Energy Management

Software as a tool

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Life Is On Schneider Electric

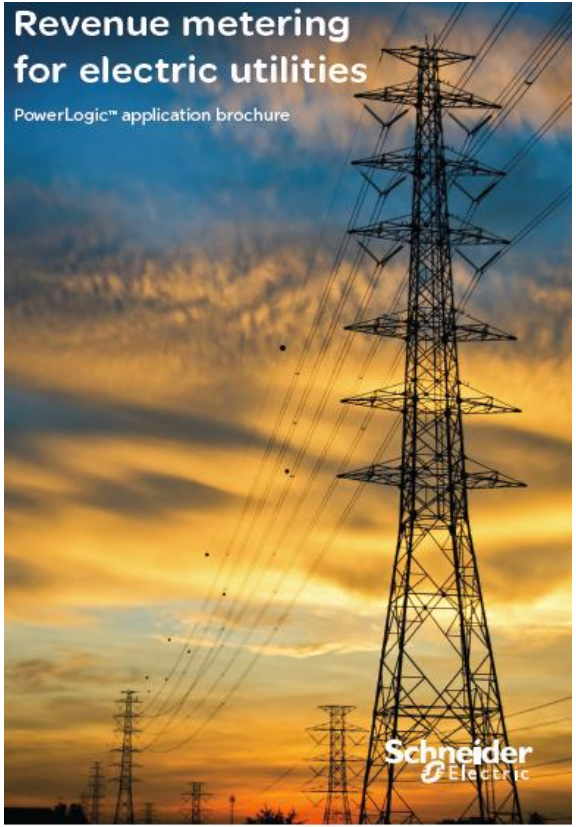
Energy & Power

Quality

Introduction to Power Quality

Electrical Power Features

- The most **essential raw** material used by commerce and industry
- No **quality** assurance checks before its used
- **No storable** in conveniently quantity
- **Unusual commodity**: Type Just In Time (*JIT Philosophy*)



Just In Time Philosophy on electrical power

Introduction to Power Quality

Ideal Scenario

- Control over specifications
- High confidence production's supplier
- Delivery on time
- Overall knowledge of product behavior

Actual Scenario

- Low control and no inspection
- Designated and approved supplier
- Delivered at point and time of use
- Knowledge on limited electrical components

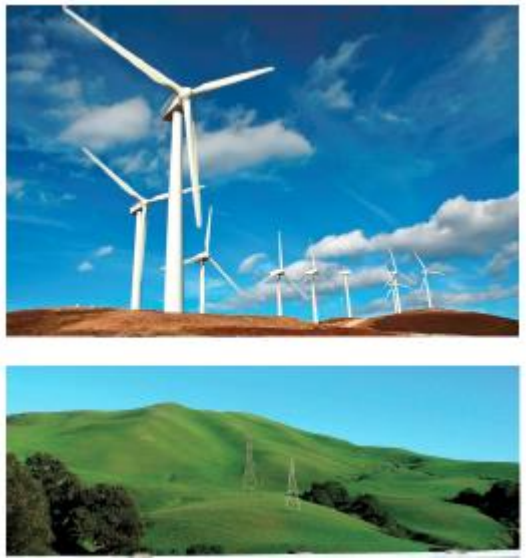
The **reliability** of the supply must be **known**

The **resilience** of the process to variations must be **understood**.

Power Quality Disturbances

Generators' point of view

- Generated far from the point of use
- Many other generators to the grid
- Several transformers
- Long distances, overhead and possibly underground cabling
- Network managed and maintained by a different utilities



The grid suffers many disturbances along its path

Assuring the quality of delivered power at the point of use is no easy task

There is no way that sub-standard electricity can be withdrawn from the supply chain or rejected by the customer

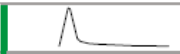
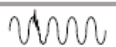
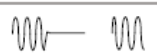
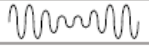
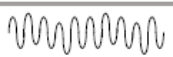
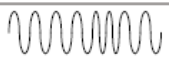
Power Quality Disturbances

Consumers' point of view

- Limited **statistics** available on the quality of delivered power
- The **acceptable quality level** as perceived by the supplier (regulator) may be very different from that required by the consumer.

The grid suffers many perturbances along its path

The most obvious power defects are complete **interruptions** and voltage dips, but they are not the only ones

