



Intelligent Grid Operator - **InGO**

Digitization and secure, future-proof operation of electricity grids

Visibility is the first step for better control



The energy and mobility transition poses new challenges to utilities and grid operators. In rural areas, numerous decentralized renewable generators must be integrated in the distribution grids. At the same time, the municipal grids face cable overloads due to the fast increase of e-mobility and new heating technologies.

Ensuring the supply security requires intelligent and automated distribution grids. Our platform-based Intelligent Grid Operator provides the secure and

economic solution for future-proof grid expansion. PSIngo enables grid operators to monitor and control both cellular and decentralized components as well as central cloud environments for micro, low voltage, and medium voltage grids. PSIngo supports the flexible integration of renewable energies into the distribution grids as well as the grid connections of powerful charging infrastructure and storage for the mobility transition.

The (partially) autonomous grid control components can be securely integrated into the process management in the control centers by using PSIngo. Assigned grids can be autonomously monitored and controlled. A secure connection enables direct grid access by the control center in addition to the parameterization and updating of the grid data. PSIngo uses self-learning algorithms for grid control which enables minimally invasive congestion resolution in the grid.

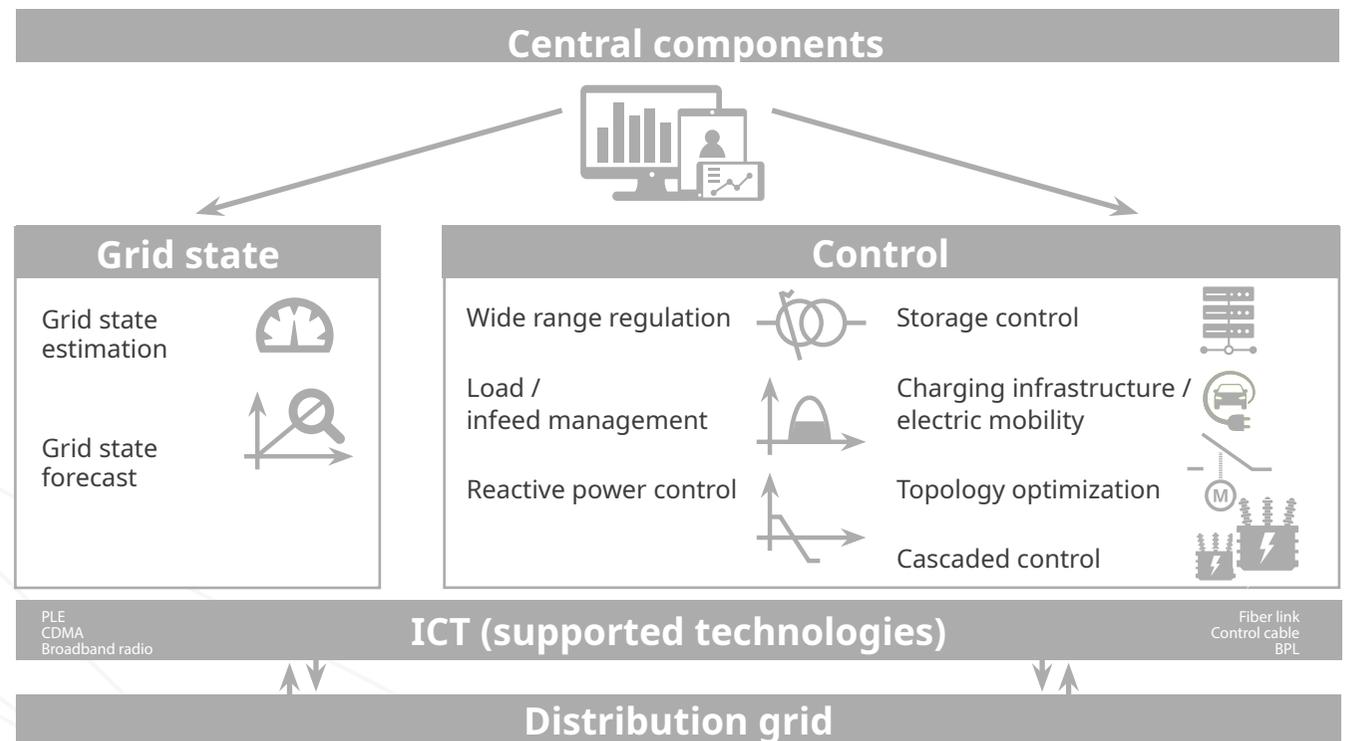
Changes in the generation environment

- + Fluctuating generation
- + Decentralized
- + Bidirectional load flow

Changed consumption by e-mobility, storage and new heating technologies

- + High simultaneity
- + New consumers with peak loads

Intelligent distribution grids ensure supply security by balancing consumption and generation on the lowest optimal level by interconnecting all supply utility types.

