APROL EnMon
Control your energy costs

PERFECTION IN AUTOMATION
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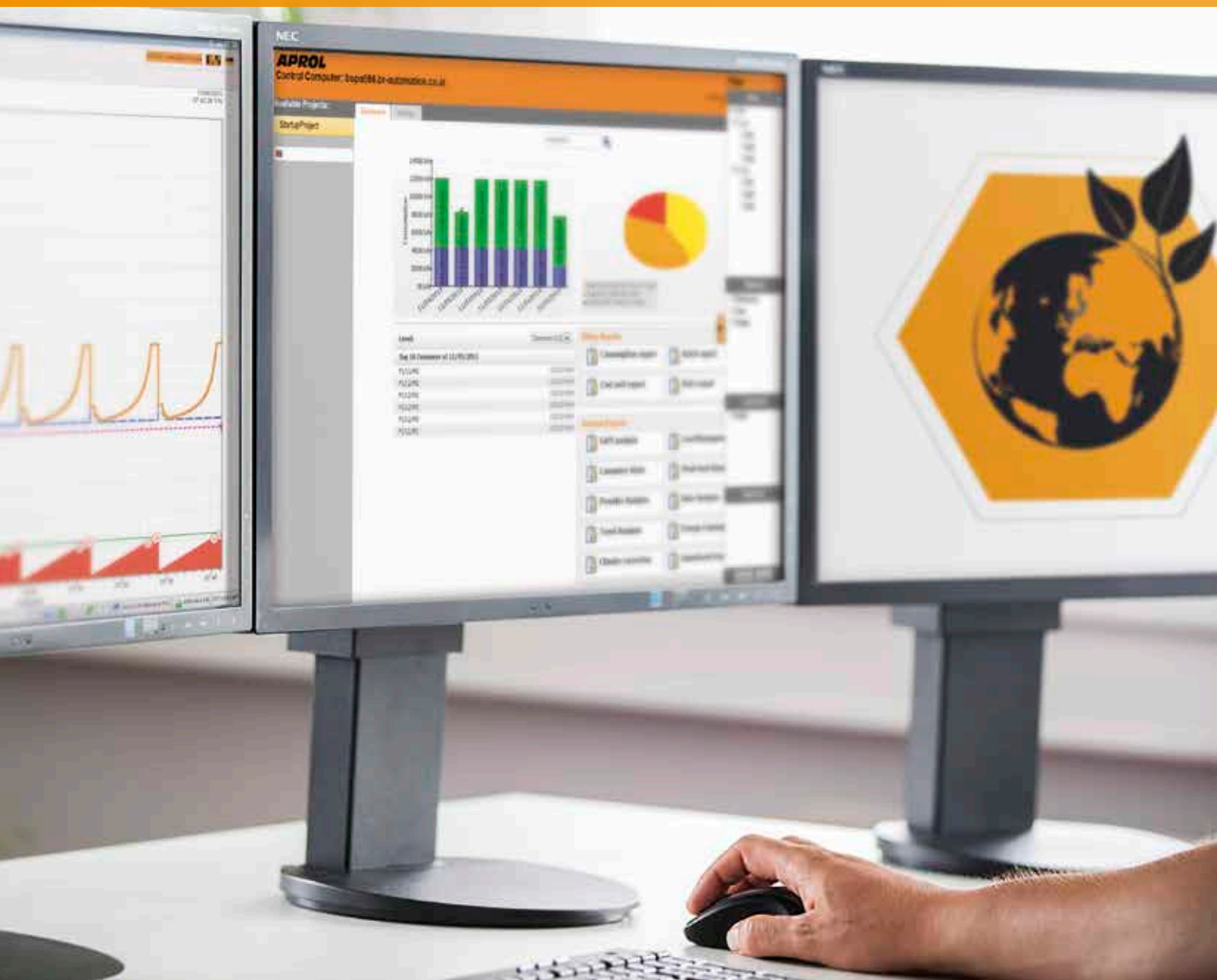

You can only manage
what you can measure.

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Significant savings through improved energy efficiency

The much-anticipated ISO 50001 international standard "Energy management systems – Requirements with guidance for use" was published in 2011.

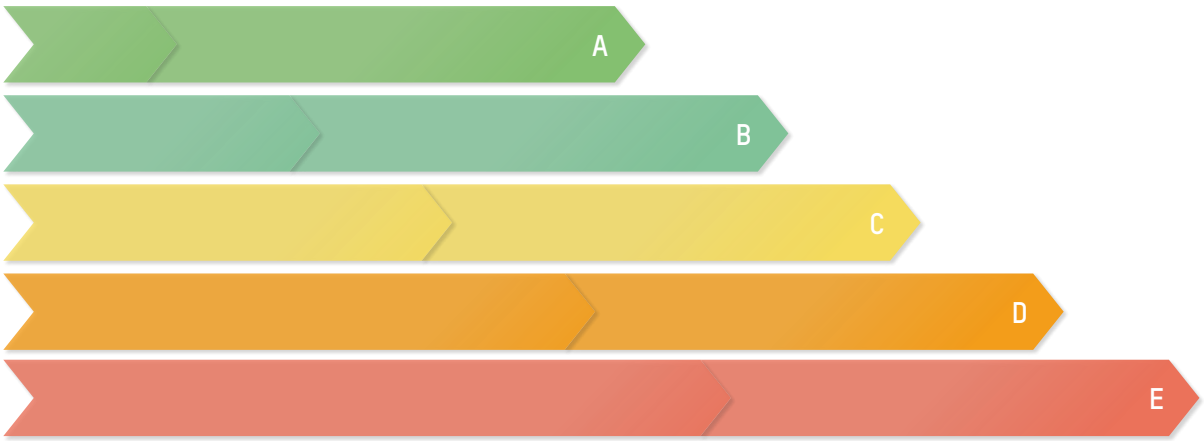
According to estimates, up to 60 percent of the world's energy use could be positively influenced by this standard. With forecasts predicting at least a 20 percent increase in energy prices by 2020, improving energy efficiency will be an effective way to control costs in addition to securing a competitive edge.