Disturbance category	Wave form	Effects	Possible causes	Possible solutions
1. Transient				
Impulsive		Loss of data, possible damage, system halts	Lightning, ESD, switching impulses, utility fault clearing	TVSS, maintain humidity between 35 – 50%
Oscillatory		Loss of data, possible damage	Switching of inductive/capacitive loads	TVSS, UPS, reactors/ chokes, zero crossing switch
2. Interruptions				
Interruption		Loss of data possible, damage shutdown	Switching, utility faults, circuit breaker tripping, component failures	UPS
3. Sag / undervoltage				
Sag		System halts, loss of data, shutdown	Startup loads, faults	Power conditioner, UPS
Undervoltage		System halts, loss of data, shutdown	Utility faults, load changes	Power conditioner, UPS
4. Swell / overvoltage				
Swell		Nuisance tripping, equipment damage/reduced life	Load changes, utility faults	Power conditioner, UPS, ferroresonant "control" transformers
Overvoltage		Equipment damage/reduced life	Load changes, utility faults	Power conditioner, UPS, ferroresonant "control" transformers
5. Waveform distortion				
DC offset		Transformers heated, ground fault current, nuisance tripping	Faulty rectifiers, power supplies	Troubleshoot and replace defective equipment
Harmonics		Transformers heated, system halts	Electronic loads (non-linear loads)	Reconfigure distribution, install k-factor transformers, use PFC power supplies
Interharmonics		Light flicker, heating, communication interference	Control signals, faulty equipment, cycloconverters, frequency converters, induction motors, arcing devices	Power conditioner, filters, UPS
Notching		System halts, data loss	Variable speed drives, arc welders, light dimmers	Reconfigure distribution, relocate sensitive loads, install filters, UPS
Noise		System halts, data loss	Transmitters (radio), faulty equipment, ineffective grounding, proximity to EMI/RFI source	Remove transmitters, reconfigure grounding, moving away from EMI/RFI source, increase shielding filters, isolation transformer
Voltage fluctuations		System halts, data loss	Transmitters (radio), faulty equipment, ineffective grounding, proximity to EMI/RFI source	Reconfigure distribution, relocate sensitive loads, power conditioner, UPS
Power frequency variations		System halts, light flicker	Intermittent operation of load equipment	Reconfigure distribution, relocate sensitive loads, power conditioner, UPS

I

✓IEEE Standard 1100-1999

Terminology

✓IEEE Standard 1159-1995

Recommended Practice for Monitoring Electrical PQ

Evolution

MERLIN GERIN

Telemecanique

POWER MEASUREMENT

MERLIN GERIN & TELEMECHANIQUE (France)
POWER MEASUREMENT (Canada)

Schneider Electric

StruxureWare™

PowerLogic
EasyLogic
Acti 9

HARDWARE & SOFTWARE:

Applications

Simplest architectures with the simplest energy meters

WAGES metering

Programmable digital input collects pulse information from any WAGES meter (Buildings and Industry)

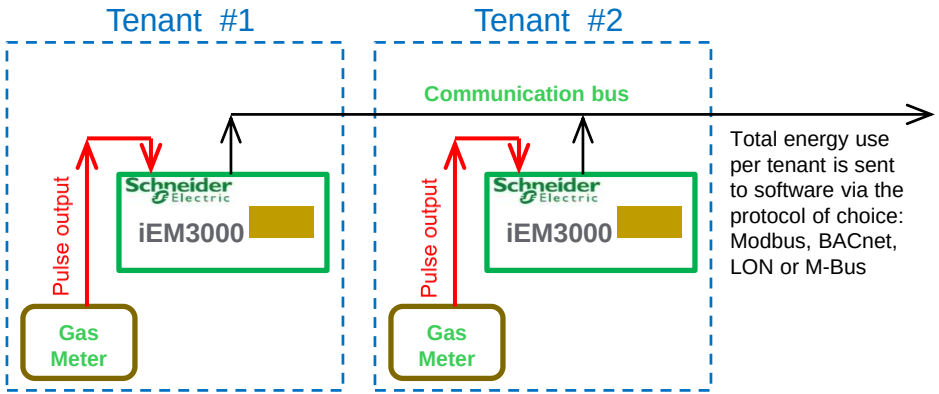
A building owner would like to meter the energy use for **each tenant** in their building, and bring this information **into energy management software**.

The building owner needs to **monitor two types of energy** to get an accurate view of the consumption for each tenant: electricity and gas.

The iEM3000 offers a simple solution for this application. The building owner installs an iEM3000 energy meter on the electrical service for each tenant and connects **the pulse output from the gas meter to** the programmable digital input on the iEM3000.

Since **the digital input is programmable**, the building owner can set the pulse constant so that the pulses from the gas meter are accurately converted into the correct quantities of measurement.

With this solution, the total energy use for each tenant can now be sent to the building owners software using their protocol of choice: Modbus, BACnet, LON or M-Bus.



kW overload alarm

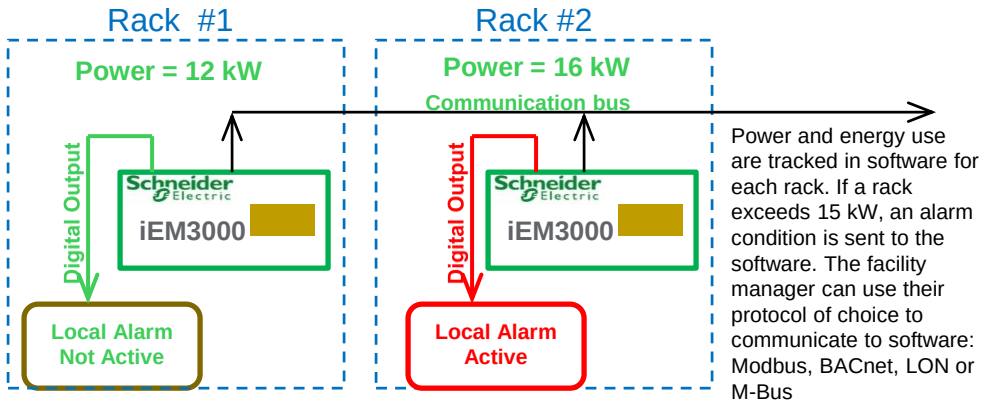
Programmable digital output used as either a kWh pulse, or as a kW overload alarm.