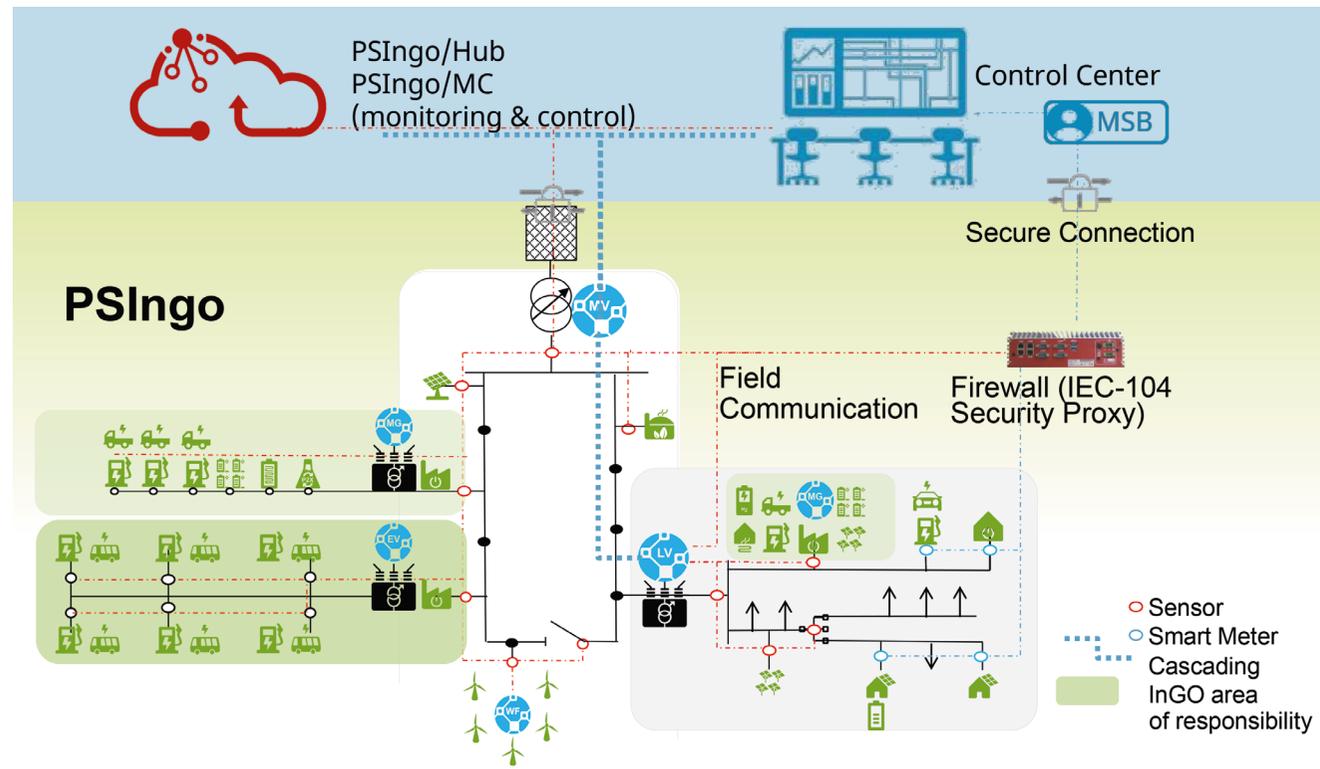


Hybrid grid process management for secure and efficient distribution grid



PSIngo is based on decentralized modules which are connected to each other and upstream systems. The selection and performance of the modules are individually configurable. Here a medium voltage ring (controlled by PSIngo/MV) with several low voltage grids (partially controlled by PSIngo/LV) is shown. In addition, flexible consumers such as micro grids or e-bus depots are supplied (PSIngo/MG and PSIngo/EV).

Every module can autonomously control its responsibility area and at the same time respond to requests from the upstream grid. The system is connected to the control system for parameterization, updates, manual control operations and upstream setpoint settings. The connections to external market participants such as measurement system operators, aggregators or mobility service providers are protected by an IEC 104 Security Proxy which means that information from the public internet can also be securely processed.



The future in your hand: Definition of the smart grid system platform InGO

An active sub-system for control centers
with the operating modes

-  Parallel switching operations
-  Assisted or partially autonomous
-  Fully automated

Modules

- PSIngo/MV** MV grid controller
- PSIngo/WF** Wind park controller
- PSIngo/LV** Low voltage
- PSIngo/WR** Wide range control
- PSIngo/EV** E-mobility, charging management
Charging management
- PSIngo/MG** Micro grid for commercial,
industrial, and area grids

Tools

- PSIngo/MC** Monitoring and control center
- PSIngo/SP** IEC 104 Security Proxy
- PSIngo/PD** Patch and device management

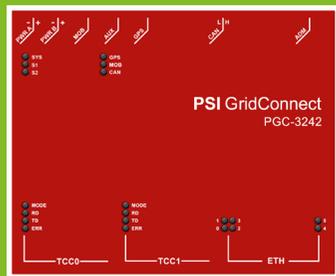
Licensing

Permanent license or PSIngo365
(including maintenance & updates)