Holistic specification of requirements

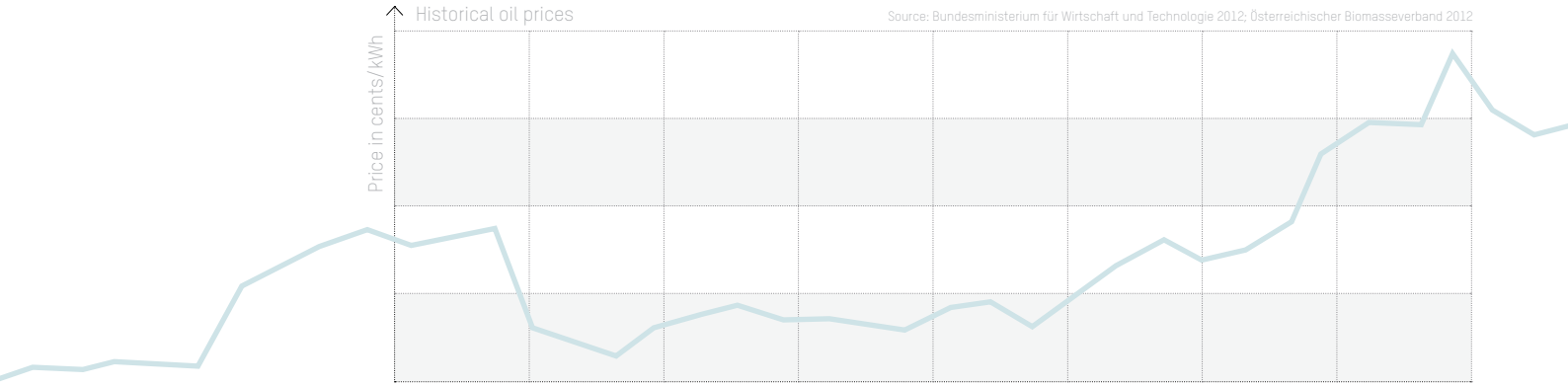
The systematic approach applied in the ISO 50001 standard is designed to help organizations improve their energy-related performance by increasing energy efficiency and optimizing the use of energy across the board. This standard specifies all of the requirements that must be fulfilled by an organization looking to introduce, maintain or improve its energy management system.

More management responsibility

Some terminology in this standard has been changed compared to EN 16001, with the introduction of an additional component – "Management responsibility" – which calls for a stronger role for administrative personnel. Nevertheless, the transition to ISO 50001 is generally considered a step forward for most organizations.



Identifying energy usage: Energy efficiency classes illustrate the energy consumption of various goods. The most efficient goods are those in class A.

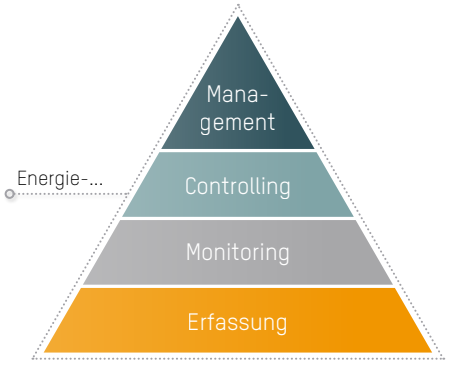


Goals of the ISO 50001 energy management system

- Regular measurement and recording of the most important energy consumers
- Monitoring of energy management programs
- Adequate precision and reproducibility
- Verification of adherence to relevant legal regulations and obligations at regular intervals
- Investigation of any deviation from expected energy usage during the current period, as well as full documentation of the deviation and the identified cause
- Regularly checking the correlation between energy usage and consumers and other underlying factors, corrections when necessary
- It is only possible to manage and optimize things that are measured.

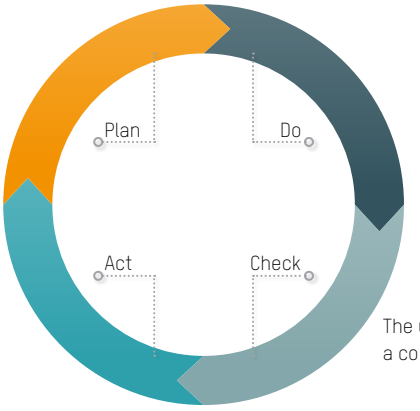
Economic goals

- Maximizing reductions in energy costs (for all energy types)
- Determining the correlation between energy costs and manufacturing costs
- Implementing consumption-based cost allocation (polluter pays principle)



Measuring and recording relevant data is an important facet of effective energy management.

- Identifying and justifying projects for saving energy
- Reducing downtime by monitoring the supply of power
- Preventing unplanned shutdowns (load curve and peak load analysis)
- Switching on consumers depending on the availability of electrical power
- Displaying energy reports and diagrams for a machine, subsystem, main system or company with regard to batch or cost unit

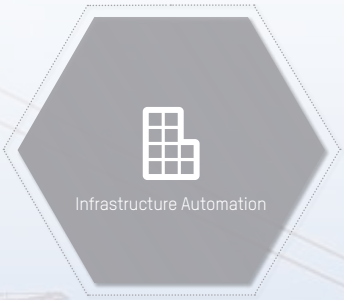


The underlying ***PDCA cycle*** (***Plan-Do-Check-Act***) reflects a continuous four-phase process for improvement.

Standalone solution for measuring and monitoring in all industries

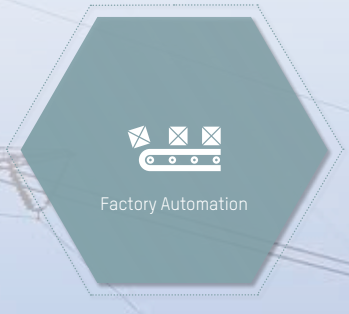
Measurement, logging and evaluation
ISO 50001 is a global standard that applies to all industries. APROL EnMon is B&R's solution for measuring, recording and evaluating all relevant energy usage to provide optimal support for the continuous improvement of processes.

Standalone – or fully integrated solution
Because APROL EnMon is a standalone solution, it can be integrated into existing automation solutions without risk. It is up to the user whether energy monitoring should be installed independently of existing building control, SCADA or process control systems. APROL EnMon has been designed as either a fully integrated or standalone solution; as such, it can be implemented into existing APROL process control systems at any time.



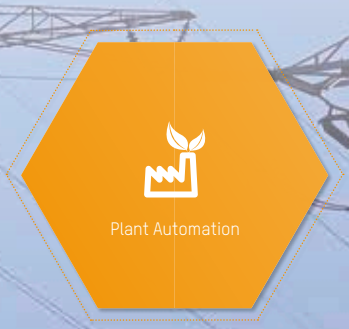
Infrastructure automation

For users such as energy contractors, the standalone solution is usually the best way forward since it doesn't require intervening in existing systems. Time-consuming interface clarification tasks on legacy systems as well as adjustments and modifications to the existing system are not necessary.



Factory automation

In the area of factory automation, energy data from individual machines is required; this data is made available over various interfaces. Other energy data is measured using additional transmitters and collected using remote I/O channels in a separate energy monitoring system.



Plant automation

For mid-sized systems typical of plant automation, adding a controller to the existing system for energy monitoring makes sure that tasks are kept separate. Direct processing the energy data in an existing APROL system is an effective way to minimize investment costs.

