Thought Leadership White Paper

Eaton Smart Home
the Energy Control Center

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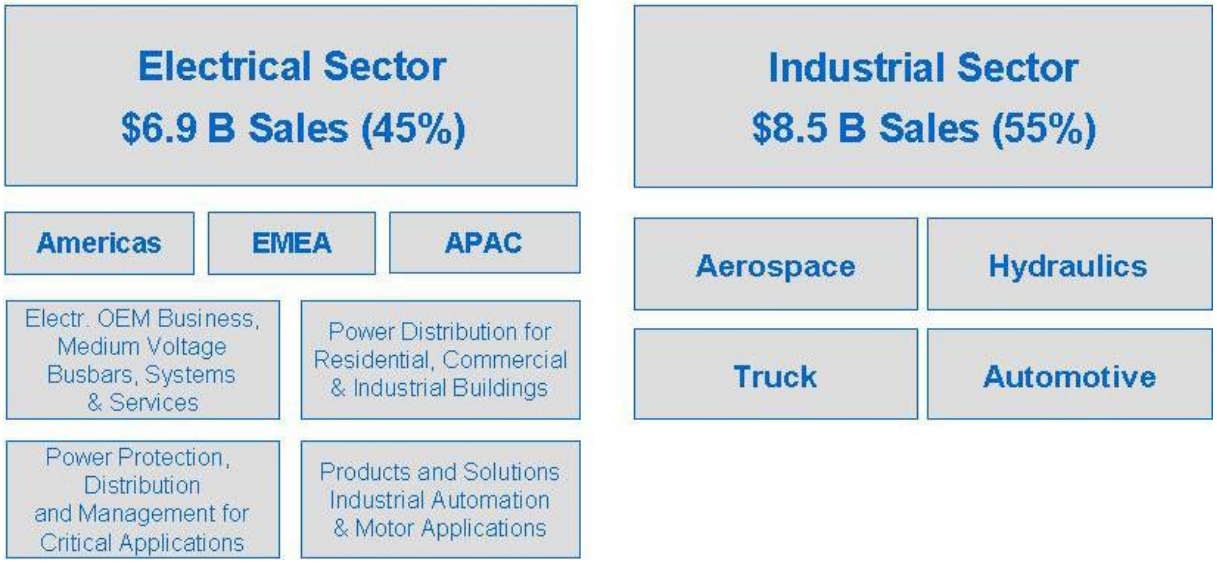
Summary:

Home is where a person places particular importance in well-being, comfort and security. Energy-efficient and energy-saving solutions are features that are also highly desirable here. An important requirement for this is a transparent and continuous display of energy consumption. Intelligent electricity meters, which communicate directly with supply companies, offer the end user a whole range of new possibilities. These allow the end user to benefit on the one hand from flexible tariff models, and at the same time as a supplier feed in electricity to the grid from renewable energy sources, such as photovoltaic or wind turbine generators. As an energy management company, Eaton is already offering diversified and customizable solutions for the “Smart Home” of tomorrow.

Table of Contents:

The Eaton Corporation

Eaton Corporation is a diversified power management company with 2009 sales of $11.9 billion.
Eaton is a global technology leader in electrical components and systems for power quality, distribution and control; hydraulics components, systems and services for industrial and mobile equipment; aerospace fuel, hydraulics and pneumatic systems for commercial and military use; and truck and automotive drivetrain and powertrain systems for performance, fuel economy and safety. The Eaton Electrical Sector generates $5.9 billion, almost half of the company's total turnover. $6 billion, equal to 51 percent of total turnover, is generated in the Industrial Sector with the Aerospace, Hydraulics and Vehicle business areas. Eaton has approximately 70,000 employees and sells products to customers in more than 150 countries. Since April 2008, Moeller has been a part of the Eaton Electrical Sector of the Eaton Corporation. Eaton's Electrical Sector is a global leader in products and services for energy distribution, safe power supply and industrial automation.



Building Automation

The term building automation covers all the monitoring, control, regulating and optimization equipment used in buildings. It forms an essential part of technical facility management. The goal of every building automation system, including all its technical units, is primarily to automatically execute operational sequences across different systems and according to preset values (parameters) or simplify their operation and monitoring. This usually involves the networking of all the sensors, actuators, operator controls, appliances and other technical devices in a building. Sequences can also be combined into a range of different scenarios. The key feature of these systems is the largely decentralized configuration of the control units and their integrated networking - not uncommonly also involving different technologies.