When used as an overload alarm, it can warn the facility manager when a specific circuit is at risk of overload (Datacenters and industry)

In this example, a datacenter manager is required to **limit the power use for each rack** in their facility. Based on both the **circuit breaker limits** and the **need to avoid localized hot spots**, there is a 15 kW limit on power use for each rack on the raised floor.

The iEM3000 meter offers an ideal solution for this application. The facility manager uses an iEM3000 meter to **track consumption and power use** for each rack in the facility. The **onboard alarm on the iEM3000 is set** at a threshold of 15 kW, and **the programmable digital output is enable to display an alarm condition**.

When the 15 kW threshold is exceeded for any rack, the facility manager receives an alarm in software giving notification. In addition**, the digital output triggers a local alarm at the rack (AUDIBLE or VISUAL)**, ensuring that the condition is highly visible.



Multi-tariff billing

Ability to track energy use in up to four tariffs to match the billing structure defined by the utility, ensuring that all sub-bills are accurately calculated. (Commercial multi-tenant buildings)

Utility Billing Schedule		**iEM3000 Tariff Schedule**
Billing rate #1 Weekday peak use: 8 am to 8 pm	→	Tariff #1 Start time = 8 am
Billing rate #2 Weekday off-peak use: 8 pm to 8 am	→	Tariff #2 Start time = 8 pm
Billing rate #3 Weekend peak use: 8 am to 8 pm	→	Tariff #3 Start time = 8 am (must equal tariff #1 start time)
Billing rate #4 Weekend off-peak use: 8 pm to 8 am		Tariff #4 Start time = 8 pm (must equal tariff #2 start time)

A building owner wants to accurately sub-bill their tenants for their electricity use. The local utility bills for electricity use using a four tariff schedule of peak/off –peak/weekday/weekend and the building owner must match this tariff structure when performing sub-billing. In addition, the iEM3000 meter gives the building owner the ability to change the active tariff by three methods:

1) Using the onboard clock

2) Sending a signal to the tariff control inputs

3) Using a command through communication

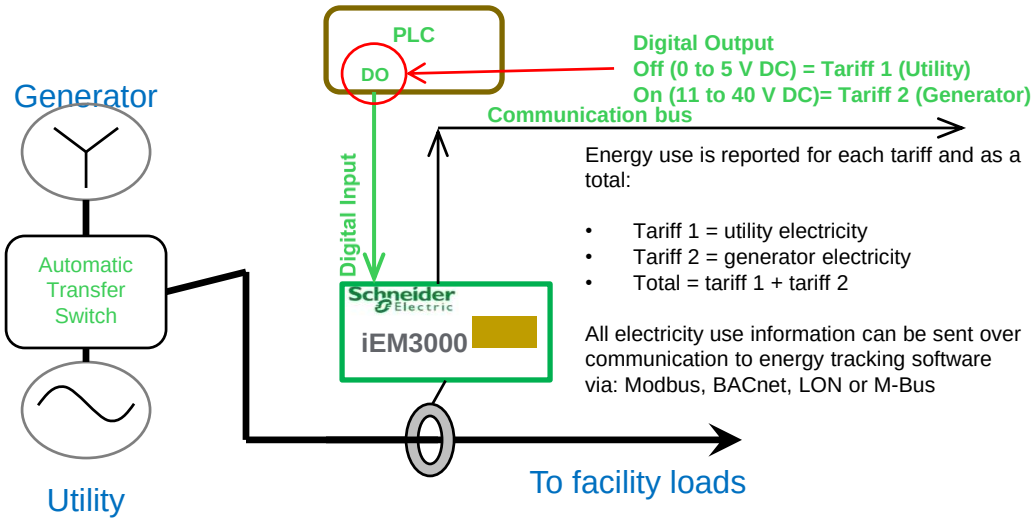
In this instance, the building owner decides to use the real time clock, which has a 3 day power-outage backup, to control the tariffs.

The building owner sets the iEM3000 tariff control mode to “internal clock” and chooses “4 tariffs” for the meter.

Grid and Generator metering

Digital input, which can be to change the tariff for active energy. The digital input can be connected to a PLC, which will send a signal to the iEM3000 and change the tariff for accumulating energy. This has applications in commercial billing solutions, where the building owner needs to use multiple tariff to accurately generate electricity bills, and also in industrial applications to accumulate energy from the grid and generator in separate tariffs.

Example – Accumulating Grid and Generator energy consumption in separate tariffs



How to track electricity use on the site. The facility has two electricity sources: a grid connection from the utility and an on-site generator. The manager needs to accurately track electricity use from both sources.

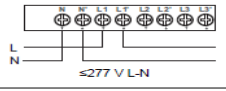
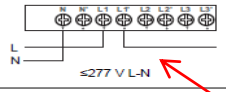
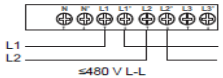
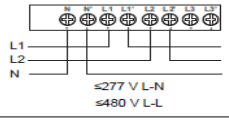
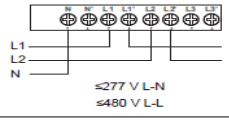
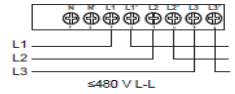
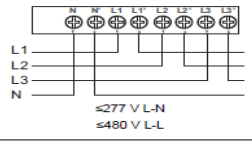
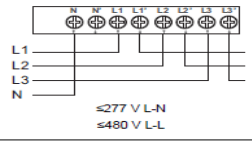
Using an iEM3000 meter to track energy delivered from both sources in different tariffs on the meter. The digital input on the iEM3000 is connected to the digital output from a programmable logic controller (PLC) and used to change the tariff when the generator is on so that electricity from this source is counted in a separate register on the meter, providing accurate up-to-date reports (electricity use and breakdown of electricity use from each of the two sources)

Global Use

Support of a wide range of wiring systems, allowing to be installed in virtually any panel in any country.

