Automotive

Customer case study

Audi uses PLCnext Technology for the sustainable production of electric cars

Highlights

- In January 2024, the Audi Ingolstadt facility became a carbon-neutral production location.
- Phoenix Contact has supported the transition to greater sustainability by providing key technologies for electrification, networking, and automation, including PLCnext Technology.
- In addition to numerous functions for IIoT applications, the open ecosystem also features integrated cybersecurity in accordance with the international IEC 62443-4-2 standard.

Customer profile: Audi

Audi stands for sporty vehicles, premium workmanship, and progressive design. Founded in 1909 by August Horch, the Audi Group – which also includes the Bentley, Lamborghini, and Ducati brands – is currently one of the most successful manufacturers of automobiles and motorcycles in the premium segment.

Figure 1: PLCnext Technology and other Phoenix Contact products have been an important part of Audi's energy transition.

Audi AG's headquarters are located in Ingolstadt, Germany, which is a networked digital factory for the electrified future. The company has built cars at this location for 75 years. Today, about 40,000 employees work in the Ingolstadt location.

Challenge: Improving the greenhouse gas balance through optimized production processes

Audi has set a goal of achieving carbon-neutral production at all sites by 2025. The Ingolstadt location achieved this target at the beginning of 2024. Phoenix Contact is supporting the transition to greater sustainability by providing key technologies for electrification, networking, and automation.

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The Ingolstadt location is home to the body shop of the all-electric Audi Q6 e-tron series. It is important to keep the energy footprint as neutral as possible, starting with the vehicle production stage. In the body shop, it is especially important to improve emission values through influencing factors such as quality, availability, and adaptability. When a no-load occurs, or a body is rejected from the manufacturing process, it incurs costs, and the production-related GHG balance increases.

Solution: Supporting electrification, networking, and automation

To prevent this from happening, Audi uses numerous measures such as shutdowns during no-load times and the use of communication-capable energy meters – for example, the multifunctional EEM-MA 370 measuring device from Phoenix Contact – to monitor consumption (Figure 2).

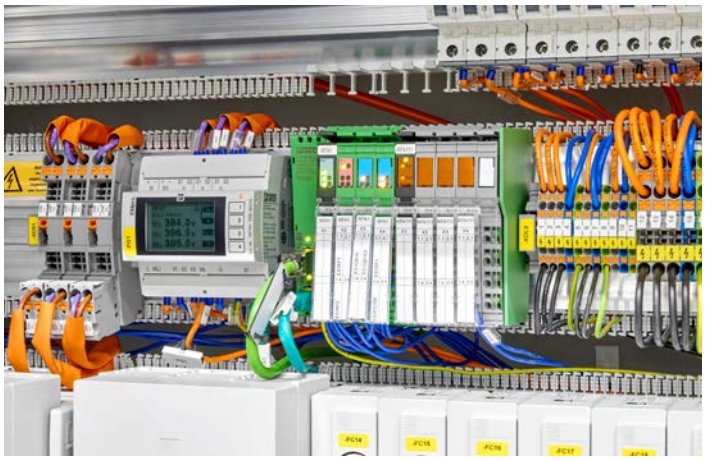

Figure 2: The multifunctional EEM-MA 370 measuring device records energy consumption data.

To optimize even further, the workers need transparency about the energy flows and information that indicates a malfunction as soon as it occurs. Even the smallest deviations from quality, which are indicated at an early stage, can have a major impact. Identifying additional potential for improvement in the process flow not only shortens the cycle times, but also optimizes the energy balance of each individual car.

The RFC 4072S safety-related controller forms the core of the automation solution in the body shop (Figure 3). It ensures that the vehicles are manufactured in a functionally safe manner. In addition to system automation, the RFC 4072S features comprehensive diagnostics for all processes and the data relevant for communication. The IEC 61131-3 programming language, which is usually favored for the production process, is supplemented by the use of high-level languages such as C/C++, and C#, which are better suited for complex, real-time applications.

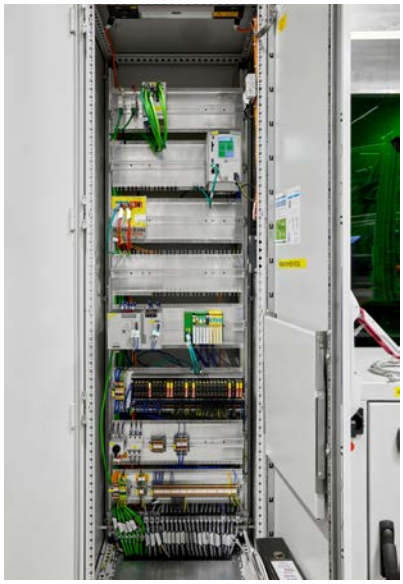

Figure 3: In addition to functionally safe system automation, the RFC 4072S PLCnext Control provides comprehensive diagnostics.

Time savings of more than 30 percent when creating the system visualization

In the Ingolstadt project, the block standard under development since 2004 based on the predecessor platform, PC Worx, has been converted to the new PLCnext Technology. As a result, the library now contains more than 600 modules optimized to control many different processes required in a body shop. The RFC 4072S PN PLCnext Control also supports the safety of machinery in accordance with IEC 62061 SIL 3 and EN ISO 13849-1 PL e. The new automation platform provides a web visualization to increase the consistency and integration of information (Figure 4).

A specially developed visualization assistant generates around 98 percent of the operating displays automatically. To do this, it accesses information from the user program and creates the system visualization with the help of more than 700 icons from the newly created system library.