Decentralized autonomous grid automation and analysis of the grid states



The future in your hand

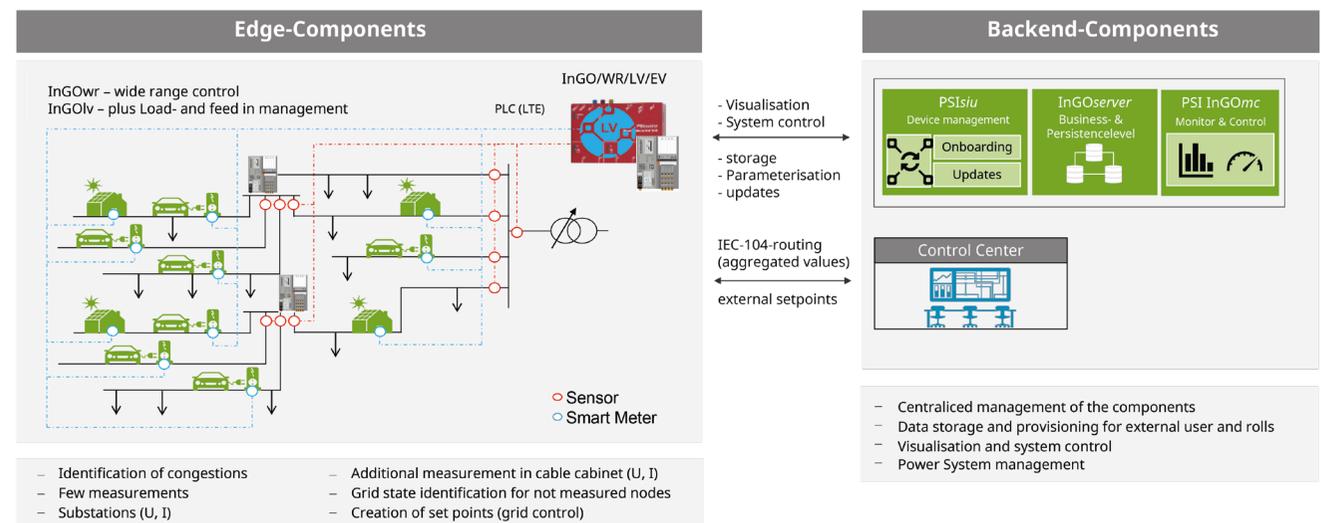


The new platform PGC-3000 has been designed for optimized use of smart grid applications in the field. In comparison to the predecessor platform STU, the PGC-3000 offers the following advanced performance and features:

- + **Very compact construction for installation in existing grid infrastructure**
- + **High system performance (4 CPU cores) for complex operational requirements in the future**
- + **More RAM and flash memory**
- + **Fully featured telecontrol interfaces**
- + **Numerous interfaces for various use cases (LAN, fiber SFP interfaces)**
- + **Expanded operating voltage range (12-60VDC instead of 12-28VDC)**
- + **System hardening by eliminating external USB interfaces**

The decentralized and autonomous system concept of PSIngo supports the grid management and the control systems by automated autonomous monitoring and balancing of the grid without requiring interventions by upstream instances. This significantly reduces the transmitted data volume and increases the resilience of the system.

