Kontron AIS GmbH

No Energy Revolution without MES

How MES software for efficient and resource-saving production enables the sustainability and cost effectiveness of the energy revolution

from Robin Schubert, Product Manager at Kontron AIS GmbH

Photovoltaics play an important role in the energy transition, which is why efficient and resource-saving production is essential. A specialized MES tailored to the needs of the industry to control, monitor, and optimize the production process in real time can make a decisive contribution.

15 years ago, Germany was the pioneer in the photovoltaic sector. Mechanical engineering and photovoltaic (PV) production reached their peak and opened up a new market that was dedicated to economic as well as environmental goals. Local companies developed the latest technologies to optimize efficiency and production in large quantities. New demand, and the fact that the way had been cleared in technological terms, also fueled global competition. With government support and strategic action, China achieved a dominant market position in the production of PV cells and modules. »

Today's market is characterized by new technologies, while adjustments in supply chains are fundamentally changing market conditions. In addition to purely cost-optimized PV modules from China, there is also a market for PV modules optimized for efficiency and quality. In addition, the latest software solutions and a high degree of automation make it possible to challenge China's location advantage.

Market growth and goals

The rapidly accelerated policy-driven transition from fossil fuels such as crude oil and natural gas to renewable energies and the tense situation of supply chains from China are enabling a second renaissance of the PV industry in Germany, Europe and the USA. Companies that have survived the tough market of recent years and new start-ups are conquering the global market with highly efficient modules and attractive prices or establishing their customer base in special applications.

The PV capacity installed worldwide was around 1 TW in March 2022. The EU alone achieved a capacity of 170 GW by the end of 2021.[1] Nevertheless, much higher production capacity is still needed if the 2 °C target set in Paris is to be achieved. Production capacities in Europe and America in particular are now playing an important role in this respect. Europe plans to expand PV production capacities to 30 GW by 2025. These plans are supported by European Union initiatives such as ESIA (European Solar PV Industry Alliance), RepowerEU and ESMC (European Solar Manufacturing Council). The USA is paving the way for expansion through the Inflation Reduction Act (IRA), which brings $ 370 billion to the industry through tax breaks. The US plans to expand production capacity to 10 GW by 2025 and a full 50 GW by 2030.