Process control

Most existing process control systems already have several locations where energy is measured. The energy data is then connected via specified interfaces and processed in a separate energy monitoring system. In this way, the existing process control system configuration remains unchanged.

Out-of-the-box energy monitoring

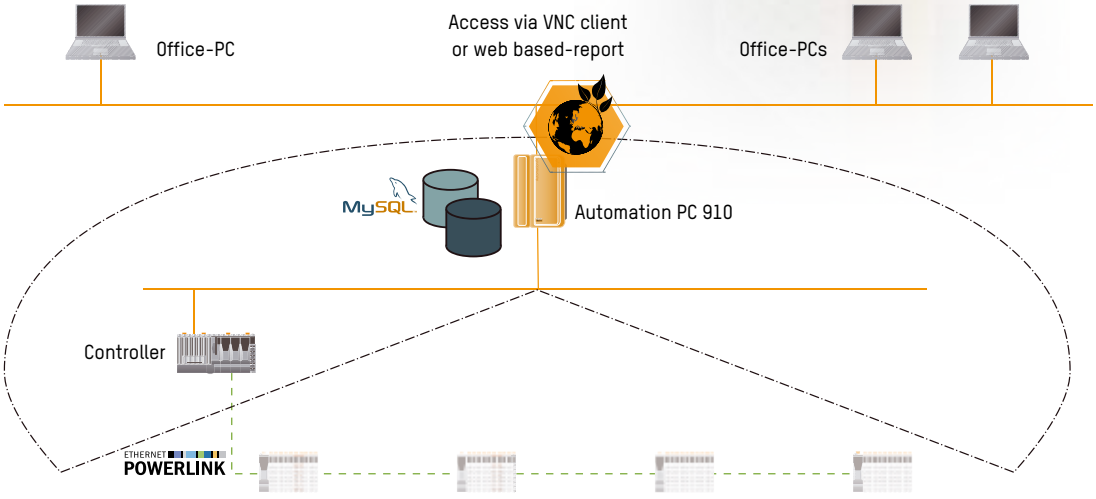
APROL EnMon possesses the flexibility to adapt to any requirement. As a finished solution package, all customers have to do is set parameters for the system to be ready to use. In the same way, complete energy management is possible through the integration of APROL EnMon into the APROL process control system.

Maximum flexibility
Based on the APROL process control system, B&R now offers APROL EnMon, an out-of-the-box solution for energy monitoring. As an engineering platform, APROL ensures maximum flexibility with the least amount of cost and effort. It considerably simplifies the implementation of energy management tasks set up in connection with the ISO 50001 and EN 16001 standards while ensuring that no information whatsoever falls through the cracks.

Ultimate scalability
Since APROL serves as the process control platform, it is also possible to implement solutions that go far beyond conventional energy monitoring tasks. The result is maximum investment protection, with more than enough flexibility and scalability for the system to grow into whatever tasks you assign it. In this way, the system is always perfectly tailored to your demands, regardless of whether it contains only a couple dozen measurement points or several thousand.

System topology

Automation PC 910: Robust solution
for control cabinet installations



The standard APROL EnMon package consists of an Automation PC 910 and X20 controller. The system can be further upgraded as needed.

Preinstalled hardware
An APROL EnMon system consists of an Automation PC 910 situated in a control cabinet. It includes the complete system with all necessary software preinstalled. In addition to the engineering and operator software, it also includes the central component of the energy monitoring system – a database with an SQL interface running on the highly stable SUSE Linux Enterprise Server operating system. All necessary energy data is stored in history and can be retrieved using a simple Web browser.

Access via web browser
Usually installed in the control cabinet without a monitor, the APC910 can be accessed over the network from workstation computers using a Web browser. No additional software is required.

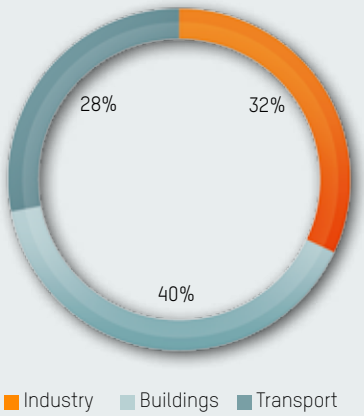
High-performance controller
At least one controller is needed to read the energy data from the I/O modules and to preprocess the values it receives. Depending on the type of processing or types of modules, several hundred measurement points can be processed per controller. Additional controllers can easily be added as needed.

POWERLINK fieldbus
Ethernet POWERLINK provides the communication pathway between the controller and the I/O modules or bus controllers. If existing bus cabling must be used, Modbus TCP or PROFIBUS DP are also possible alternatives.

Full acquisition of all energy types and energy consumption

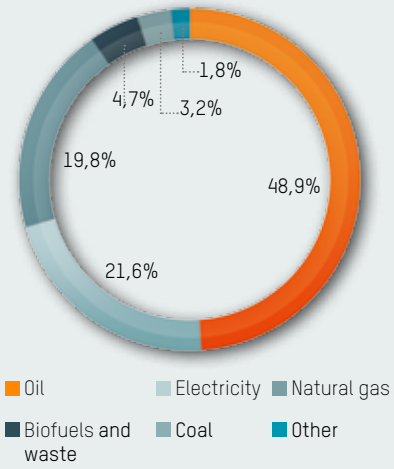
Energy consumption by area

When looking at the amount of energy consumed for buildings, industry and transport, it becomes evident that approximately 70 percent of energy is used for industry and buildings.



Total energy consumption

Total energy needs are covered primarily by oil, gas and electricity. Electrical power, heating and water are used intensively in buildings. In industry, energy sources are highly dependent on the sector.