Concepts for aggregated display of information in form of stop light values provide new insights and optimized interaction with the decentralized and autonomously operating PSIngo. In PSIngo/MC, data points are transmitted via standardized protocols and visualized. At the same time, they can also be queried by the control center. The automatic archiving and documentation of measurement data and control interventions allow detailed analysis of specific grid situations, measured value trends and control interventions performed by the system. The additional information provided by the system (for example, available grid capacities or potentially critical grid areas) is a valuable database for designing advanced solution strategies in the areas asset management, grid management and grid planning.



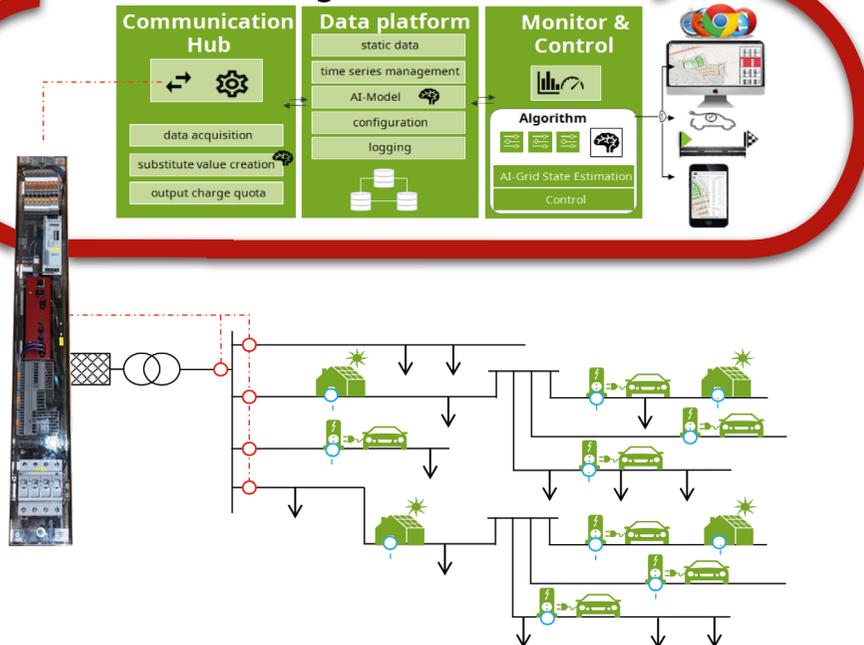
Central, cloud-based visibility and control

PSIngo provides the energy industry with the required intelligence - even for cloud-only operations. The platform PSIngo/Hub combines the advantages of a central cloud infrastructure with the possibility of using decentralized grid controllers as fallback level. This provides operational security and resilience. The distributed cloud environment is in particular used for managing mass data. This allows flexible storage, processing and analysis of large data sets. They are quickly available and flexibly usable at all times.