The role software plays in the production of new technologies

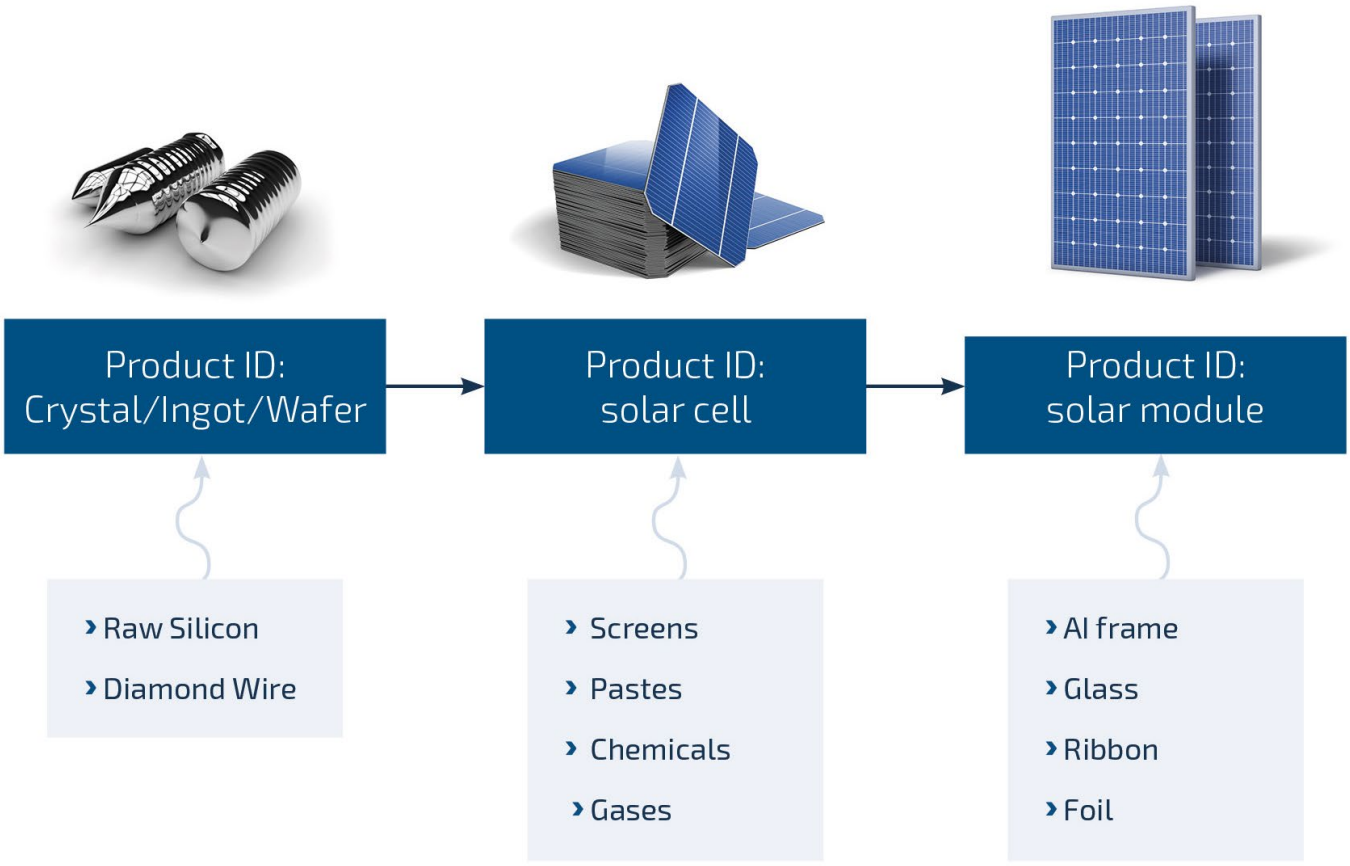
Production of technologies such as solar cells, electrolyzers and batteries requires a high level of precision and control of the production process. In the area of cell production for PV modules in particular, it is important to produce very high quantities with consistent quality. To meet these requirements, MES (Manufacturing Execution Systems) are implemented in production. These software solutions enable the control and monitoring of the production process as well as continuous control optimization. Data is recorded in real time – from order approval to completion. At the same time, waste is avoided, and the consumption of resources is conserved, which makes a sustainable contribution to the series production of new technologies. Every improvement in efficiency or increase in production capacity is decisive for market success. As the requirements increase, so does the need for specialized MES solutions. Industry-specific MES solutions, such as FabEagle®MES from Kontron AIS GmbH, offer functions such as Virtual Single Product Tracking to meet industry-specific challenges and the rapid scaling of production sites. The functions and modules of an MES specialized in PV are divided into the three pillars of traceability, production control and transparency.

What makes an MES stand out in PV and battery production?

An important point is the reliable collection of process and equipment data using industry-specific interface standards such as SECS/GEM, PV02 and OPC UA in order to reliably record production conditions and data, material movements and process parameters. Specific commands can be assigned for material and workpiece carrier interlocks. These prevent incorrect material handling and control the proper execution of the steps in the work plans.

End-to-end material tracking is an essential feature. It not only ensures correct inventory data, but also ensures consistent upstream and downstream genealogy. In PV module production, for example, tracking begins with the finished solar module and can go all the way back to the solar cells, wafers, ingots, crystals, raw silicon and the consumables that go into the manufacture of a module. Forward tracking starts with the raw silicon and leads to all the finished solar panels that were manufactured from a specific batch of silicon. »

[1] Clean Energy Technology Observatory – executive Summary (European Commission ISSN 1831-9424, Photovoltaics in European Union 2022)



Product data is collected for each product (wafer, cell, module) based on a product ID. All material, process and measured data is recorded so that it can be traced back to the original material.