Figure 4: A visualization assistant creates 98 percent of the operating displays.

This also applies to the conveyor systems, where employees may only operate the areas that are visible. Here, the generator creates

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an individual user interface for each system part. This approach has reduced the installation time to a third of the time previously required, a considerable advantage for adaptations and commissioning.

The control stations required for system operation can be integrated flexibly into the 1-gigabit system network via the built-in switch of a push-button box with emergency stop button (Figure 5). Industrial PCs from the Basicline series with IP65 protection are installed as main and auxiliary control panels on a column at the individual robot cells. The step chains and diagnostics displayed there give the operating and maintenance personnel direct access to all important information so they can react quickly when necessary.

Figure 5: Industrial PCs from Phoenix Contact are installed as main and secondary control consoles on a pedestal.

The control panels used in the conveying technology are a special feature. The eHMI Linux clients were developed to meet Audi's requests. The focus here was on compliance with the international IEC 62443 security standard and simple update and patch management. The IPCs' maintenance is integrated into the tried-and-tested maintenance processes and procedures.

Development of a holistic safety concept in accordance with IEC 62443

The constantly increasing number of information sources – such as sensors, cameras, and process/quality technologies – leads to ever larger amounts of data and, consequently, inevitably to points of attack that must be protected against unauthorized access.

Audi always considers such projects from a cybersecurity perspective. Audi worked with Phoenix Contact, as a TÜV-certified IEC 62443-3-3 Security Service Provider, to develop a holistic security concept during the planning phase of the project (Figure 6). The concept implements the functional system requirements of IEC 62443-2-4. A threat analysis helped define and implement measures to increase the security of the production area.

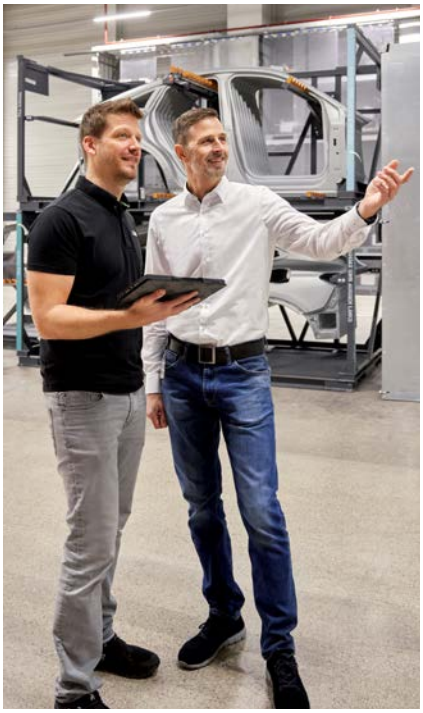

Figure 6: Audi and Phoenix Contact worked together to develop a comprehensive safety concept.

Results: Working toward a sustainable future

PLCnext Technology and other Phoenix Contact products have been an important part of Audi's energy transition. The open ecosystem has a large number of interfaces from the sensor to the cloud. This enables it to contribute to the continuous flow of information in carbon-neutral production.

In addition to the standard programming of PLC systems in accordance with IEC 61131-3, PLCnext Technology also enables the parallel use of high-level languages such as C/C++, C#, and Matlab Simulink. Both languages run together in real time on the PLCnext Control controller family, allowing the production to benefit from the expertise of both IT and OT specialists.

The PLCnext Technology ecosystem is contributing to the transition toward the automation of the Audi production facilities. Through smart electrification, effective networking, and open automation, Audi is laying the foundations for sustainable, future-proof production and the flexible integration of new technologies such as machine learning.

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Controllers with extensive security functions

The PLCnext Control controllers are certified by TÜV Süd in accordance with IEC 62443-4-1 ML3 and the IEC 62443-4-2 SL2 Feature Set. The devices feature extensive security functions, including:

- A firewall and network segmentation, as well as monitoring and network load limiting
- TSL Security (Transport Layer Security) for access-secure communication
- Certificate management for asymmetric cryptography and key management
- User administration with role-based access control and connection to central user management systems
- Local and central connection to event logging systems
- Device and update management
- TLS implementation compliant with IEC 62351-100-3
- IEC 61850 communication stack as an app (Figure 7).

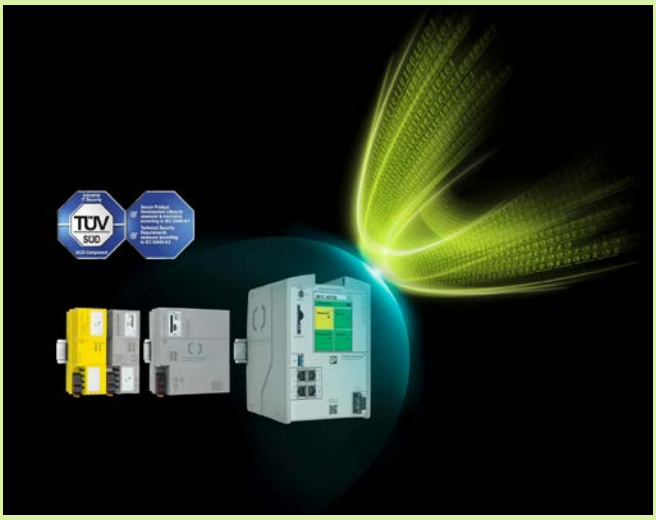

Figure 7: PLCnext Control is certified in accordance with IEC 62443 and features comprehensive security functions.

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