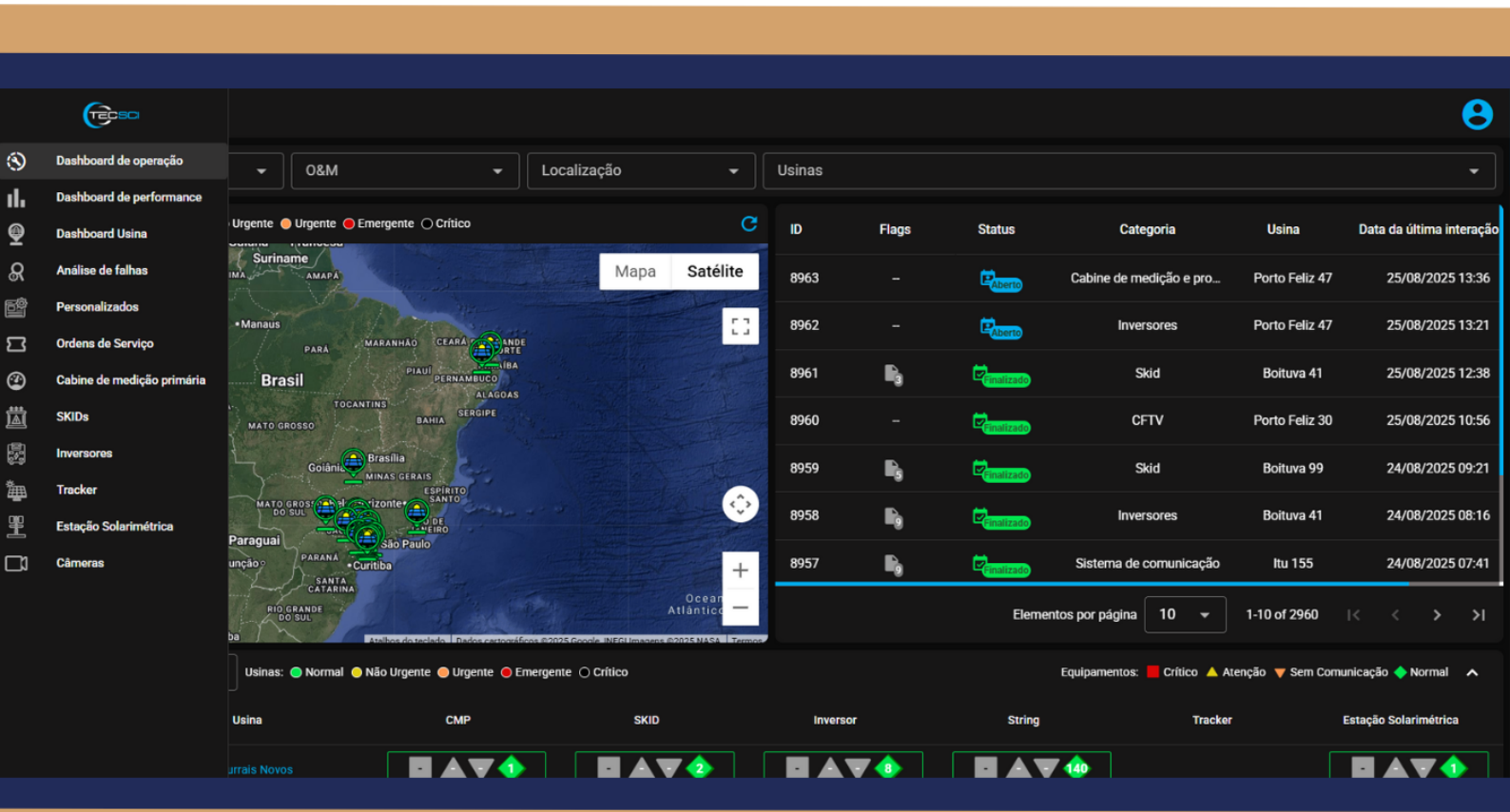
DATASHEET

MONITORING SYSTEM & PV SCADA



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1 . Company Presentation

TECSCI Ltda. is a proudly Brazilian company and an international reference in the development of technology for the photovoltaic sector. Its work stands out for the development of proprietary products, constant innovation, and excellence in technical support.