Example – An OEM Needs to Standardize on an Energy Meter for use in Multiple Countries

iEM3100 Wiring Systems Supported

Power system	Energy meters		Wiring	
1PH2W L-N	iEM3100 iEM3110 iEM3115 iEM3135	iEM3150 iEM3155 iEM3175		
1PH2W L-L	iEM3100 iEM3110 iEM3115 iEM3135	iEM3150 iEM3155 iEM3175		
1PH3W L-L-N	iEM3100 iEM3110 iEM3115 iEM3135	iEM3150 iEM3155 iEM3175		
3PH3W	iEM3100 iEM3110 iEM3115 iEM3135	iEM3150 iEM3155 iEM3175		
3PH4W	iEM3100 iEM3110 iEM3115 iEM3135	iEM3150 iEM3155 iEM3175		

Neutral "out" connection is not required for iEM3100 models

iEM3200 models can be used in 1-phase and 3-phase delta and wye wiring systems, with 1, 2 or 3 CTs. Select models also support VTs.

In this example, a large OEM wants to standardize on an energy meter that will be used across a large region. The OEM wants to pursue projects across several countries and needs a meter that can be used without limitations.

The iEM3000 meter has the flexibility and standards compliance to solve the OEMs problems. The OEM knows that wiring systems can vary across regions and appreciates the flexibility that the iEM3000 provides. Similarly, the iEM3000 complies with local, regional and global standards, making it the perfect fit for the OEM's needs.

iEM3000 Standards Compliance

- CE Mark
- UL Listed (in progress)
- C-Tick (Australia)
- GOST (Russia)
- CCC (China)
- Accuracy: IEC 62053-21/23; EN 50470-1/3
- MID Certified (select models)

Communication Protocols

A wide range of options

Energy meters

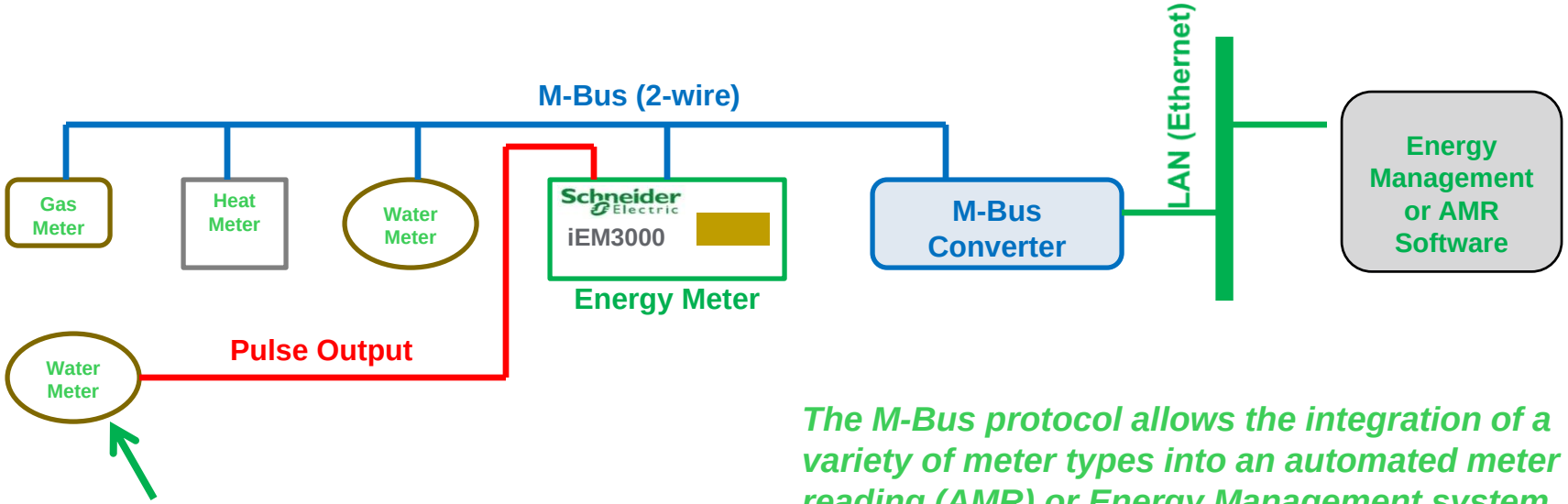
Communication protocols

Easily integrate into commercial and non-critical buildings with native protocol support to add simple energy management applications to any **BMS**, **AMR / AMI** or **EMS** system

More than just kWh meters

- Full four quadrant measurement of active and reactive energy delivered and received provides a full view of both energy consumption and on-site generation
- Extensive real-time measurements (V,I,P,PF) give customers more detail on their energy usage
- Multiple tariffs give customers the flexibility to match the billing structure of their utility