The capital expenses are low and companies do not have to buy their own expensive hardware. Our cloud

solution enables grid operators to respond quickly to customers and market requirements as well as provides maximum security against cyber attacks. Grid operators can efficiently optimize the grid utilization and guarantee maximum supply security. Now individual solution concepts can be designed for rural medium and low voltage grids with numerous infeeds as well as load-driven municipal grids and customer-owned micro grids.

PSIngo/Hub in the PSI Cloud



Platform-based solution for automation, monitoring and control of electric grids in the cloud.

Grid status determination for early detection of impending grid congestions

PSI grid management as central service

PSIngo/Hub with cloud-enabled grid apps

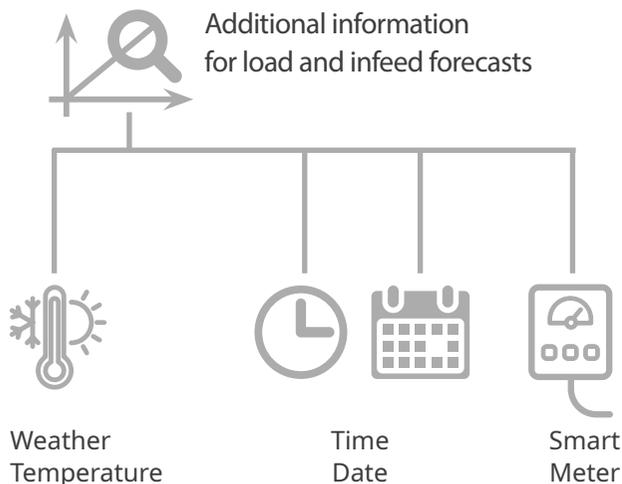
- + Licensing by "PSIngo365" cloud version
- + Cloud-enabled grid apps
 - + Integration of control system with e-mobility back-end
 - + Load management for charging infrastructure
 - + State estimator for LV level
- + System provisioning in high-availability PSI computer center
 - + Connection to back-ends of mobility service providers
 - + Measurement point integration (IEC 60870-5-104, OCPP)
 - + Installation and parameterization of PSIngo/Hub
 - + Integration tests
 - + Project support
 - + Training for project teams
 - + Comprehensive documentation
 - + Integration of existing hardware (I/O cards)

Economic grid development with artificial intelligence

The exact grid state estimation of PSIngo is optionally based on artificial intelligence. The behavior of the distribution grid is learned based on major variables such as grid load, electricity consumption and electricity generation in combination with external information such as weather forecasts. Thus, the system detects critical grid situations in time, determines the optimum solution from the available alternatives and derives the necessary control commands.

Now grid operators can optimize the voltage regulation and auxiliary power usage as well as avoid thermal overloads. PSIngo is capable of operating with few measurements from the distribution grid which allows fast, scalable and cost-efficient digitization of the grids. Furthermore, the innovative algorithms for grid control enable immediate integration into the grid management and planning processes.

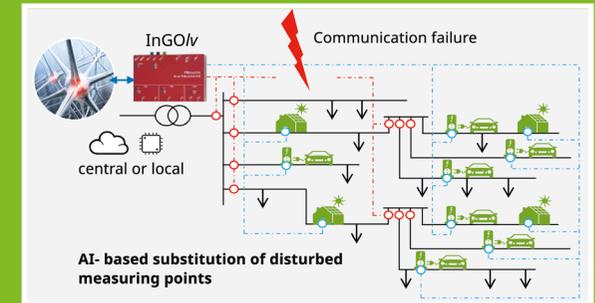
- + Reliable detection of grid overloads
- + Multi-criteria decision optimization
- + Autonomous grid management in smart grids
- + Holistic integration of all work processes
- + Minimally invasive grid interventions in case of congestions
- + Exact forecast results for the grid state
- + Vendor-neutral load/infeed management
- + High system availability due to hybrid design
- + Adaptive grid structure and topology detection
- + Consideration of compensating currents and many other features