Our solutions include:

- **Monitoring System and PV SCADA:** Real-time visualization of all plant assets, integration with cameras, ticket management, maintenance management, and AI-powered tools to optimize O&M and EPC work. Reaching more than 500 MW in portfolio in 2024 alone.
- **Controllers for Trackers (TCUs and NCUs):** We have developed 100% national technology, based on LoRaWAN and Artificial Intelligence, with a manufacturing unit in Juiz de Fora/MG, producing 6MW daily (approximately 3000 units per month).
- **Automation Panels:** Automation solutions for Low Voltage and Medium Voltage circuit breakers. Currently, the portfolio includes more than 40 plants automated by TECSCI.
- **Photovoltaic Cleaning Robot:** A national product, with autonomous and efficient operation. Performs cleaning in less than 5 seconds and 2 liters per module. The equipment was developed to optimize cleaning time and reduce natural resource consumption.

Figure 1: TECSCI Solutions.

Our team, with over 60 employees, operates a 2000 m² manufacturing unit in Juiz de Fora/MG and offices strategically located 500 meters from the Federal University of Juiz de Fora, facilitating access to new talent.

Our services are carried out with high quality and in compliance with current standards and regulations, providing complete and integrated solutions to our clients.

2 . TECSCI Monitoring System

The TECSCI monitoring system was developed to ensure complete visibility, security, and control over the operation of photovoltaic plants. Through a robust hardware and software architecture, the solution integrates real-time field data, provides intelligent dashboards, and generates automatic alerts — all with security, scalability, and plant performance in mind.

Communication Architecture:

Communication is carried out via Ethernet network and RS485 serial bus, using the industrial protocols MODBUS TCP/IP and MODBUS RTU. This architecture ensures high reliability and flexibility for integrating a wide range of equipment.

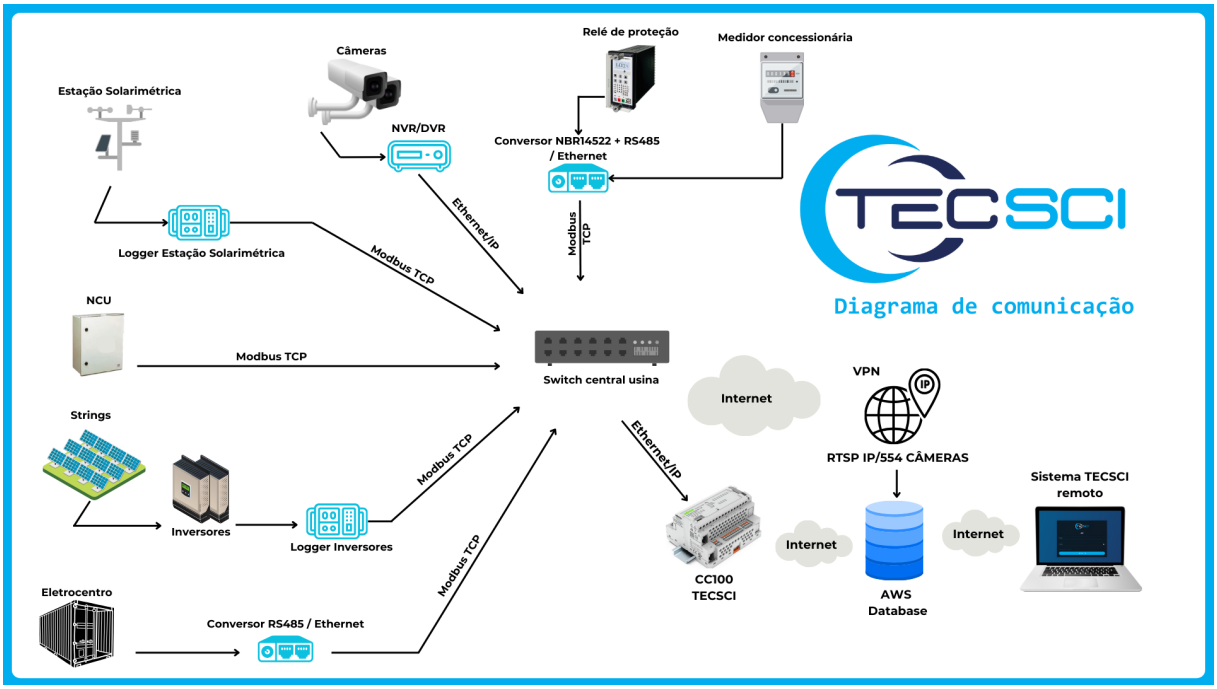

Figure 2: Communication architecture of the TECSCI monitoring system.

