world's future power supply and net zero goals. Therefore, it is essential to have reliable quality assurance processes during the manufacturing process of wind turbines, to ensure longevity and stable operation as well as low maintenance effort during the whole lifetime of a turbine. With ZEISS metrology solutions, it is possible to perform measurement and inspection on small and big dimensional components on the highest level of accuracy.

Quality assurance for a prolonged lifespan



Blades and molds

Precise manufacturing of blades and fiber parts is essential for operation and longevity. ZEISS 3D scanning tools visualize deviations in size, shape and position, enabling detailed and accurate mold inspection of blades and other components.

Inspection of casted parts
Hub, torque arm, housing
Molded and pre-machined parts require inspection at every step of production, from incoming inspection to pre- and final machining. At each step, ZEISS Metrology Solutions provide the right data according to the level of accuracy, whether it is optical 3D or CMM data.

Bearings inspection
Main shaft, pitch control and more
Bearings for the drive train and pitch control are vital to the operation of the turbine and are subject to high loads. The accuracy of all bearing components is the determining factor for longevity, low lifetime maintenance, and the elimination of noise and vibration. The bearings have an impact on the efficiency of the drive train and must be fully functional at all times.

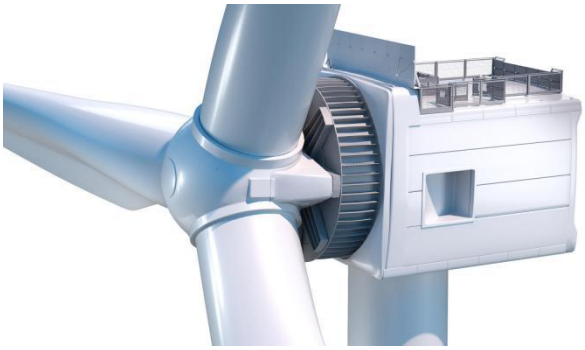
Drivetrain components

Drivetrain shafts
The drive train converts the rotation of the hub to the generator for power generation. For the direct drive technology, the shaft is part of the rotor of the ring generator. For the wind turbine equipped with an acceleration gearbox, there are usually different shafts such as the low speed and the high-speed shaft connecting the hub through the gearbox to the compact generator. Accurate measurements regarding size and form are essential to ensure a smooth-running system and to prevent imbalances from causing damage to the system.

Gearbox (acceleration)

The gearbox accelerates the rotational speed coming from the low-speed shaft through two or three stages by a predefined ratio. The low-speed stage, intermediate speed and high-speed stage accelerate the speed and as a result the high-speed shaft runs the generator at ideal operation. All gearbox components must be manufactured very precisely to ensure a perfect fit and interaction. This is mandatory to achieve the highest power, to transfer the torque and to minimize the energy loss.

Generator



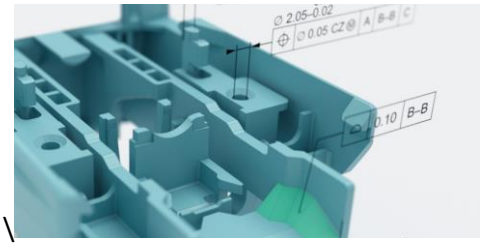
Generator for direct drive technology

The direct drive technology describes a design where the generator is directly built into or next to the hub and rotates with the same speed as the hub. As there is no gearbox and the generator is part of the drive, it is so called direct drive. Dimensions and tolerances of the components are crucial for to high energy output by providing enough flexibility under stress. Accurate measurements and analyses are essential to identify potential issues early on and prevent costly breakdowns while improving overall efficiency.

Compact generator combined with acceleration gearbox

This more "compact" generator type is located inside of the nacelle at the end of the high-speed shaft coming from the acceleration gearbox. This generator type requires high accuracy based on the higher speed and sometimes the more complex double feed design. Precision of the components is crucial for the overall efficiency of the generator and is preventing costly failures

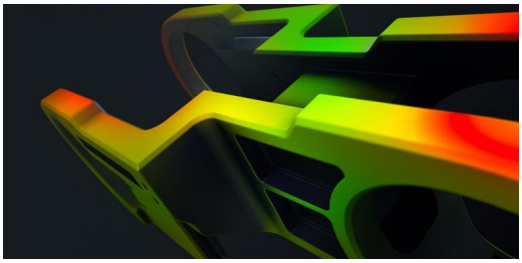
Powerful software for efficient analysis

- \ 

All-purpose software for dimensional metrology

ZEISS CALYPSO

Coordinate measuring machine software: ZEISS CALYPSO measures geometric elements - accurately, fast and efficiently. Select the required measurement features to configure your inspection plans. When used in connection with ZEISS measuring systems and sensors, ZEISS CALYPSO provides you with a powerful system from a single source. The software also adapts to your needs: With numerous optional add-ons, ZEISS CALYPSO also provides the perfect solution for demanding applications.