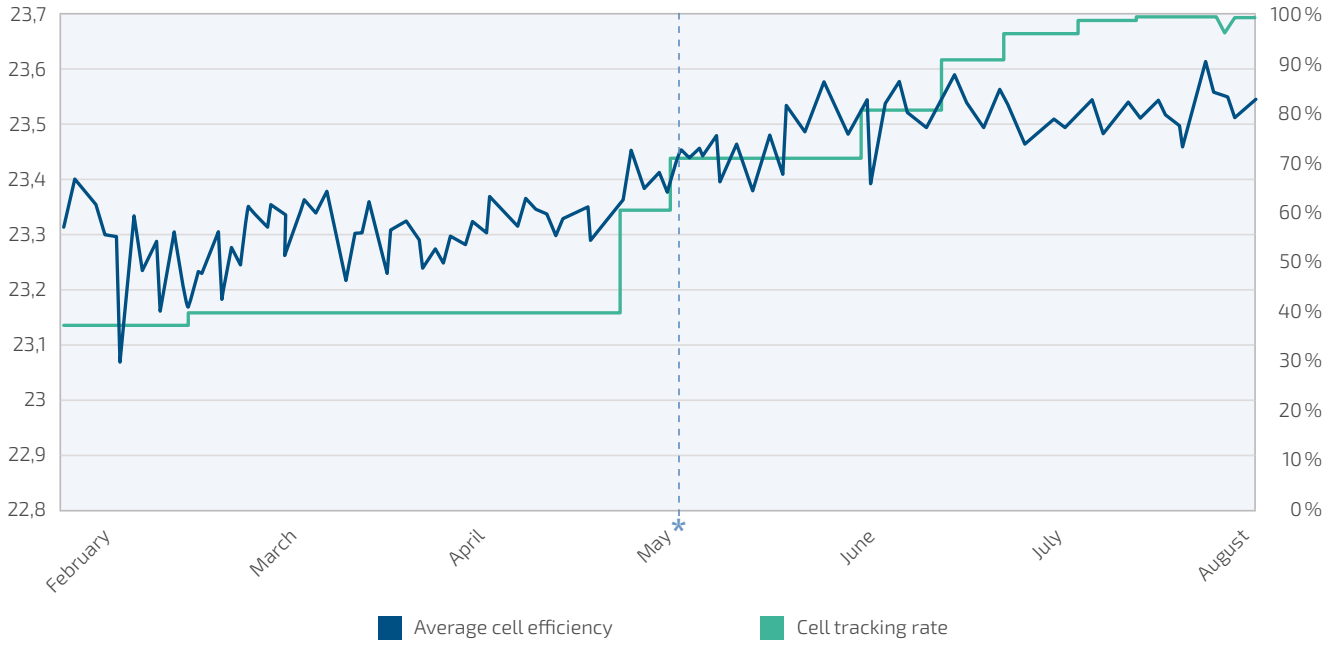
If the inventory of semi-finished and finished products and the related consumption of raw materials and utilities is to be tracked, a real-time connection between the MES and the ERP system is essential for a continuous exchange of master data, work orders, production progress and quality information. Production data collected in this way can be used directly to calculate KPIs such as Overall Equipment Effectiveness (OEE) in order to precisely monitor and continuously improve production performance.

An MES for PV or battery production is rounded off by cross-site production monitoring, which enables companies to set up production worldwide and at the same time maintain control of each process stream. As a result, production figures can be compared and process improvement findings can be easily implemented at multiple production sites.