The main controller used is the **WAGO CC100**, which combines IT and OT (Information and Automation Technology) functionalities, enabling integration with various plant sensors and actuators. Among its features:

- 8 Digital Inputs (DI) and 4 Digital Outputs (DO);
- 2 Analog Inputs and 2 Analog Outputs (AI/AO);
- 2 PT100 channels and 1 RS485 port.

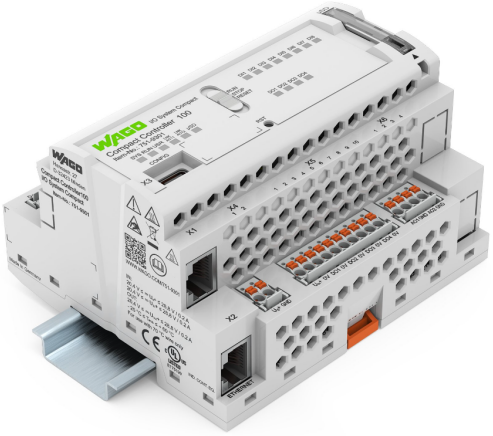

Figure 3: WAGO CC100 Controller.

All data collected in the field is sent to the **TECSCI cloud server**, hosted on the **AWS (Amazon Web Services) platform**, ensuring **availability above 99.9%** and high reliability for remote access, reporting, and historical analysis.

In the event of a temporary internet outage at the plant, the system ensures continuous data collection through local storage: the **WAGO CC100** controller retains recorded data for more than **7 days**, automatically synchronizing with the cloud once the connection is restored. The entire process includes **automated backup** and **encryption**, ensuring the integrity and security of information.

2.1 . Installation Requirements

For the proper installation of the TECSCI system, the following are required:

- Stable internet connection with a minimum speed of 10 Mbps;
- Modbus communication with all plant equipment;
- Submission by the CLIENT of:
  - Equipment list with model and manufacturer;
  - General electrical layout of the plant in `.dwg` format;
- Fixed IP addressing for all devices.

2.2 . *Dashboards and Intelligent Visualizations*

The TECSCI platform offers interactive and customizable dashboards that provide a unified view of all plants, focusing on operation, performance, faults, and maintenance.

- **Operation:** Real-time status of plants and active alarms.
- **Performance and KPIs:** Comparison between actual and target generation, with irradiation, efficiency, and loss indicators.
- **Equipment:** Detailed view of inverters, transformers, LV/MV panels, weather stations, etc.
- **Alarms:** Filters by criticality, fault history, frequency analysis, and associated losses.
- **Reports and Charts:** Generation of standardized reports and customizable charts across dates, plants, and variables.

Figure 4: Dashboards of Inverters, Switchgears and CMP.

2.3 . Alerts and Notifications

The system generates automatic alerts based on operational failures, performance deviations, and critical events, enabling immediate action by the O&M team.

- **Fault Identification:** By reading and processing equipment variables, the system identifies problems occurring in the plant in real time;
- **Notifications:** When a fault/anomaly is detected in the plant, alerts are sent via email and to mobile devices through Telegram in real time, according to the configured alarm severity level;
- **Georeferenced Device Map:** Real location of equipment displayed on a map, with status, alarms, and performance of each device, including Strings;
- **Work Order Opening:** Triggering of the field team to handle and normalize identified occurrences;

Figure 5: Georeferencing with alarms and notifications on Telegram.

2.4 . Integrated Artificial Intelligence

TECSCI incorporates Artificial Intelligence (AI) technologies into its systems to predict solar generation and detect failures with greater accuracy.

The features include:

- **Generation Forecasting:** Artificial Neural Networks (ANNs) based on irradiation history and meteorological variables;
- **Transfer Learning:** Use of pre-trained models for plants with limited historical data;
- **Federated Learning:** Models trained locally without exposing raw data, ensuring security and privacy.

This approach enables continuous improvement of the models and adaptation of forecasts to the reality of each plant.

3 . Solar Trackers Module

The TECSCI system includes a dedicated module for solar tracker supervision, providing a complete interface for monitoring the performance of the solar trackers in use.

The platform is compatible with different tracker models and reads key operational data, such as: current tracker position, reference angle (target), wind speed sensors, operating status, and alarms.