M-Bus Metering Example



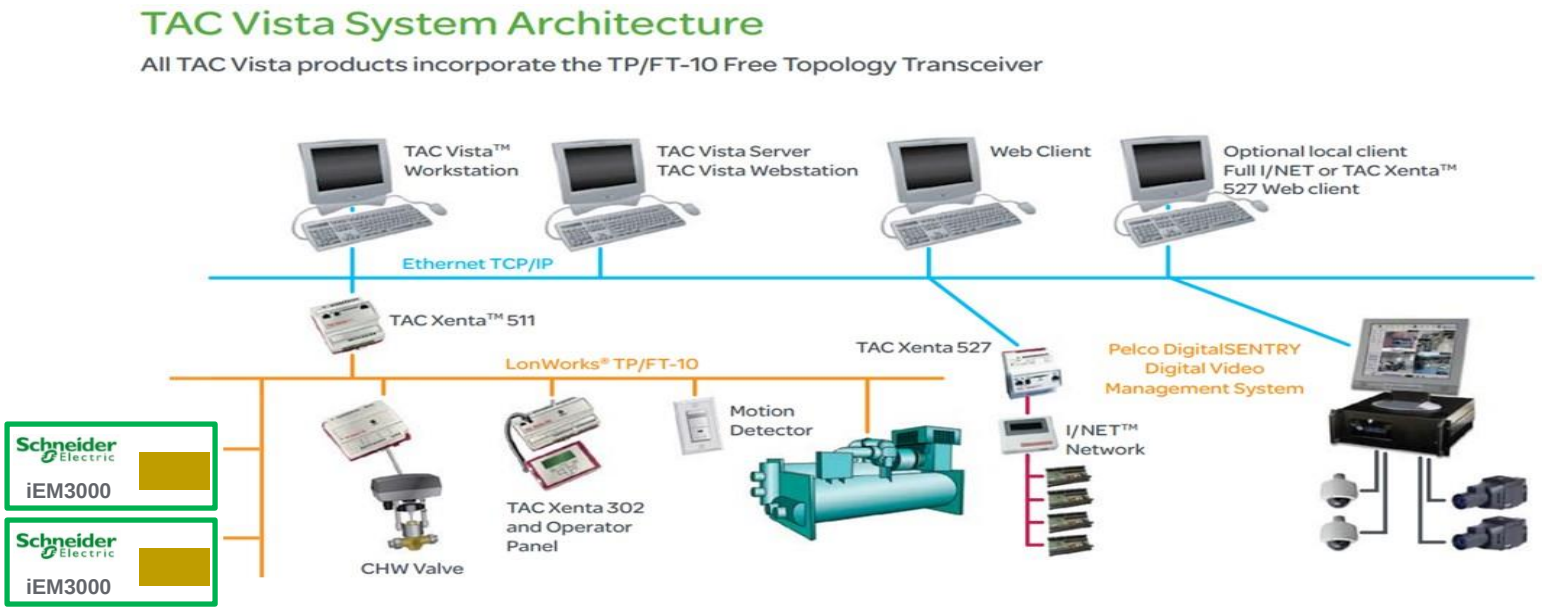
Water
Air
Gas
Electricity
Steam

Any pulse output WAGES meter can be connected to the programmable digital input (DI) of the iEM3000. The pulse count from the WAGES meter is then available over M-Bus and can be read into the Energy Management Software

The M-Bus protocol allows the integration of a variety of meter types into an automated meter reading (AMR) or Energy Management system

The iEM3000 Energy Meter from Schneider Electric can be seamlessly integrated into any metering system that is based on the M-Bus protocol