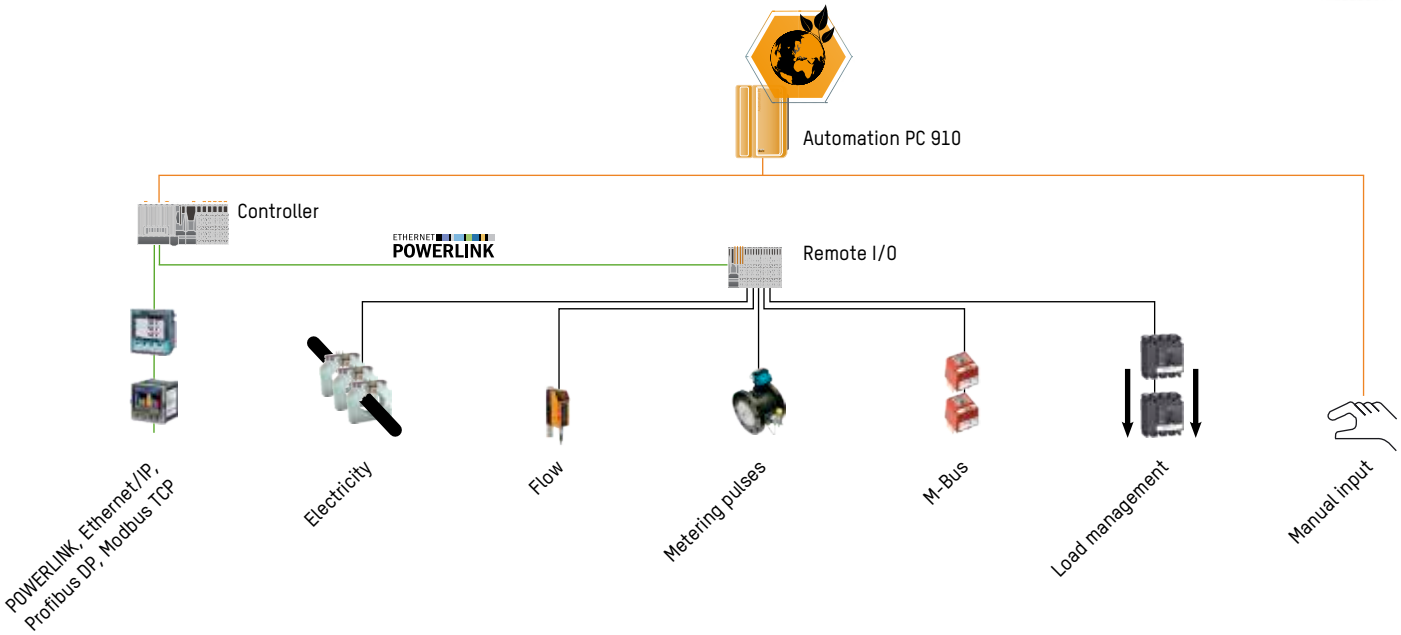
Source: International Energy Agency

User-defined energy types

APROL EnMon provides energy monitoring for all different types of energy, not just electrical. These types of energy can be defined as needed so that the user can specify names that correspond to the particular requirements at hand (e.g. Heating Gas A7, Heating Gas B3). A generic approach is used throughout the data reporting, making it unnecessary to make any adjustments whatsoever.

Highlights

- → Electric
- → Gas
- → Oil
- → Steam
- → Thermal
- → Air
- → Water
- → Other, including renewable energy sources



All consumed energy is recorded using compact X20 I/O modules. The following lists some of these modules as well as their features.

- **Energy measurement module for electrical power**
  X20AP energy measurement module for active power, reactive power and apparent power; records phase sequences, individual phases and cumulative values; current over neutral line; records frequency and harmonics (up to the 31st harmonic)

- **Analog signal for volume/mass flow rate**
  X20AI analog input module for analog measurement signals (e.g. flow rate)

- **Metering pulses for volume/mass flow rate**
  X20DC digital counter module for digital measurement pulses (e.g. flow volume)

- **Meter reading for volume/mass flow rate**
  X20CS interface module with integrated M-Bus master for connecting up to 250 M-Bus slaves (e.g. meter reading for gas, water, electricity, heat, and impulse meters)

- **Meter reading for volume/mass flow rate, energy**
  X20IF interface module connecting POWERLINK, Modbus RTU, Modbus TCP, PROFIBUS DP, EtherNet/IP (e.g. meter readings of existing measurement points)

- **Switching loads / Load shedding**
  The X20DO digital output module or X20IF interface module can be used to connect or disconnect loads either manually or using load management.

- **Manual entry of unmetered consumption/estimated values**
  A faceplate in the operator software can be used to make manual entries for unmetered or estimated energy values, rates and rate periods.

- **Energy data for the ACOPOS servo family**
  A POWERLINK fieldbus connection allows all relevant data to be read and displayed just like with the X20AP energy measurement module.

Load management protects against peak loads

The analysis of APROL EnMon reports provides optimal support for reducing energy costs by avoiding peak loads and preventing unplanned outages that can result from sudden overloads.

Creating a "worst-case" analysis of peak load helps determine the relationship between the contractually guaranteed power from the energy provider and the worst-case requirements of the system. This makes it possible to improve distribution by being able to plan for or shift loads and/or to avoid peak loads by specifying a load shedding scenario that identifies those loads that can be disconnected. The intervals for these purchasing limits depend on the type of energy, with fifteen minutes for electrical energy and sixty minutes for gas. The average amount of energy supplied or consumed within this interval determines the peak load rate applied for that particular billing period.

Configurable behavior
Configurable software control modules make it possible to manually connect and disconnect loads.

- **"General switch" control module**
  This module is used for connecting and disconnecting loads either manually or using programming logic. This allows manual intervention at any time in addition to being able to connect or disconnect loads in order to empirically determine the power requirements of consumers that are not measured separately.

- **"Load shedding" control module**
  Used for automatically connecting and disconnecting up to ten loads per block. This is done based on the average power forecast within a billing period. Load priority and the associated timing can be configured as needed.

ETHERNET POWERLINK

open SAFETY

Increased availability of the electrical power grid with the X20 energy measurement module

Unplanned outages of machines, systems or individual consumers can result from excessive energy consumption or for other reasons. Due to the widespread use of inverters in many different industries nowadays – not least in order to save energy costs – the resulting harmonics play a large role in diminishing power quality in electrical grids. These harmonics must be taken into consideration when measuring energy in order to achieve sufficient precision. Because of this, they are covered up to the 31st harmonic.

Avoiding reactive load with direct detection on the consumer

Preventing reactive current reduces energy consumption and decreases the load on the mains power supply. Targeted measurement of reactive and apparent power helps identify the cause right at the source.

Monitoring the mains frequency

Unexpected failure of electrical components, especially in isolated operation, can also be prevented by determining the mains frequency with a precision of 0.01 Hz.

Detecting unbalances

Recording current via the neutral line can help detect unbalances on the consumer brought about by short-circuited coils, for example, which makes it possible to avert the resulting disturbances by carrying out targeted measures in a timely fashion.

Intuitive faceplate-based operation makes it easy for the operator to access detailed information.

APROL EnMon

Thermal power / Thermal energy

Flow measurement in accordance with ISO 5167
The "FlowCalculation" control module calculates the rate of flow in pipes with a circular cross section in accordance with ISO 5167-2 (orifice plates), ISO 5167-3 (nozzles and Venturi nozzles) and ISO 5167-4 (Venturi tubes). A high degree of precision is achieved by calculating the mass flow rate using Newton's method and taking the flow speed and Reynolds number into consideration.