Figure 6: Dashboards of the Solar Trackers module.

The information is centralized in interactive dashboards or on a georeferenced map, facilitating quick identification of faulty equipment and faster response from the O&M team.

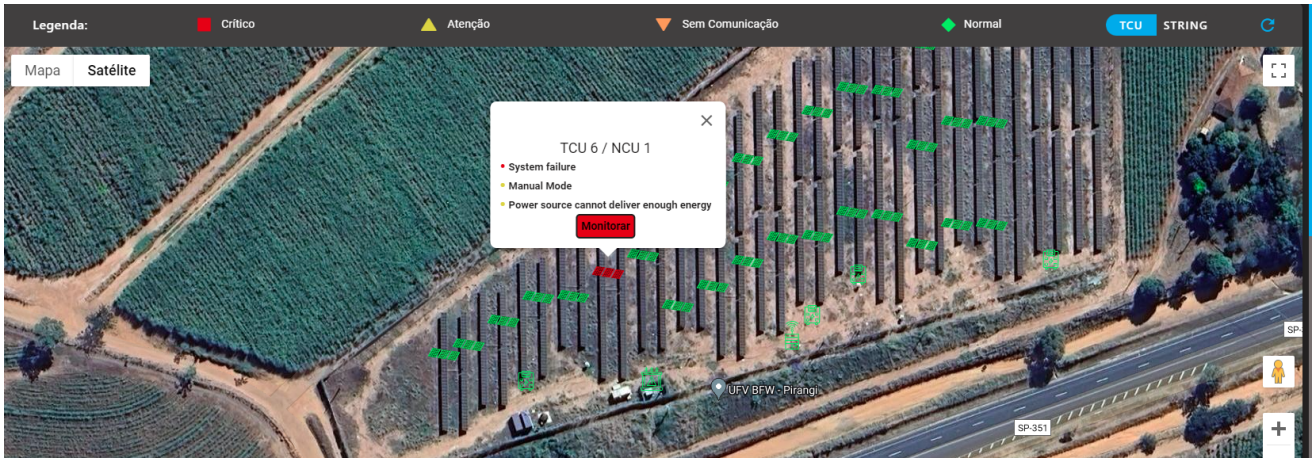

Figure 7: Georeferencing with device criticality.

In addition to continuous monitoring, the system also calculates tracker availability, allowing accurate performance tracking.

All faults and alarms are categorized by criticality and can be configured for automatic delivery via email or Telegram. The platform also enables direct creation of work orders (WO) in the **CMMS module** (Section 5), from any anomaly detected in the trackers, ensuring traceability and fast response.

If the trackers are integrated with the **remote control module** (Section 7), it is possible to perform maneuvers directly from the TECSCI interface, such as forced movements (custom, safety, or cleaning) and alarm reset, as provided by the manufacturer.

4 . Performance Analysis

This module transforms plant data into valuable insights for O&M, management, and engineering teams, enabling the identification of losses, operational deviations, and improvement opportunities — all with a simple and powerful visualization.

Performance Indicators and Intelligent Visualizations

The platform provides a range of technical indicators to assess the operational health of each plant:

- **Power vs Irradiance Chart:** Analysis of the plant's operational curve in real time or historically;
- **Generated Energy:** By inverters and main meter, with daily history and comparisons;
- **Expected Energy:** Calculation based on measured irradiance;
- **Comparisons:** Actual vs Expected vs Target;
- **Solar Irradiance:** Actual vs Target;
- **PR (Performance Ratio)** and **Capacity Factor**;
- **Equipment Availability**;
- **Consolidated Alarms by plant and by asset**;
- **Generation Simulations:** Based on real meteorological data, the system calculates how much the plant should have generated each day;
- **Loss Consolidation:** Estimation of losses due to temperature, clipping, unavailability, etc.;
- **Asset Ranking:** Positive and negative highlights within the portfolio, supporting predictive maintenance actions;
- **Reports and Data Export:** Export via API, PDF, Excel, or through customizable charts and tables.

Figure 8: Dashboards of performance indicators.

5 . Computerized Maintenance Management System (CMMS)

The TECSCI CMMS module enables full control of preventive, corrective, and predictive maintenance of photovoltaic plants, centralizing all activities, work orders, history, and indicators into a single platform. This information is accessible both via **web system** and through the **mobile application**.