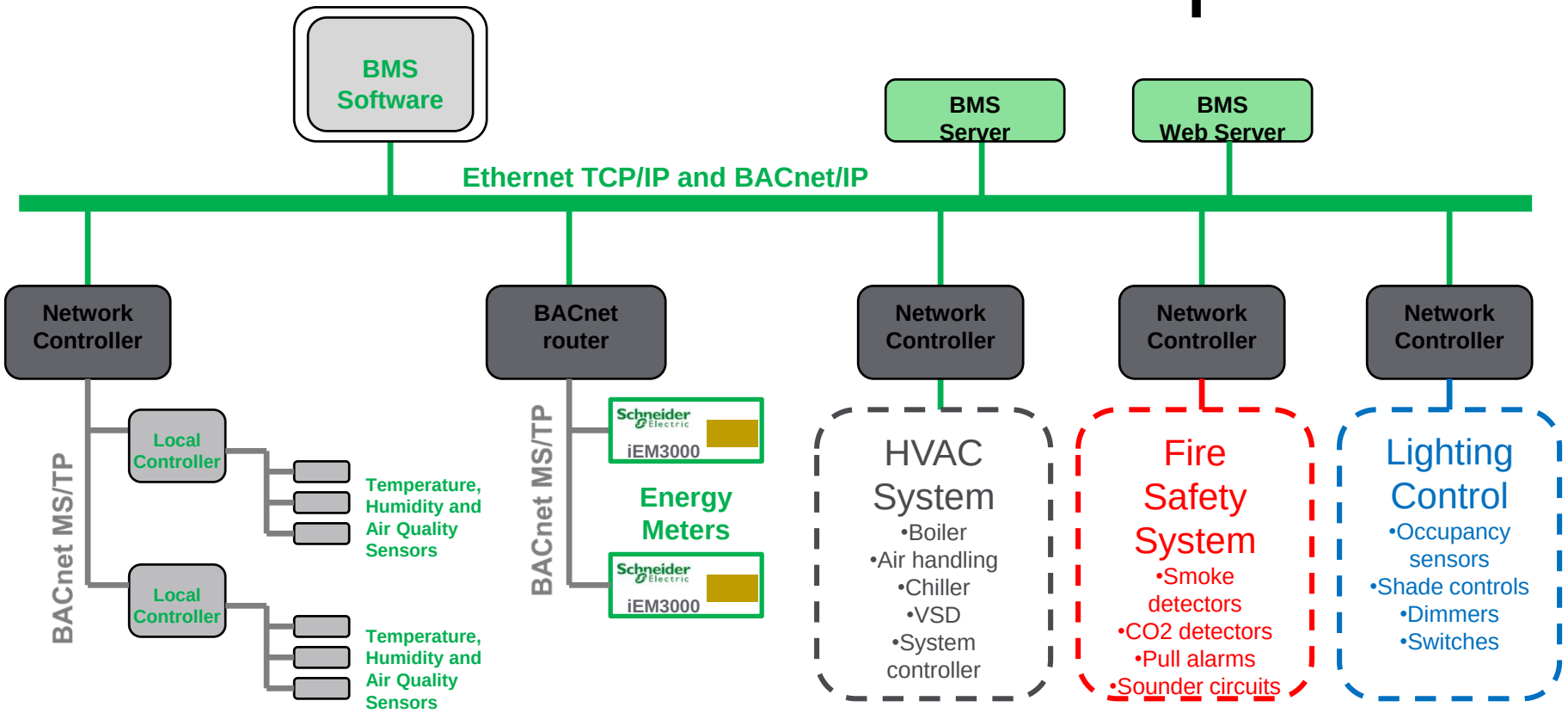
LON BMS Example



Energy Meters

The Schneider Electric iEM3000 Energy Meter can be seamlessly integrated into an existing TAC Vista System

BACnet BMS Example



Software

ION Technology

Power & Energy management software to meet the toughest demands

Customized real-time monitoring

- Access **real-time** status of sensitive power distribution components
- **Trend chart** tools with customized views to reveal **patterns** and anomalies quickly

Data analytics and visualization

- Smart **dashboards** with configurable presentation widgets and kiosk options
- Powerful **graphics** templates and libraries
- Automated power quality reports and **waveform analysis** tools
- **Comprehensive templates** for energy and power reporting, with flexible report distribution options

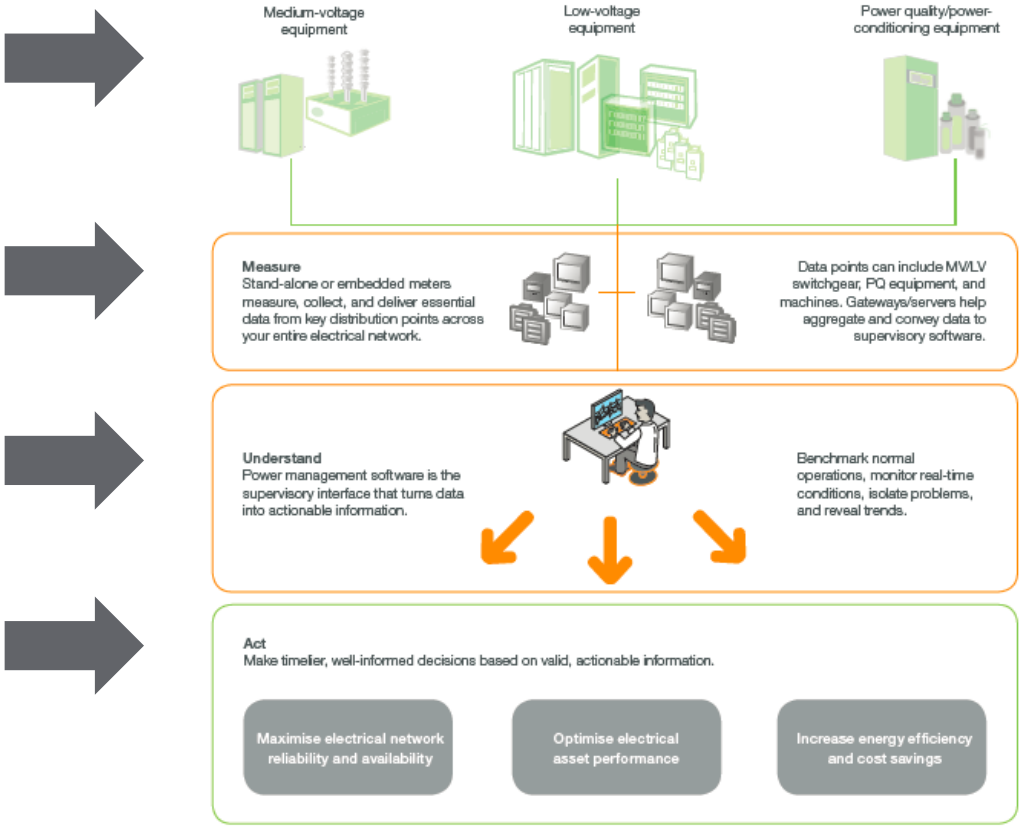
Alarm and event management

- Powerful **alarm** triggering, **notification**, and analysis tools
- **Sequence of events** reporting for power system event root cause analyses

Robust technical infrastructure

- Ready-to-use **communications** with many electrical distribution devices
- Fully **compatible** with current operating systems and databases
- **Interoperable** with integration to other systems and devices through open data and protocol standards
- **Scalable** through flexible deployment options

Improve availability and reliability while creating cost and operational savings



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Measure

Gather accurate power and energy data from key distribution points, monitor power quality, log events

- ✓ **Interoperable** and **complementary**, so you can share data between platforms and benefits between users
- ✓ **Comprehensive protocol**, form factor, and standards support for easy integration and expansion into existing systems and multivendor environments.
- > **Scalable** in size, performance, and functionality via flexible system customization, so you dictate how, where, and when to expand.