Benefits of AI-based grid state calculation

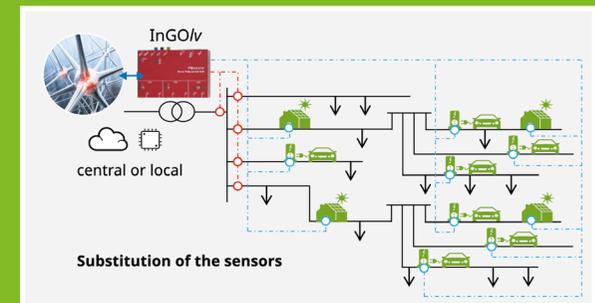
- + Increased outage security in case of communication errors
- + Continuous forecast results for the grid state by self-learning algorithms
- + Reduced capital expenses for measurement sensors
- + Fast, scalable and economic digitization of the distribution grids
- + Consistency and transparency of grid data by combination and validation of previously isolated databases

Increased efficiency by using AI-based processes



Increased availability

In case of central or local communication outages with measurement points in automated distribution grids, a reliable grid state estimation based on the learned data is performed for the respective area which significantly increases the availability.



Requiring fewer sensors

Cost-efficient digitization of distribution grids is possible by using a self-learning grid which makes the measurement points obsolete. The learning-capable AI will make ever better decisions over time.

The superior AI-based solution for the distribution grids of the future

Overview of PSIngo benefits

- + Reliable look-ahead detection of grid overloads
- + Optimized load and infeed management across voltage levels
- + Switch for operating mode (manual/automatic)
- + Operation by web user interface and mobile apps
- + Hardware-neutral (integration of measurement systems)
- + Development environment for exploratory analyses and adaptation to new use cases
- + Individual design (in the cloud, as control system or decentralized autonomous operation)
- + High system availability due to fallback levels and hybrid system design
- + Topology monitoring and execution of automatic switching operations
- + Scalable vendor-neutral load management (residential, commercial, public traffic)
- + Interfaces for external applications
- + "Click-to-deployment" tools for simple system engineering and configuration
- + New possibilities for process management – cooperation between field service and smart grid system
- + Comprehensive multi-criteria optimization



InGO: Integrated and resilient

Monitoring and control tasks are performed with maximum autonomy but still connected to the cloud or control system with the upstream controller instance. This provides coordination across voltage levels for compliance with the required system limits as well as the ability to receive setpoints from the control center.



InGO: Smart grid ready

"Smart grid ready" means integrated project roll-out covering everything from reliable acquisition of measurements for monitoring and analysis to automatic patch and device management. InGO is integrated as an active sub-system into grid management processes and off-loads the control center on all distribution grid levels.



InGo: Securely competitive

InGO offers coordinated grid control to avoid investing in the wrong equipment - a competitive and attractive alternative to conventional grid expansion. The appropriate tools for integration and project design are available for grid planning and support of all involved staff.



InGO: Independent of the control center

InGO communicates with the upstream grid control center using standardized telecontrol protocols. The decentralized controller transmits operating parameters, grid states and aggregated values to the control system. In the opposite direction, setpoints and switching operations (active/passive) are sent to InGO.



InGO: Self-learning intelligence

The increasing market synchronization of the distribution grid including generating plants requires artificial intelligence for forecasting and managing the potential dynamics. InGO has already gained relevant field experience with grid structure detection using an AI environment and a small set of measurements.



InGO: Scalable grid expansion

For grid operators, InGO is a flexible, economically reasonable and risk-free alternative. In order to optimize the planning of the transformation process triggered by the energy transition, InGO first integrates measurements from the "depth of the grid" for more transparency and better planning. The next step is the successive rollout of intelligence at the required locations.