With this solution, your team reduces unplanned failures, gains agility in handling incidents, and ensures full traceability of interventions — optimizing the operation of your plants.

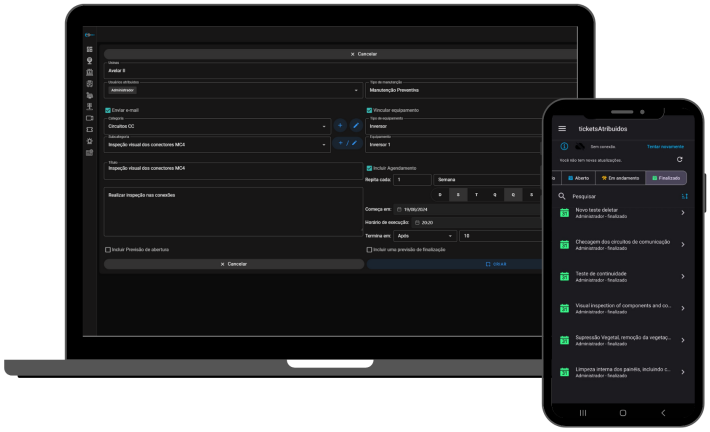

Figure 9: Work Order Management via TECSCI Web and App.

Application with Offline Operation

The field operator can access the TECSCI app directly on their mobile device. After receiving a work order (even in areas without connectivity), they can:

- Download the WO and move to the maintenance location;
- Fill out the checklist directly in the app;
- Attach photos, text notes, reports, and materials used;
- Close the WO even without internet, with information uploaded once connectivity is restored.

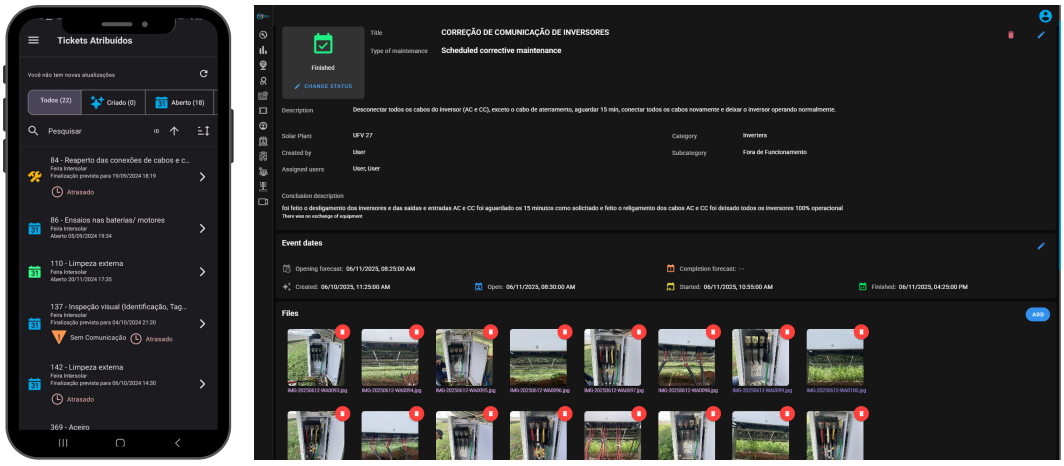

Figure 10: Performance indicator dashboards.

Work Orders

Each WO (Work Order) can be generated in an optimized way from alarms, individually, or scheduled in periodic plans according to the maintenance schedule. The information recorded in each order includes:

- Status chronology and WO updates;
- Log of interactions, messages, and attachments;
- Detailed description;
- Responsible for creation and execution;
- Affected equipment (automatically filled in case of alarm);
- Confirmation of component replacement;
- Completion with checklist, images, reports, and execution time;