Energy and flow calculation for water and steam
APROL EnMon also includes the "PowerCalculation" control module for directly calculating the energy and flow of water, saturated steam and superheated steam (in accordance with IAPWS-IF97). This eliminates the need for expensive dedicated energy computers unless absolutely required for calibration certification.

ETHERNET POWERLINK

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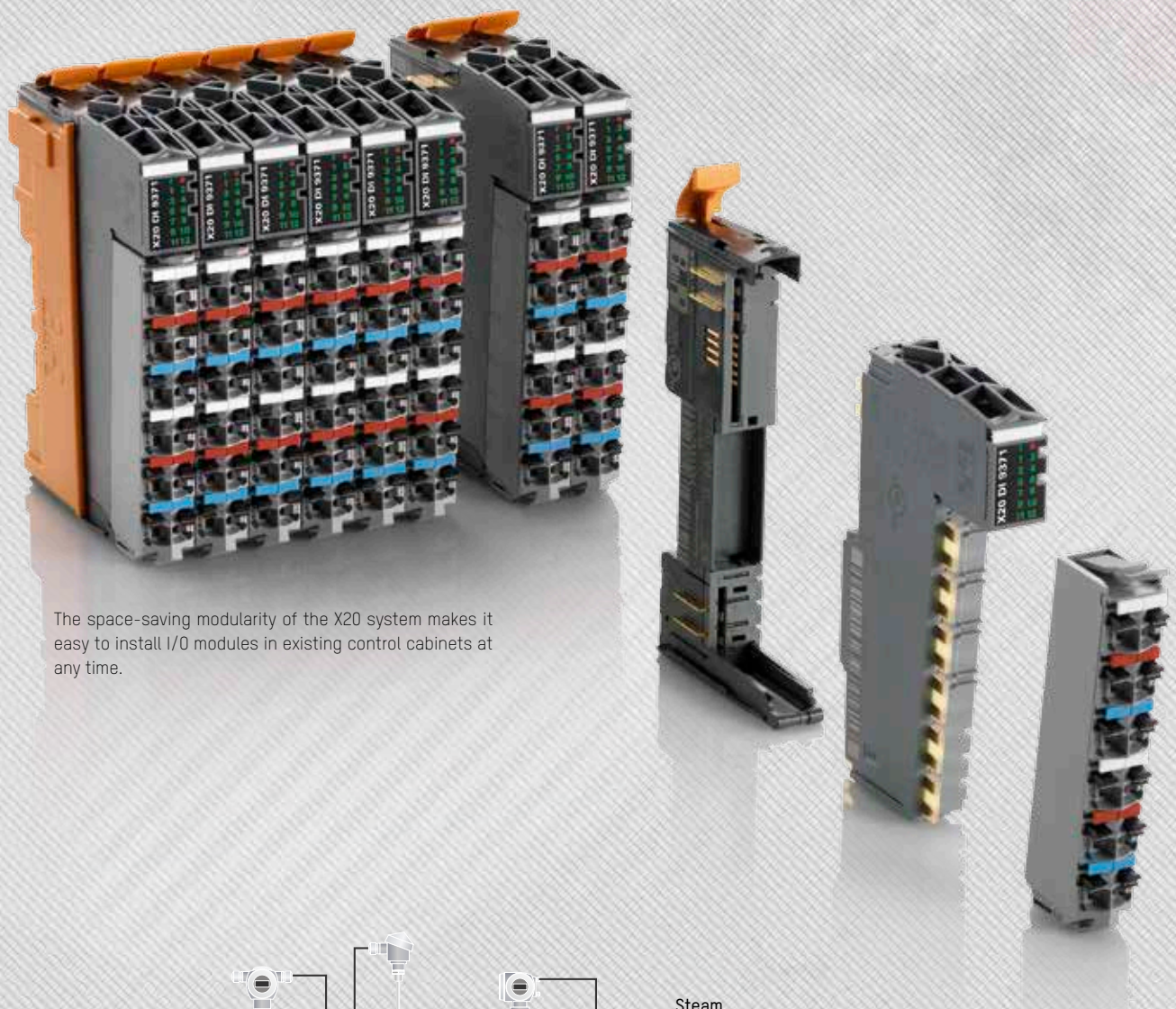
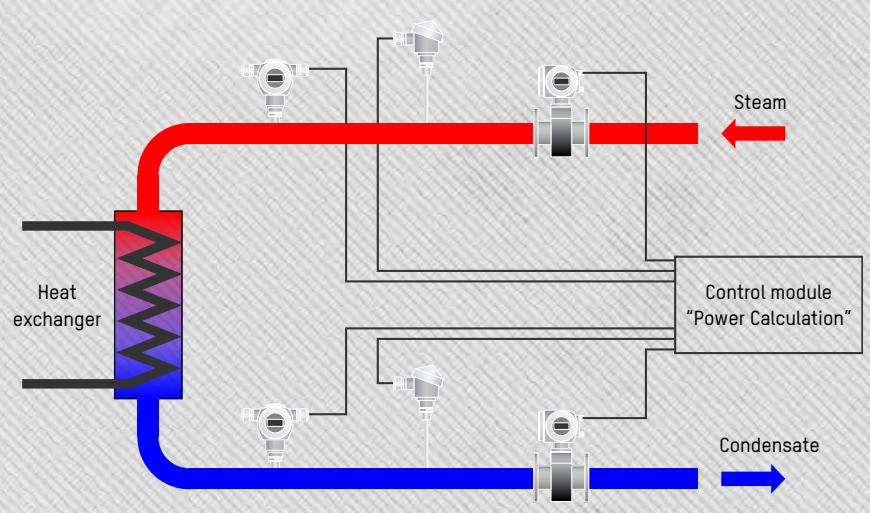


The space-saving modularity of the X20 system makes it easy to install I/O modules in existing control cabinets at any time.



„PowerCalculation" control module for calculating the energy and flow from 1 or 2 measured sections in accordance with IAPWS-IF97.

APROL EnMon is delivered on an Automation PC 910 with all of the necessary software already installed. No additional steps are necessary to set up the APROL system software.

Configuring APROL EnMon

STEP 1

Hardware configuration
Automation Studio

STEP 2

TAG configuration
Excel spreadsheet

STEP 3

Validation and download
CaeManager

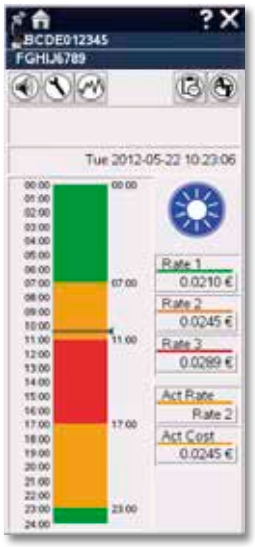
Easy configuration
As an out-of-the-box solution for energy monitoring, APROL EnMon is delivered on an Automation PC 910 with all of the necessary software already installed. The complete hardware configuration is also included; all the user has to do is adjust the network settings as needed (IP addresses, host names, etc.).