Secure integration of control systems and protection against cyber attacks



IEC104 Security Proxy for secure connections to IEC 60870-5-104 end devices

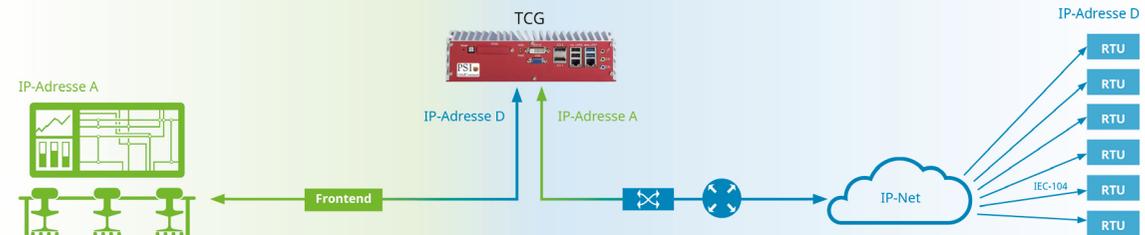


Main functions

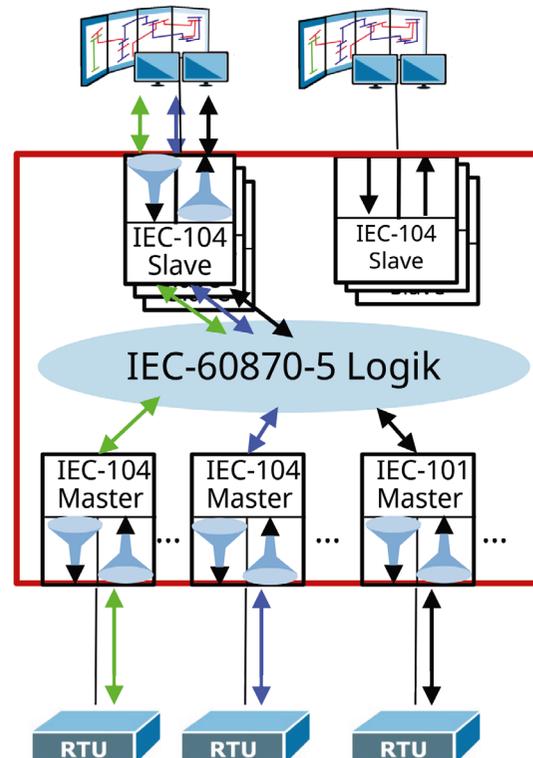
- + Verification of correct implementation and use of the IEC 104 protocol
- + Filter for sent and received objects
- + Listen-only mode
- + IEC104 compliant and redundant connections to control systems and RTUs
- + Migration of the IEC 104 connections between legacy system and new system
- + Encrypted communication with control systems and RTUs

Security functions

- + Hardened system
- + User of secure protocol variants
- + Integrated firewall



Control System 1 Control System 2



The increasing digitization of the energy industry increases the risk of cyber attacks on energy infrastructures. In addition to control systems, cloud applications and telecontrol equipment, the communication processes between the system components are particularly at risk.