- 

One software for advanced metrology

ZEISS INSPECT

Discover the strength of ZEISS INSPECT, a software solution that allows you to analyze a variety of data types, including optical 3D data, volume data, blades and airfoils, and moving image data. The software's powerful features ensure your specific needs can be met, regardless of the system you use. Easy drag-and-drop data import and user-friendly templates ensure efficient workflows and accurate results.

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Intelligent inspection software for high demands

ZEISS PiWeb

ZEISS PiWeb supports decision making on the shopfloor with measurement results, values for temperature and other input data from various sources and equipment. This allows you to efficiently track your production quality across all machines along the production. ZEISS PiWeb can capture and analyze results from tactile, optical, manual or CT measurements from other parties as well as other machines such as CNC milling and more.

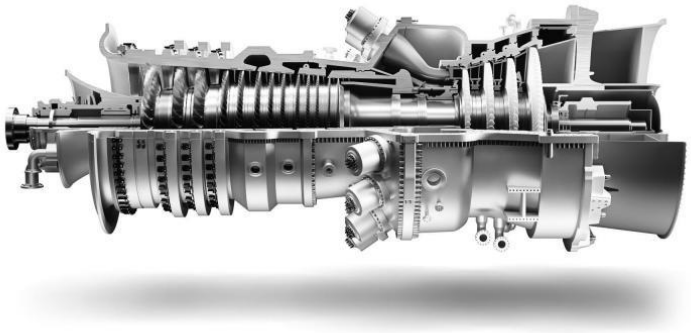
- From blades and injectors to metallurgical and other inspections, ZEISS provides the appropriate solution for your application.

ZEISS Solutions for Power & Energy

Quality Assurance for Gas & Steam Turbines

ZEISS Power & Energy Solutions

Part quality controlSoftwareZEISS solutions for power & energy

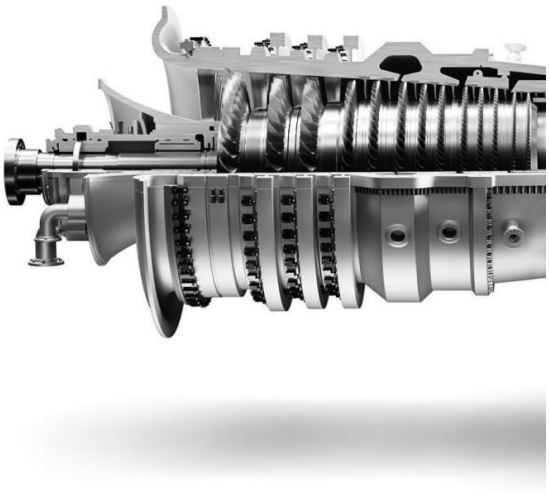


Achieve reliable and sustainable performance for gas and steam turbines

Maximize efficiency

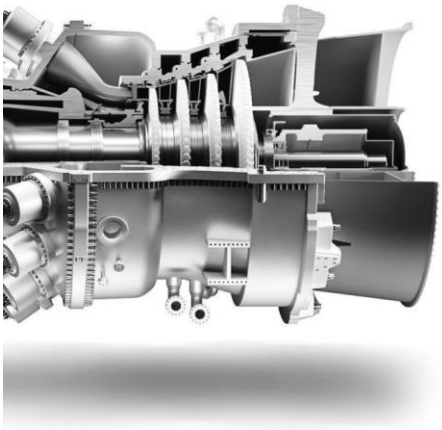
Gas and steam turbines require meticulous attention to detail in design and operation. Even the slightest quality issues can lead to operational hazards, reduced efficiency, and shorter service life. ZEISS offers solutions, enabling customers to achieve the highest quality standards and accelerate production, ensuring the turbines' safety, efficiency, and longevity.

Providing part quality control for optimum performance of gas turbines



Compressor component quality control: Providing part quality control for optimum performance

A compressor is the crucial component for compressing air by a defined ratio to achieve efficient combustion and provide air for the cooling of the blades in the hot zone. As a result, it is subject to strict quality controls to ensure the compressor proper functioning and optimum performance. Discover how ZEISS Metrology can support you here.