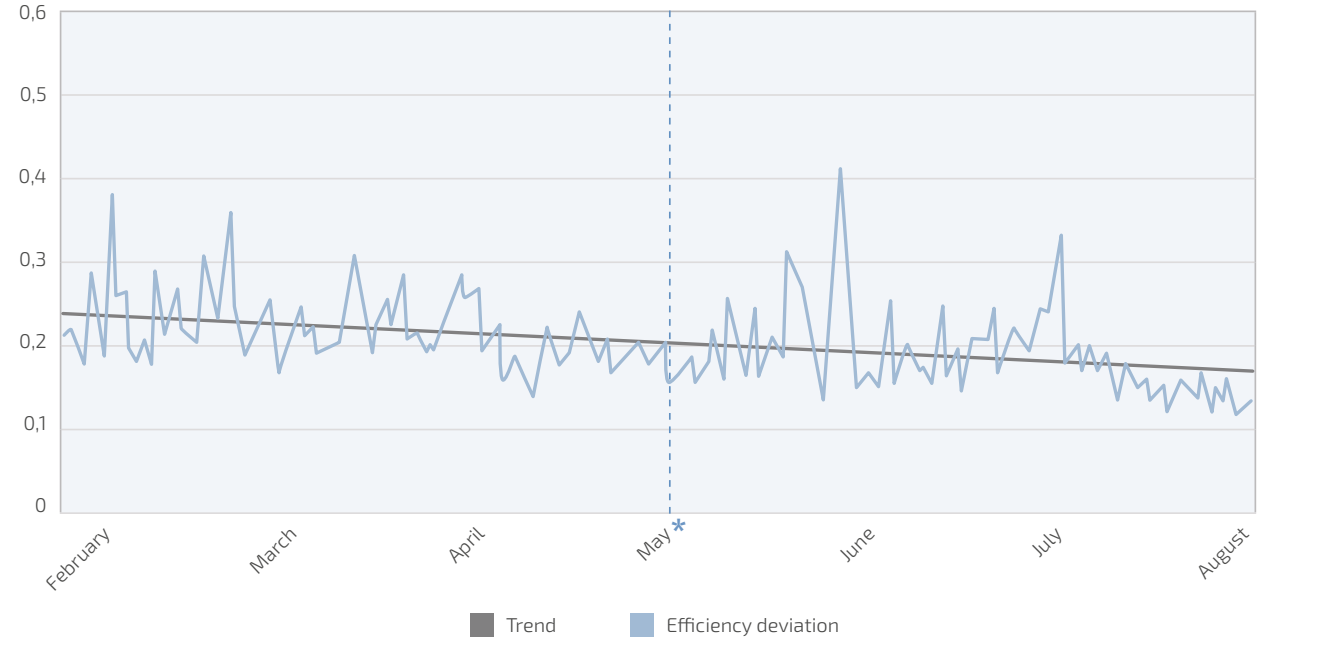
Taking into account the enormous growth potential predicted, scaling also plays an enormous role in addition to the features already described. According to the ITRPV market report from 2022, over 60 % of solar cells will be manufactured at sites with a production capacity of more than 5 GW in 2029.[2] At the same time, wafer throughput in processing machines is expected to increase by around 30 % per hour. This requires not only very advanced technologies in the machines, but also high-performance, reliable and highly available software solutions that support these advances. »

[2] International Technology Roadmap for Photovoltaics (ITRPV), 2021 Results, 12. Edition, März 2022

Material tracking and solar cell efficiency



Material tracking and standard deviation of solar cell efficiency



* Improvement of the tracking rate

The two diagrams show production data during the introduction of an MES for photovoltaics from Kontron AIS. The first diagram illustrates the relationship between cell tracking rate and cell efficiency, the second shows the spread of efficiency within a batch. When tracking rates exceed 60 %, cell efficiency increases significantly, and spread is steadily reduced. The highest tracking rates are achieved using the MES specialty "Single-Wafer Tracking".

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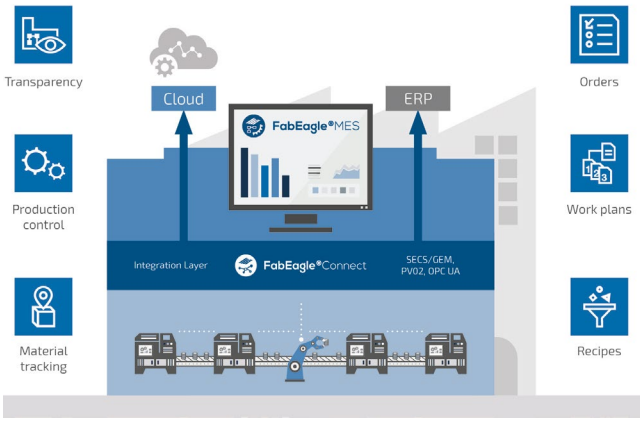

The functionality of FabEagle®MES modules enable full transparency and control of production. The MES is integrated into the system and hardware landscape using FabEagle®Connect as a low-code integration solution. Particular attention is paid to PV-specific interface standards such as PV02 and SECS/GEM, which come from the semiconductor industry.

Energy revolution only possible with MES

An MES contributes to more efficient production because it optimizes the utilization of resources and production output. Only an MES can ensure that the production of PV cells and modules and batteries is as efficient as possible while conserving resources at the same time.

About Kontron AIS GmbH

Kontron AIS GmbH sets the benchmark in industrial software – for more than 30 years and with an experienced team of over 250 employees. The proven software products and customized digitalization solutions enable machine and equipment builders as well as factory operators to break new ground in automation and secure long-term competitive advantages. Together with its customers, Kontron AIS implements worldwide cross-industry, intelligent digitalization strategies and solutions for the smart manufacturing of tomorrow.

As a subsidiary of the Kontron AG, Kontron AIS offers integrated, end-to-end IoT concepts consisting of hardware and software as well as worldwide project management, service, and support thanks to a global network

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