→ **Hardware topology in Automation Studio**
A controller for recording energy data is a standard component in every APROL EnMon system. The hardware topology depends on customer requirements and is the first thing to be configured in the integrated Automation Studio project.

→ **Defining the measurement points in a spreadsheet**
The second step involves defining the measurement points and associated parameters in a spreadsheet program (e.g. Microsoft Excel) as well as assigning the necessary templates to the sensors. This data is subsequently used to automatically generate all of the programs used to record, process and archive energy data.

→ **Configuration validation and download**
The third step comprises the automatic validation and any error output from all of the project elements (user software) before downloading to the APROL EnMon system (controller and control computer).

Convenient entry of time-of-use rates
Rates can sometimes be up to twice as high during peak times or seasons compared to non-peak rates. What this means is that shifting loads to times where rates are lowest (e.g. nights) can result in substantial cost savings. APROL EnMon provides support for entering these different rates, either based on the time of day (Rates 1, 2 and 3 can be assigned in 15-minute blocks from 0 to 24 hours), the season (summer/winter) or even for configurable holidays.



The faceplate provides an overview of rates and rate periods.

Dashboard for energy managers

Two customized user interfaces for APROL EnMon users

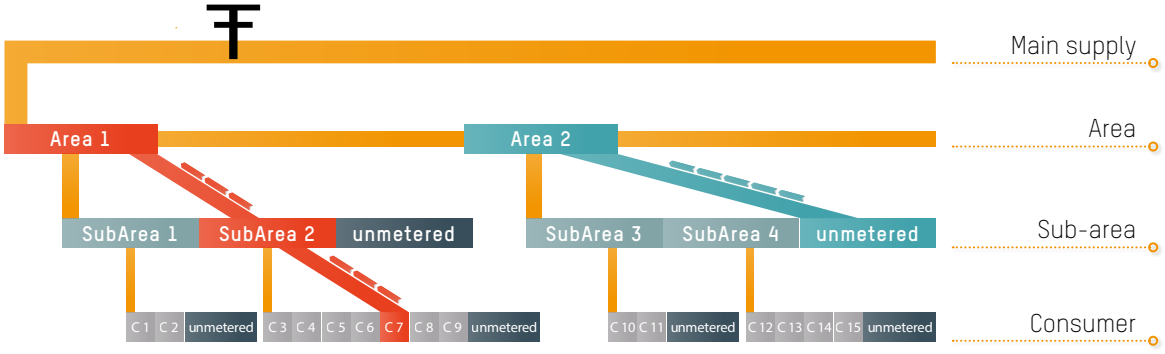
For energy managers and members of the energy management team, a web-based reporting environment called the "EnMon Dashboard" is available. In addition, APROL EnMon provides a powerful system diagnostics and operator environment, which is primarily used for measurement and control engineering.

Selecting energy measurement points

The APROL "EnMon Dashboard" makes it possible to selectively choose all of the energy measurement points available in the system. It follows the hierarchy of main distributor / sub-distributor / consumer by allowing each measurement point to be assigned as an area, sub-area or consumer. For further evaluation, recorded energy data sets are also grouped together according to energy type (medium), respective cost unit and batch ID.

Calculations take hierarchical levels into account

In practice, not all outlets are fitted with energy measurement equipment; as a result, the system automatically uses the results of the higher level (overall measurement) when calculating consumption. The difference between this overall measurement and the sum of the individual lower-level measuring points can then be further analyzed. This ensures that measurements are not counted twice.



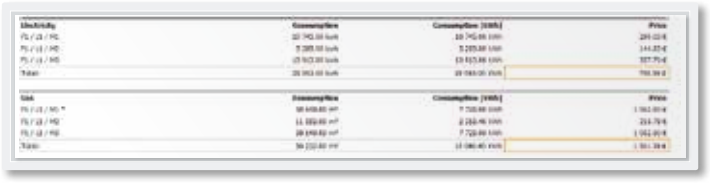
Hierarchical levels. Red indicates the location of the C7 consumer in the sub-area 2 path of area 1. Since the entire path is used to identify a consumer, it is possible for several consumers to have the same label (e.g. C7). Turquoise indicates that all unmetered consumers of area 2 can be recorded when the area is selected.

The APROL EnMon Dashboard provides the ultimate overview.

APROL EnMon Dashboard – The front page for energy managers and members of the energy management team

→ **Top 10 consumers visible at a glance**
To provide a quick overview, the top 10 consumers from the current day are listed.

→ **Grouping according to billing and analysis reports**
All available APROL EnMon reports are grouped as either billing reports or analysis reports. Selecting one of these reports generates the report for the current selection of energy measurement points.

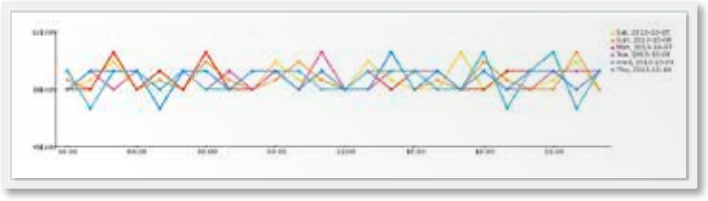


→ **Table view**
Displaying an EnMon report in table form allows all details to be shown and prevents any information from being lost.

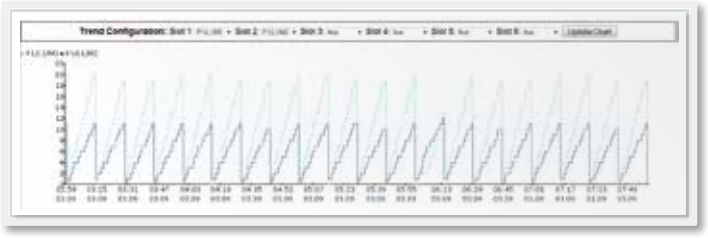
→ **Bar graph view**
The table view of an EnMon report can be expanded into a bar graph.

→ **Pie chart view**
Instead of the bar graph, the table view can also be expanded to show a three-dimensional pie chart.

→ **Trend diagram view - Average value trend**
The trend diagram displays the chronological track of average values (average value over the measurement period) from all historically tracked energy data sets. This data can be used to display processes such as trending information for load curves.



→ **Chronological trend in the Trend Analysis report**
This chronological trend diagram displays a detailed track of all of the values recorded historically by the APROL Trend system. This makes it possible to perform analyses regardless of billing periods and display peak loads without any gaps.