Indicators and Maintenance Plan

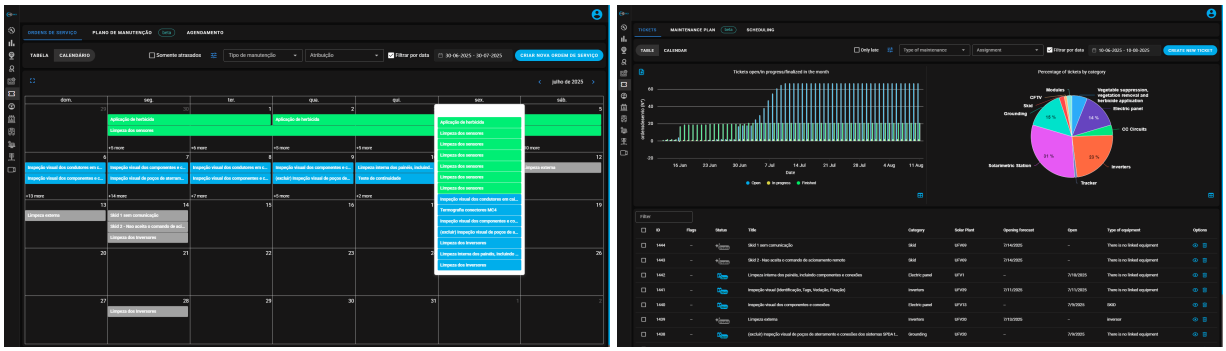

Figure 11: Maintenance dashboards.

The platform automatically generates essential KPIs for technical management and auditing, in addition to enabling the creation of the maintenance plan for the plant's entire asset tree:

- Listing and status of all tasks (preventive, corrective, and predictive);
- Creation of periodic tasks;
- Relation with Equipment in the asset tree;
- Maintenance Indicators;
- Detailed reports.

6 . PV Plant Automation

TECSCI offers complete solutions for PV plant automation, providing dedicated panels for monitoring and remote control of the main electrical equipment of the plant, such as low and medium voltage circuit breakers (metering cabins and transformers).

TECSCI Automation Panels

TECSCI automation panels are designed to increase operational efficiency, reduce downtime, and enable safe remote operation. Each panel includes PLC, interface relays, power supply and battery bank, and gateways for communication via Ethernet or RS485 (Modbus).

Figure 12: TECSCI Automation Panel.

Implementation Conditions

The supply and integration of automation will depend on the plant's technical assessment. For this purpose, it is necessary to previously map:

- The available reading and actuation flags in the circuit breakers, transformers, or metering cabins;
- The existing electrical and communication infrastructure;
- The accessibility conditions for the plant's signals and electrical diagrams.

Only after this analysis will the detailed scope of supply and automation be defined.

Operational Benefits

TECSCI automation enables:

- Reduction of up to 4 hours of downtime per MWp per month;
- Average operational savings of up to R$10,100.00 per MWp per year;
- Reduction of technical dispatches and labor costs;
- Safe and monitored operations even in remote areas;
- Prevention and fast response to electrical failures.

After device automation, readings and actuations can be integrated into the TECSCI monitoring system, according to technical feasibility, using the remote control module presented in the next section.

7 . Control System

The TECSCI platform also offers the remote control module, which enables direct and secure control of various plant devices — such as circuit breakers, inverters, trackers, and relays — all through a web interface, with operation logs and real-time feedback.

This feature increases the autonomy of the O&M team, reducing the need for on-site interventions and optimizing response times to incidents.

Important: Integration with field devices depends on the availability of suitable infrastructure in the plant, such as:

- Devices compatible with remote control (e.g., motorized circuit breakers, inverters with control interface);
- Communication available through the local network (Modbus, Ethernet, etc.);
- Signal mapping and availability provided by the CLIENT.

TECSCI will carry out the integration with the available equipment according to the plant's technical conditions and the information previously provided by the client.