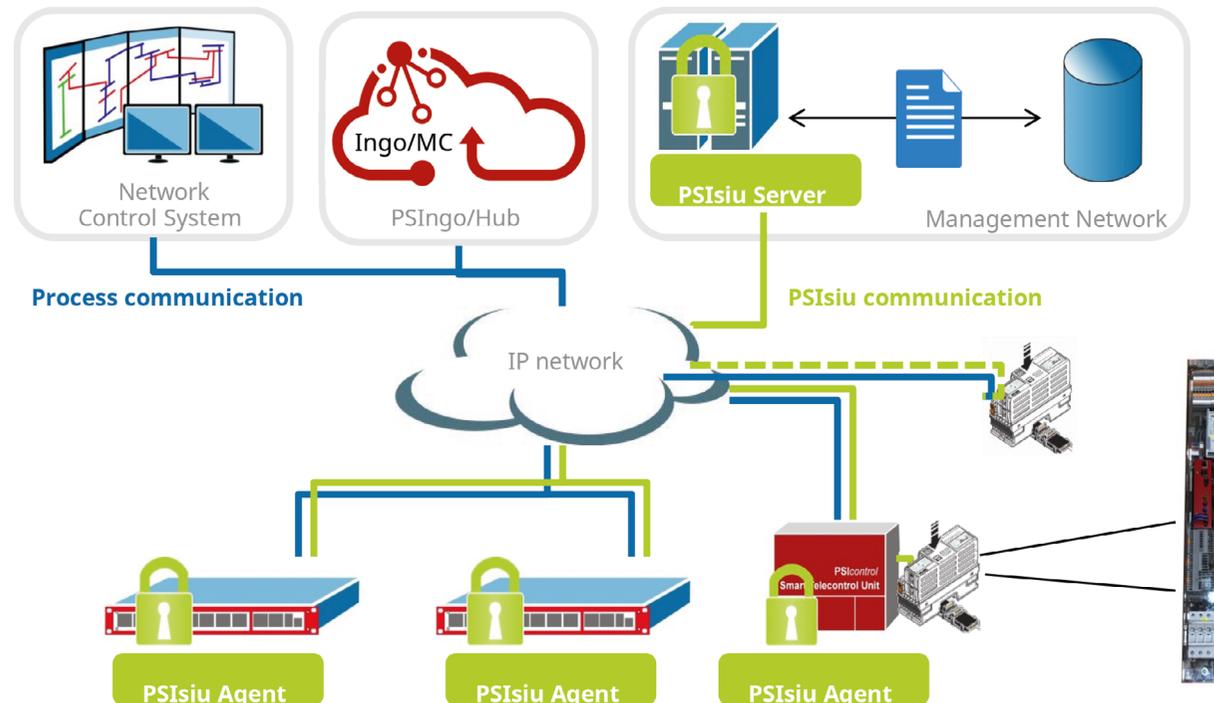
The IEC 104 Security Proxy enables secure and efficient integration of telecontrol equipment. It operates as a separate instance between control system or the PSIngo/Hub and the IEC 104 end devices, establishes - as IEC 104 master - connections to end devices and operates as IEC 104 slave with regard to the control system. The implemented listen-only and filter functions expand the usability of the proxy. The powerful hardware provides sufficient reserves for secure operation of communication-intensive process interfaces with large numbers of connections.

The operating system platform NENUX provides important upgrades for secure data transmission between network control systems and RTUs.

Secure start-up, update and device management

You are responsible for installation and updating a large number of devices? You are responsible for contemporaneous installation of security updates on all devices? You are responsible for logging security-relevant events and issues?

PSIsiu provides software and device management for state-of-the-art grid edge technology. The software continuously provides you with an overview of all devices of the Telecontrol Gateway and Smart Telecontrol Unit product family as well as software distribution to the devices in the field. The increasingly important integration of third-party devices must be examined if needed. The redundantly designed PSIsiu server provides versioned system components (system software, application software, configuration, usw.). You can define the required configuration level for each component of each device in the system which the PSIsiu agent then installs and monitors autonomously. The device management uses only the secure protocols SFTP and HTTPS as well as SNMPv3.



Patch and device management PSIsiu

- + Test, provision and update system components
 - + Secure start-up
 - + Software versions
 - + Software modules
 - + Security patches
 - + Configuration files
 - + Data models
 - + Certificates
- + Monitor devices
 - + Central overview of devices
 - + Display device status
 - + Make backups
 - + Generate security reports
 - + Start-up devices

PSI GridConnect GmbH

Greschbachstr. 12 · 76229 Karlsruhe · Germany
Phone: +49 721 94249-0 · Fax: +49 721 94249-10
info@psigradconnect.de · www.psigradconnect.de