→ **Line graph and consumer status**
A separate line graph for each consumer shows its on/off status. This makes it possible, for example, to analyze the effectiveness of connecting/disconnecting consumers in the event of peak loads and to optimize staggered timing based on this information. Consumers that continue to run unnecessarily during production downtime can also be identified in this way.

Billing reports

Graphical billing reports provide a quick yet complete overview of costs.

Four different billing reports for a clear overview of costs

→ **Consumption report**
The consumption report lists the consumption data and costs for each consumer (grouped by energy type or consumer) individually and collectively

→ **Rate report**
The rate report lists the consumption data and costs for each rate (grouped by energy or rate) individually and collectively.

→ **Cost unit report**
The cost unit report lists the consumption data and costs for each consumer (grouped by energy or cost unit) individually and collectively.

→ **Batch report**
The batch report lists the batch data, consumption data and costs for each batch (grouped by energy type or batch) individually and collectively.

Analysis reports

In addition to billing reports, there are also analysis reports for recording key performance indicators, triggers of peak loads, rate comparisons, etc.

→ **EnPI (energy performance indicator) analysis**
An EnPI analysis can be used to trace the energy consumption per batch or unit produced (quantity, weight, volume).

→ **Load management analysis**
Load management analysis shows the development of predicted loads per billing interval as well as the connections and disconnections initiated by the "LoadShedding" control module.

→ **Consumer status analysis**
This report displays each consumer in a separate line graph that shows its status: 1 (on) or 0 (off). This makes it easy to identify consumers that continue running even during production downtime.

→ **Peak load analysis**
Applying a worst-case analysis over a certain period of time makes it possible to determine which peak loads might occur under unsuitable conditions.

→ **Energy provider analysis**
Rates charged by various energy providers can be evaluated based on historical consumption data regardless of daytime and seasonal rates.

→ **Climate adjustments**
For determining energy consumption in light of climate adjustments (daily temperature figures / heating degree days).

→ **Unmetered consumption**
When installing an energy monitoring system, it is important to determine where the additional measurement points should be installed. An analysis of the static or dynamic behavior of unmetered components can be used to determine whether additional measurement points may be required in another process.

→ **Trend analysis**
The trend analysis directly accesses the data stored in the Trend system. Load curves can thus be displayed in their exact chronological order.

→ **Rate analysis**
The chronological trace of total consumption is color-coded for different rates. Consumption data is shown both individually and collectively (grouped by rate).

→ **Chronological comparison**
For comparing the course of days, weekdays, months and years (comparison depth 1 to 7).

EnMon Alarm and Trend system consumption data
With APROL EnMon, the Alarm and Trend systems are available without restrictions. This means that alarm and trend data points defined in the templates are monitored and recorded automatically in the respective archive when a relevant event occurs. All of this data is accessible without limitations in web-based standard reports.

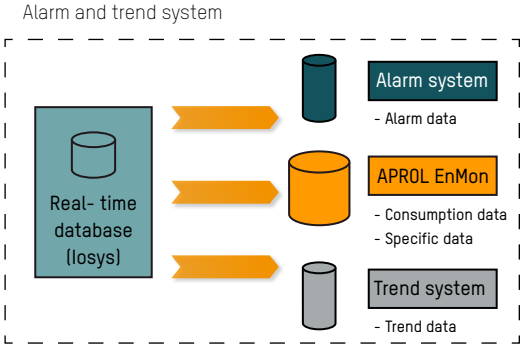
Business intelligence systems
Many large end users employ business intelligence systems to systematically analyze data to gain knowledge that can improve operational or strategic decision-making in pursuit of defined company goals.

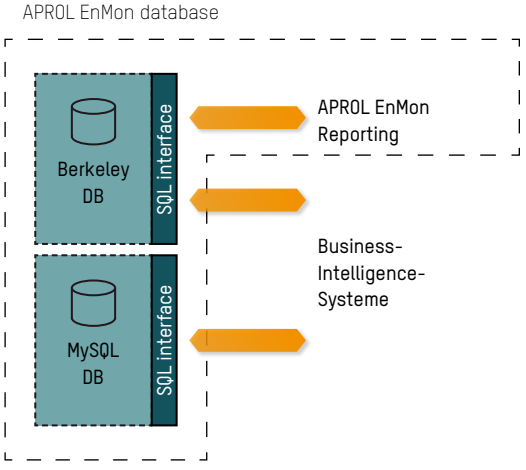
APROL EnMon provides an SQL interface to the integrated Berkeley database for BI systems. It can be used to read all historical data.

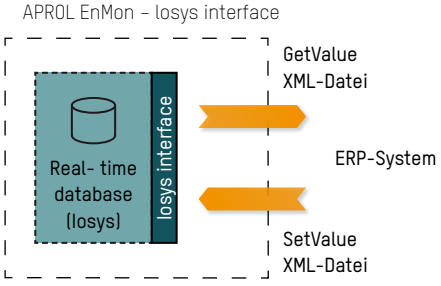
The maintenance-free APROL EnMon energy monitoring solution is thus cleanly separated and protected from all IT systems.

Enterprise resource planning systems
ERP systems are deployed within a company to optimize business processes by making the most efficient use of all of the company's business-related resources.

APROL EnMon uses the losys interface to provide read and write access to all process variables, for example to read current rate information. There is no need to design an expensive communication interface between the ERP system and the energy monitoring system.