Hot zone blades and components: Solutions for coated parts in production and maintenance
The fuel is ignited in the combustion chamber to produce high-pressure hot gases. These gases expand through the blades and vanes of the turbine stages and drive a shaft. The high temperature along this process requires proper air cooling and a special coating for all components. Proper design, coating of the parts as well the integrated cooling holes are essential for efficient operation and to prevent breakdowns. Discover the solutions of ZEISS.

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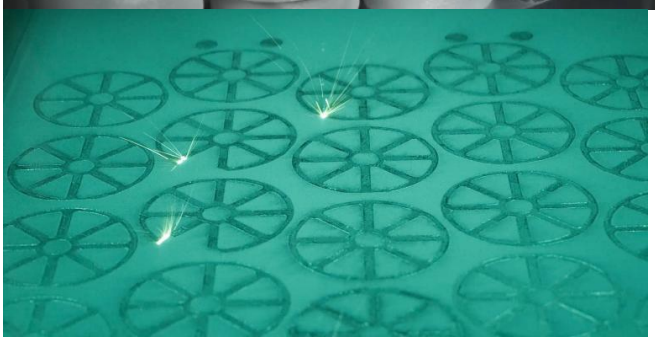
- 

Additive Manufacturing: Quality assurance is key

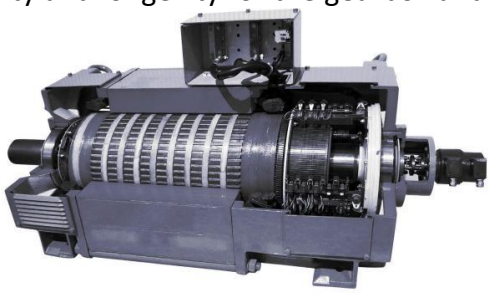
Additive manufacturing processes, such as 3D printing, open up new opportunities for the design of components and, at the same time, more efficient production. Being able to simultaneously manufacture multiple components in one batch speeds up production, which contributes to improved process efficiency. Moreover, the material properties reach a level that is comparable to conventional production technologies such as casting or forging.
To guarantee consistent quality during the production process, in-process quality assurance is carried out. This includes material analysis, technical cleanliness and complete 3D scanning of free-form surfaces and special structures. You want to improve your processes? Then take a look at the solutions from ZEISS.

Steam turbine: Enhancing efficiency with quality control
Steam generation can have several sources, such as exhaust gas from gas turbines, iron casting, nuclear power, or other high-temperature sources. The available steam pressure and volume define the turbine

design to include high-pressure, a medium-pressure, and a low-pressure turbine section. The pressurized steam flows through the blades and vanes to produce mechanical energy to run a generator. ZEISS metrology solutions ensure performance at the highest level and increase efficiency based on various data. Design and performance improvements are the key factors for power generation.

Gearbox for speed reduction

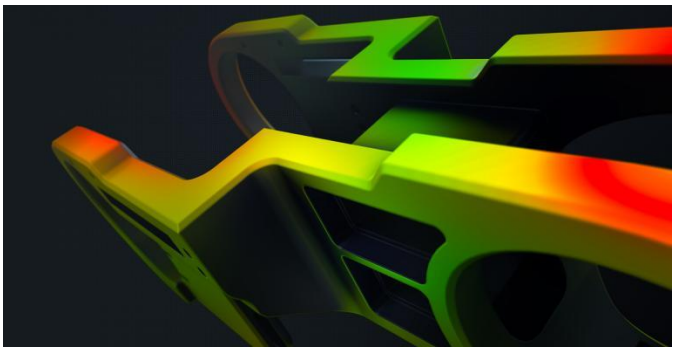
For power generation, gas and steam turbines run at a specific speed that is optimized based on the turbine design and efficiency. This speed level can deviate from the input needed at the generator side. In this case, a speed reduction gearbox is built into the power generation setup to align the speed level and torque of the turbine shaft through the gearbox to the generator. ZEISS Quality Solutions can increase reliability and longevity for the gearbox and its components, reducing costly downtime and repairs.



Generator: Maximizing efficiency with quality control

The generator consists out of the rotor, stator and stator housing, and converts mechanical energy into electrical energy. The generator can be mounted directly on the shaft of the gas and steam turbine or can be driven by the speed reduction gearbox.
Tight tolerances and a small air gap between the stator and rotor are crucial for the overall performance. ZEISS solutions help to enable high efficiency based on accuracy. From blades and injectors to metallurgical and other inspections, ZEISS provides the appropriate solution for your application.