Life Is On Schneider Electric

Understand

Turn data into meaningful, actionable information for you and your stakeholders

The dashboard view can present any measured parameter from the database as well as pull in real-time data feeds from the Internet to give you exactly the information you desire on screen.

Real-time and historical power quality analyses

Detect, diagnose, evaluate, and isolate power quality disturbances. Trend measured parameters to identify potential disturbance patterns. Display millisecond-accurate alarms and trends for sequence of events and root cause analysis. Amalgamate trend and alarm data for sophisticated disturbance views and analysis.

Intuitive visualisation and reporting tools

Display any measurement from your electrical distribution network; integrate live Internet data streams into smart dashboards. Access network diagrams, waveforms, and real-time or historical trend graphs from the convenience of any Web browser. Use predefined or custom device comparison tables for an at-a-glance status of the assets in your network. Distribute preconfigured or fully customised reports manually, by schedule, or by alarm/event trigger.

Real-time energy consumption monitoring

Track and trend any parameter to reveal demand peaks and systemwide energy costs. Identify patterns in operational usage trends. Disseminate information to a larger audience and educate stakeholders to help drive changes in behaviour. Optimise network capacity and avoid overbuilding.

Robust, flexible platform architectures

Designed for step-by-step investment, our software delivers exceptional scalability to grow with your changing business requirements, thereby driving down the total cost of ownership. Choose from pre-engineered or customised options. Full redundancy for communications, network servers, alarming, trending, and data synchronisation is also possible.

Seamless hardware integration and system interoperability

Native support with a vast selection of Schneider Electric products as well as third-party devices enhances overall capability. Open standards-based interoperability lets you cater to other departments and share data with third-party SCADA, automation, building management, and accounting systems for a comprehensive view.

Dynamic control interfaces

Control of devices, objects, and electrical distribution points in real time with dynamic single-line diagrams. Use point-and-click navigation to reveal deeper layers of detail in the electrical distribution system.

One-line diagrams use animated, interactive, industry-standard symbols as well as dynamic line colouring for connection status to enhance control and display functions.

- ✓ **Real-time and historical power quality analyses**
- ✓ **Robust, flexible platform architectures**
- ✓ **Real-time energy consumption monitoring**
- ✓ **Dynamic control interfaces**

Act

Make timelier, intelligent decisions based on valid, actionable information

Effective applications result from measuring and understanding the intricacies of your energy and power usage – more than just power network management. Gain new levels of energy efficiency, cost savings for your business, demonstrated sustainability and environmental responsibility for shareholders, and answers to governmental regulations and directives for energy performance. Get it all without compromising productivity.

- ✓ Identify billing discrepancies
- ✓ Allocate costs/tenant billing
- ✓ Reduce peak demand, power factor penalties
- ✓ Find opportunities, verify savings
- ✓ Green standards compliance
- ✓ Reduce rates with energy suppliers

CONCLUSION

Standards and regulations in USA

Sources: WBDG web
www.wbdg.org

Rating systems:

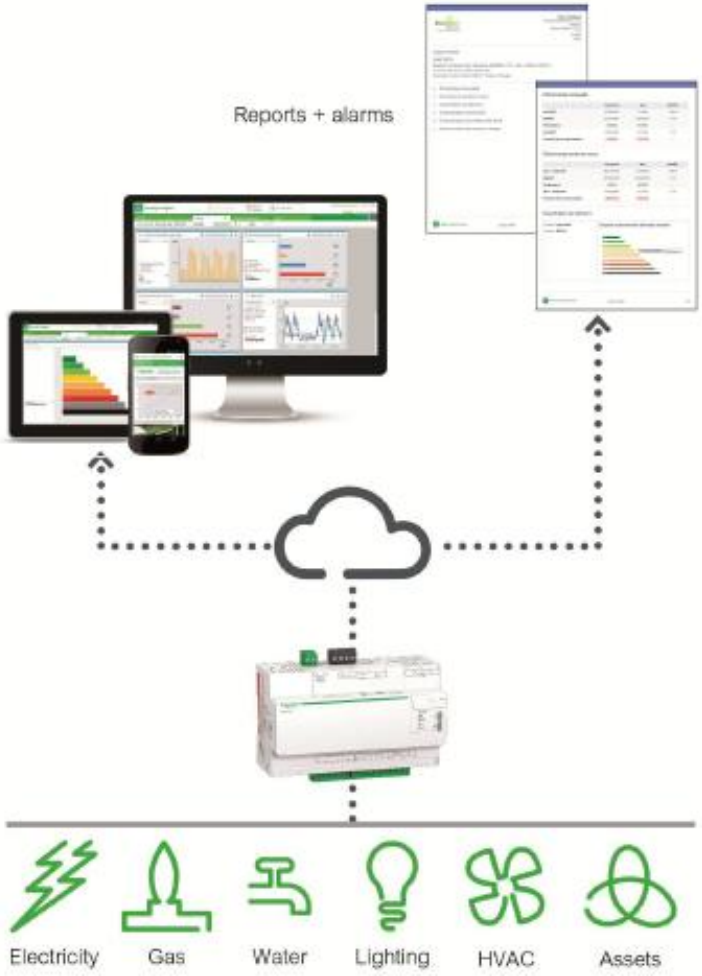
- **LEED**: In 2000, the U.S. Green Building Council (USGBC) followed suit and developed and released criteria also aimed at improving the environmental performance of buildings through its Leadership in Energy and Environmental Design (LEED) rating system for new construction.