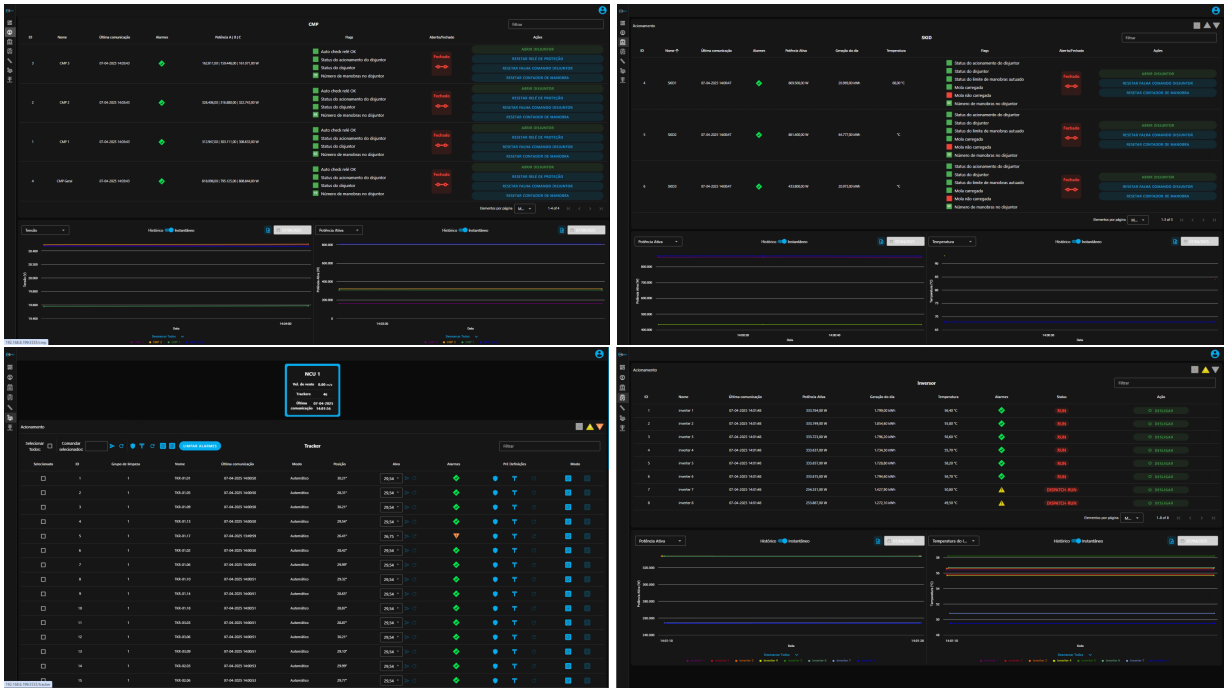

Figure 13: Control dashboards for e-houses, skids, trackers, and inverters.

8 . Integration with Cameras

The TECSCI system supports integration with surveillance cameras compatible with the **Hikvision API**, enabling visual monitoring and reception of real-time alarm events.

1. Supported Camera Types

   The following categories of cameras are compatible with the system, provided they allow integration via the Hikvision API:

   - Fixed Cameras;
   - PTZ (Pan-Tilt-Zoom) Cameras;
   - Thermal Cameras.

2. Alarm Reception and Acknowledgment

   Alarms must be previously configured by the client directly in the camera or via the Hikvision interface. Once configured, event data is automatically captured by our platform through the API and integrated into the supervisory system.

   Each alarm will be:

   - Stored in the system database;
   - Displayed to the operator with information such as date, time, event type, and source;
   - Required to be **manually acknowledged by the operator**, ensuring traceability and control.

3. System Visualization

   Integrated cameras will be displayed in the main monitoring interface, allowing:

   - Real-time monitoring;
   - Access to historical images;
   - Association of alarms with specific locations or equipment.

4. Interface Examples

   Below, we present screenshots of the system operating with cameras integrated via the Hikvision API:

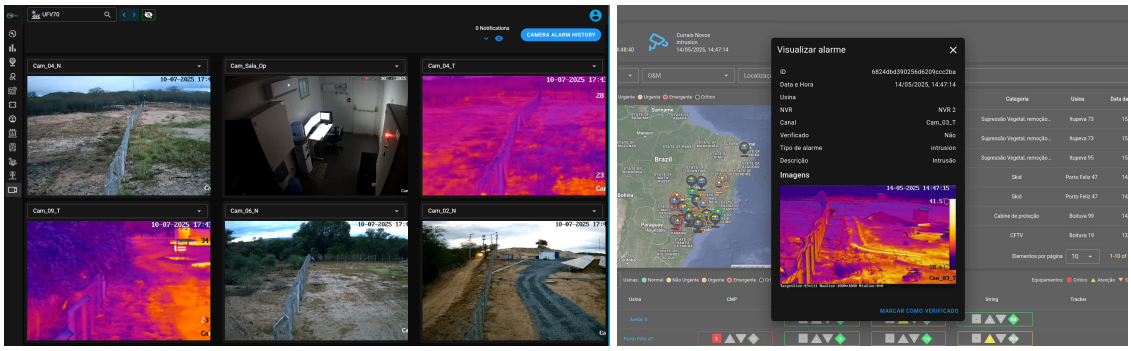

Figure 14: Image streaming and Intrusion Alarms powered by AI.

Note: It is the client's responsibility to ensure proper configuration of cameras and alarms at the source, as well as network connectivity for correct system integration.

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