Powerful software for efficient analysis



- ### One software for advanced metrology

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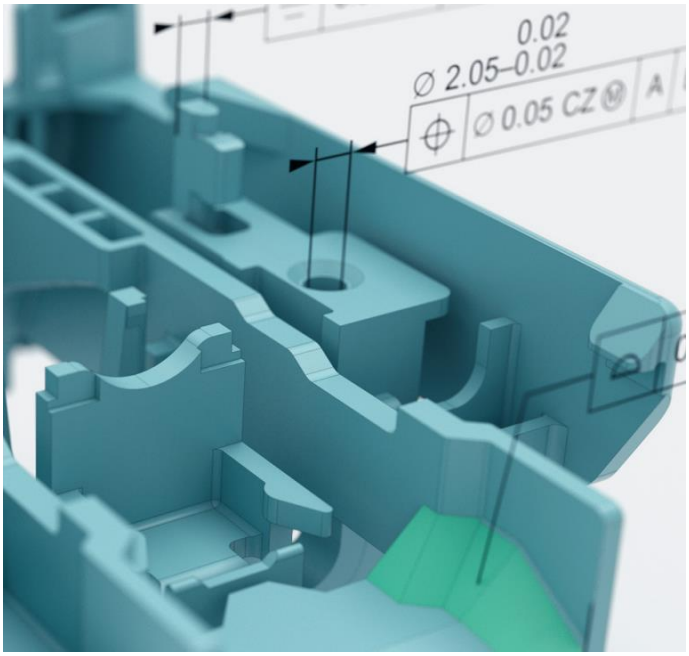
- 

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From blades and injectors to metallurgical and other inspections, Zeiss provides the appropriate solution for your application.

ZEISS Solutions for Power & Energy

Quality Assurance for Hydrogen Technology

ZEISS Power & Energy Solutions

PrecisionElectrolyzer potential

Precision in green power quality solutions

Early detection ensuring safety and efficiency

Hydrogen is a key component in the transition to renewable energy and in achieving global net-zero targets. Producing green hydrogen with electrolyzers and hydrogen storage will fundamentally change the energy market by enabling new uses for excess wind and solar power generation, long-term energy storage and replacement of fossil fuels. To ensure that these technologies can be operated efficiently and safely, quality assurance plays a crucial role. With ZEISS Quality Solutions, deviations and irregularities can be detected early in the laboratory or later in production and operation. Explore our portfolio for more information.

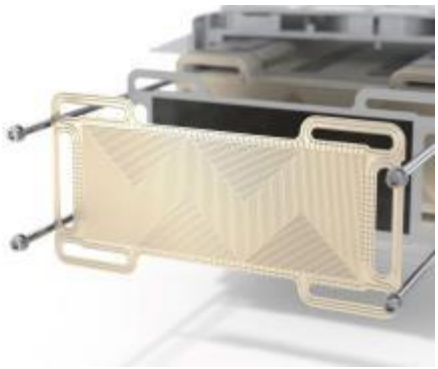
Unlocking electrolyzer potential

Analysis of membranes, compositions, seals, coatings, and solid material

Metrology and advanced materials analysis techniques, such as light and electron scanning microscopy, ensure bipolar plates, membranes, and coatings to meet the appropriate performance requirements. ZEISS Energy Solutions provides a comprehensive understanding of the different materials that improve the performance, reliability, and lifetime of electrolyzers.

Bipolar plate inspection
In electrolysis stacks, bipolar plates are important for the guided flow of water, oxygen, and hydrogen. The geometry of the surfaces and the leak-tightness between the individual sheets are critical. Therefore, the flow field structure and the sealing area need to be inspected to ensure the geometrical dimension for the functional aspects as well as for the stacking process.

Cell frame
The cell frame includes flow fields, openings, and sealings to fix the membrane in a defined position for separation and to seal the different sections within the stack. This is to guarantee the purity of hydrogen and prevent to materials from mixing. Cover plates and cell frames need to be inspected in terms accuracy and dimension to ensure accurate stacking and tightness of the stack.



Stack deformation testing
Analyzing the system and design can provide additional information and potential for improvement. The system can be monitored with other media in a test environment or in actual operation to examine the deformation and heat distribution of the stack in operation. The position of the sealing and the deformation under load are important information. Discover the opportunities of ZEISS Quality Solutions.