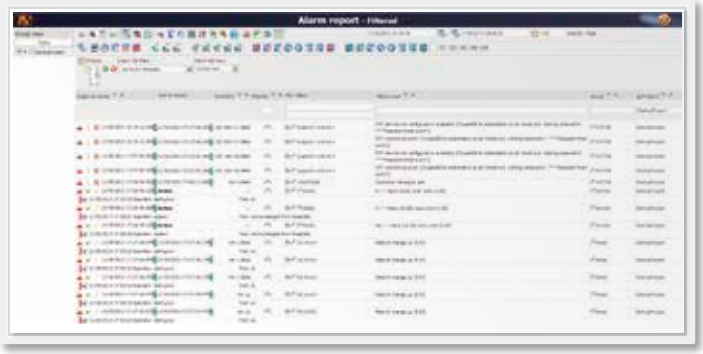




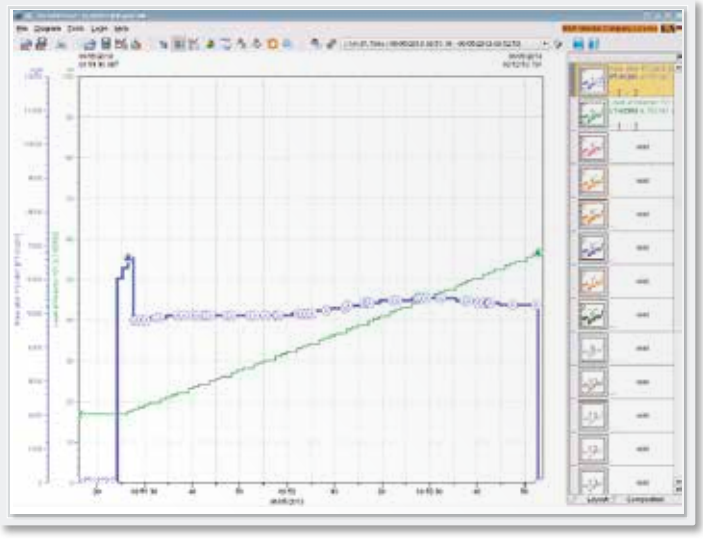


AlarmReport, TrendViewer, Process graphics

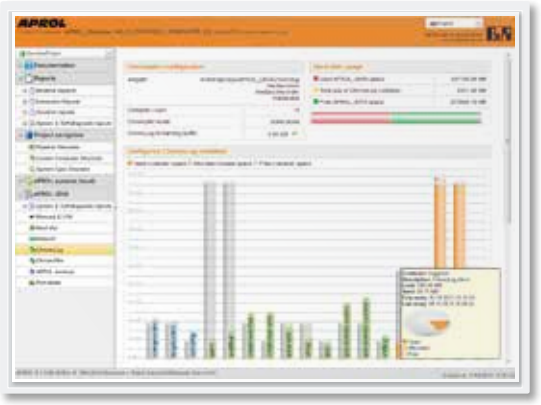
AlarmReport shows all alarms
As the primary instrument for gaining insight into the alarm system, the AlarmReport shows all historical and currently pending alarms in chronological order Extensive filtering and visual options provide optimal support when analyzing the causes of disturbances.



Analysis of signal curves and correlations with the TrendViewer
In addition to the continuous display of process data in the TrendViewer, it is also possible to view event data (alarms, messages, switching actions, etc.) collectively in a diagram. The TrendViewer makes it possible to clearly identify correlations such as peak electrical loads that occur when large consumers are connected, for example.



The APROL System Diagnostics Manager provides maximum transparency.



System and self-diagnostics

The APROL System Diagnostics Manager provides a web-based interface that can be used for diagnostic purposes.

- All relevant data from the energy monitoring system is easily accessible to the operator.
- System and self-diagnostics run in the background and automatically detect any problems that occur (fan failure, loss of connection, insufficient memory, CPU load, etc). It also generates alarms and records signal trace curves.

This type of web-based interface for troubleshooting also provides access to the controller so that I/O modules and I/O channels can also be displayed and diagnosed.

Process graphics ensure clarity

APROL EnMon helps operators gain a clear overview by graphics such as single-line graphs for tracing energy flow throughout the system.

- Easily created by placing dynamic graphic macros using drag-and-drop.
- Clicking on the graphic macros opens up the associated faceplate showing details of all of the available values from that particular measurement point.
- Clicking again opens related trend curves and alarms.
- An image tree makes it possible to build hierarchies as needed.

Customized training for APROL EnMon

SEM820.3 APROL Solutions Training – Basic
The basic knowledge necessary for getting started.
Length of training: 3 days

Highlights

- → Configuring the entire topology (I/O modules, fieldbus systems) using Automation Studio
- → Structure and contents of templates for input signals and transducers
- → Defining measurement points using a Microsoft Excel-based tool
- → Generating, validating and downloading all of the necessary programs in the EnMon system using CaeManager
- → Using all Web-based EnMon reports, including the AlarmReport
- → Backup and restore

SEM821.2 APROL Solutions Training – Advanced
Incorporates more advanced knowledge.
Length of training: 2 days

Highlights

- → Trend system, including the TrendViewer evaluation tool
- → Creating simple process graphics (single-line graphs)
- → Using the DisplayCenter
- → Using additional web-based standard reports
- → Fieldbus technology (POWERLINK, PROFIBUS DP, Modbus TCP, etc.)
- → Basic functions of control modules

Scalability and licensing

APROL EnMon Standard Package
In order to implement a cost-effective solution, licensing must be tailored to individual requirements. The APROL EnMon Standard Package therefore includes the following system software (licenses):

- 1x APROL licensing Set – OEM Runtime/Operator/Engineering for operating APROL EnMon on an Automation PC 910
- 1x AS single license – APROL Edition for the complete hardware configuration (controllers, I/O modules, fieldbus connections)
- 1x APROL ADD-ON – OPERATOR via Net - For 1 user to simultaneously access the operator station (graphic images, etc.). Unlimited concurrent access to web-based reports.
- 1x APROL ADD-ON – SQL server access for read access to all APROL EnMon data sets from an SQL client (one license necessary per project)
- 1x EnMon solution – Reporting/PROJECT for using APROL EnMon reports (one license necessary per project)
- 1x Process Automation Library Edition (PAL-EnMon)/CNTRL for using the EnMon Process Automation Library edition on a controller (one license necessary per controller)
- 1x APROL I/O license – Runtime 50 I/O points for using up to 50 I/O signals from I/O modules (can be expanded)
- 1x APROL NEW GV license – Runtime 50 GVs for using up to 50 I/O signals from fieldbus systems (can be expanded)

AP:OEM-ROEX-EnMon APROL EnMon Standalone Solution
This package includes preinstalled system software (APROL EnMon Standard Package) and hardware (Automation PC 910 with accessories and controller with no I/O modules) as well as all required licenses (operating system, APROL, etc.).

- 1x "APROL EnMon Standalone Solution" licensing package includes all items listed under "APROL EnMon Standard Package"
- 1x Automation PC 910 with preinstalled APROL EnMon system software
  System unit with 2 slots (1x PCI / 1x PCIx4 slot)
  Intel™ Core® i7 quad CPU board, 2.3 GHz
  16 GB RAM DDR3 (2x 8192 MB)
  180 GB SATA SSD (MLC) hard drive
  USB mouse/keyboard (English layout)
- 1x X20CP3586 controller
  X20 CPU ATOM, 1.6 GHz, POWERLINK, 3x IF
  1x CompactFlash 1024 MB

Additional licenses for extending the AP:OEM-ROEX-EnMon package

- 1x Process Automation Library Edition (PAL-EnMon)/CNTRL required if an additional controller is to be used
- 1x APROL I/O license – Runtime if more than 50 I/O signals from I/O modules are needed in a project

Integrated automation
Global presence
Solid partnership

ETHERNET POWERLINK

open SAFETY

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