Standards:

- **ANSI/ASHRAE/USGBC/IES Standard 189.1-2014** purpose of this standard is to provide minimum requirements for the sitting, design, construction, and plan for operation of high-performance green buildings.
- **ISO50001 standard** - the International Energy Management standard

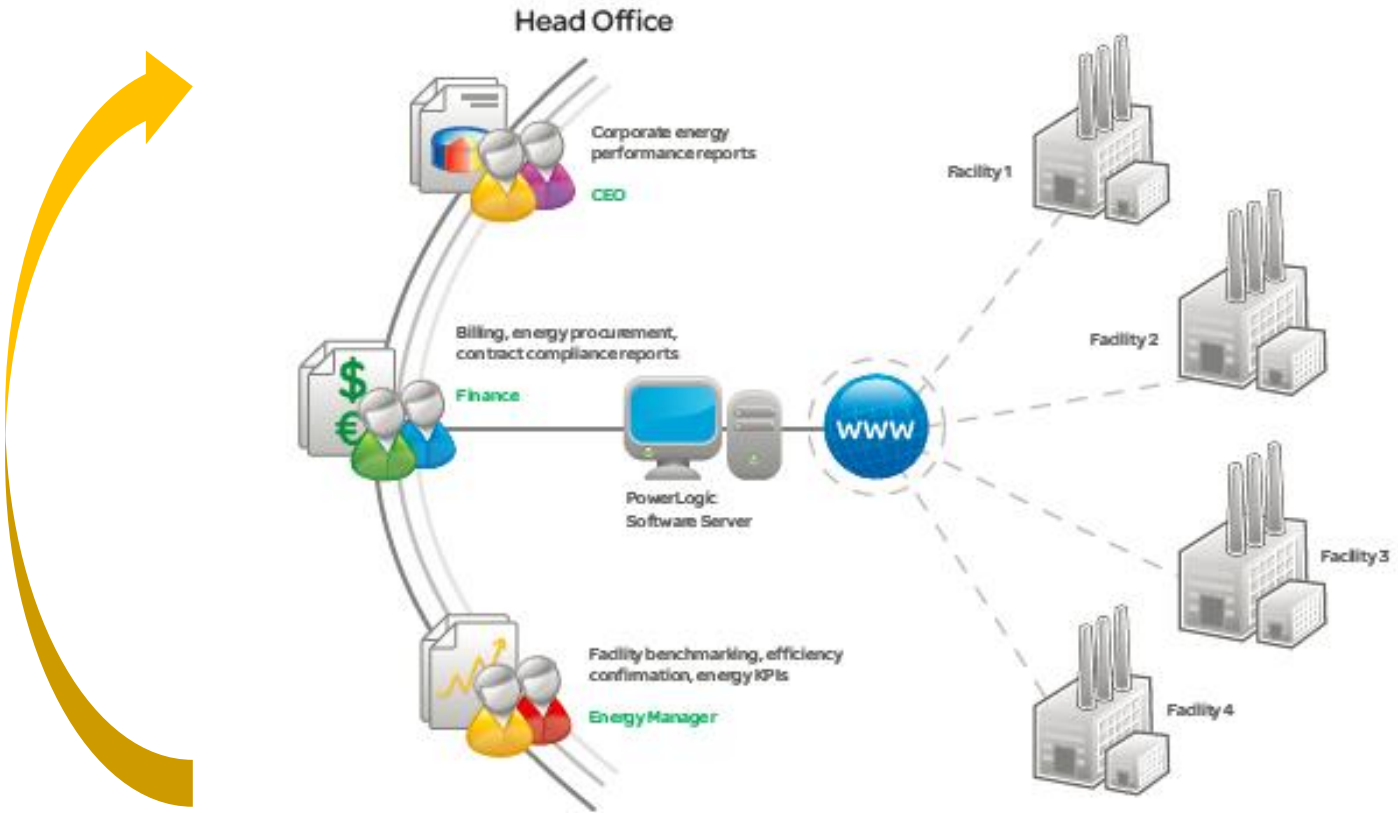
Green Product Certifications:

- **Energy Star** is a widely recognized government-run product certification label for energy efficient products.



Building Operations and Maintenance

PDCA : PLAN – DO – CHECK – ACT


Head Office
Corporate energy performance reports
CEO
Billing, energy procurement, contract compliance reports
Finance
PowerLogic Software Server
WWW
Facility benchmarking, efficiency confirmation, energy KPIs
Energy Manager
Facility 1
Facility 2
Facility 3
Facility 4