Quality Assurance for Photovoltaics

ZEISS Power & Energy Solutions

PhotovoltaicsQuality assurance for photovoltaics

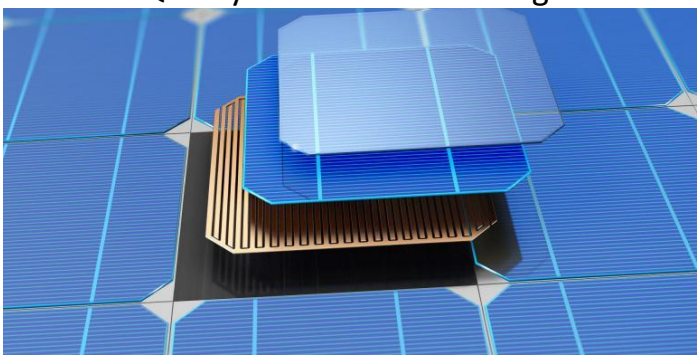
Quality control for cost reduction and longevity

Photovoltaic energy is an essential component of the renewable energy. Solar cells are a key part of solar panels with a highly complex production process. It involves a multitude of steps, including flocking, diffusion, interfacial passivation, etching, screen printing, and others. Each of these production steps is critical to ensuring the solar cells work efficiently and are produced at low cost.

Discover how the ZEISS portfolio supports you in achieving effective quality control and thus increasing customer satisfaction.

Quality assurance for photovoltaics

Quality solutions ensure high conversion of electric energy for photovoltaics



Solar cell

The production process of solar cells is very complex. Manufacturers must ensure the uniformity of ion diffusion on the silicon wafer, the uniformity of passivation layer thickness, etc. during the entire production cycle. The durability of solar cells is a very important issue. Industrial microscope solutions, with its advanced optoelectronic technology, can play a unique advantage in the production of solar cell applications, such as coating granularity, coating thickness, porosity analysis, material failure analysis, and more.

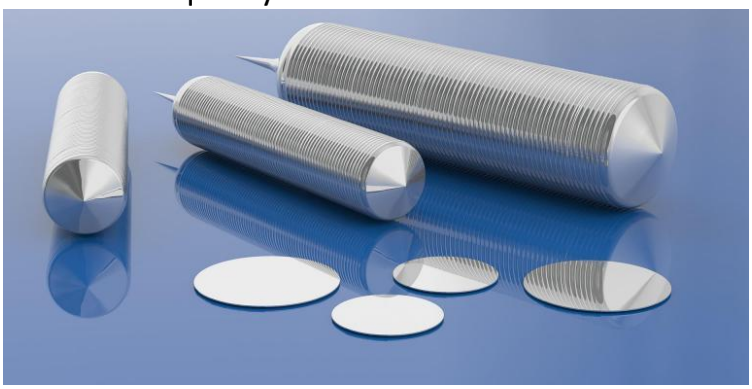
Casings for inverters and junction boxes

Casings of the inverter and junction box are important to protect the electronical components under harsh weather conditions at any time. Therefore, the dimensional requirements are essential for sealing of the casing and to provide flexibility on dealing with temperature changes. CMMs and optical solutions ensure the quality. Furthermore, optical testing is able to provide additional information on the behavior along the stress test.

Electronic components and connectors

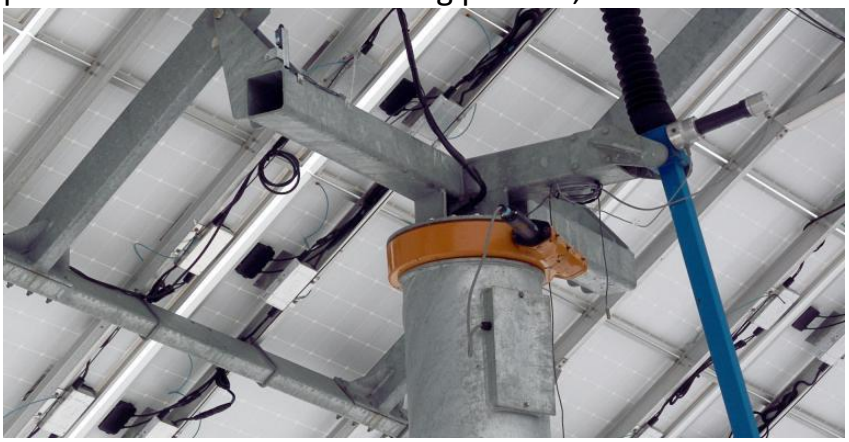
Electronics and their components are essential for processing the electricity generated and feeding it into the grid. They connect the individual strings up to the inverter and transformer and are responsible for the direction of the current. To ensure that the components perform

reliably under temperature fluctuations and high operational loads, they are subject to continuous quality assurance.



Tooling for wafer and profile production

Wafer manufacturing requires the highest accuracy in tooling and technology for cutting multiple slices simultaneously. Precision in the cutting process is mandatory to guarantee an efficient process, defect free parts and speed up production. Speed is also key in the production of aluminum string profiles, and therefore the tools must be precise and robust.



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