Home Automation

Home Automation describes the growing development of automation in the private home. What was previously "static" in the electrical installation is being replaced by "intelligent"

components. For example, this means the networking of all electronic sensors and actuators in the building. Special bus systems network the devices or allow them to communicate wirelessly via radio. Unlike static installations, the functions of the components in networked systems are programmed to suit the needs of the end user, instead of being determined by the circuitry. This opens up a host of new possibilities which considerably increase comfort, security and flexibility in the building in equal measure.

The term “Home Automation” overlaps with “Building Automation” but includes its own particular functions that are scalable. The automation of public or industrial buildings particularly focuses on the automatic or semi-automatic control of lighting systems, doors and windows, heating, cooling and ventilation systems as well as security and surveillance systems. Although a number of building automation technologies are also used in home automation, the latter also adds additional technologies or focuses to a greater extent on specific ones - for example individual comfort features, intuitive use, protection against tampering or low susceptibility to failure. Typical examples for the home area include multimedia applications, automatic plant watering or aquarium maintenance, and not least individual lighting scenarios and tailored alarm systems. They also include automatic and emergency call facilities for disabled persons, those with dementia or those at risk of falling.

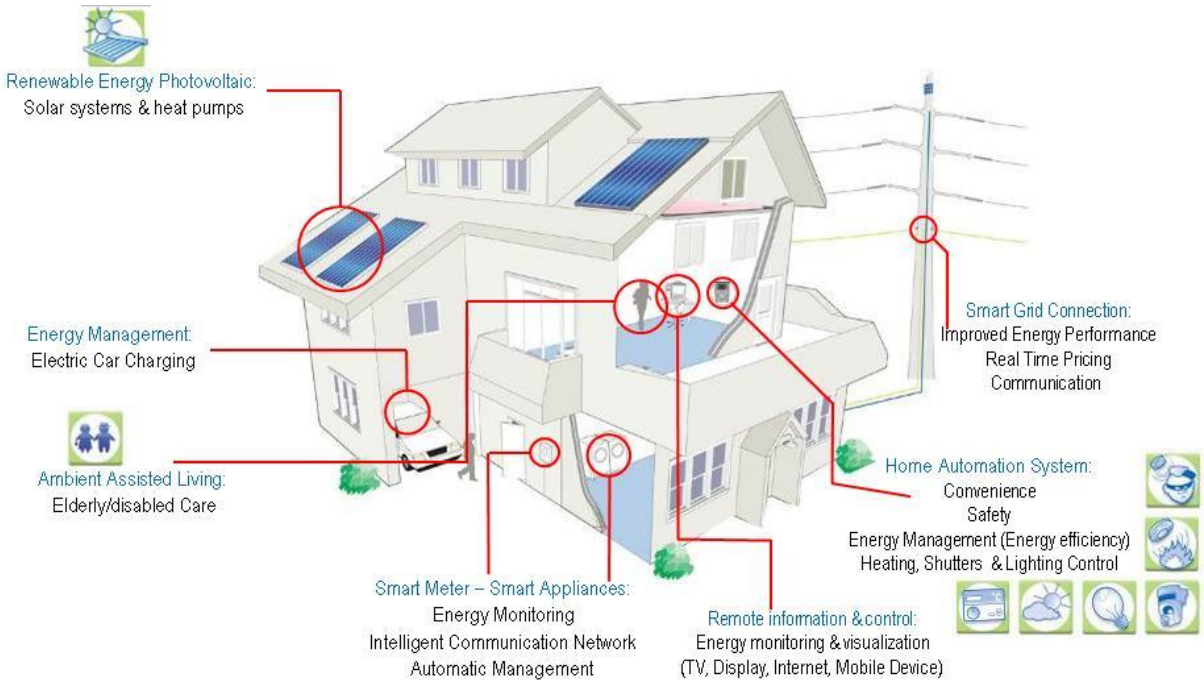


Figure 1: Eaton Smart Home functions. Intelligent meters communicate directly with power supply companies.

Eaton Home Automation Solution

Since its launch in 2003, Eaton’s xComfort system has been successfully tried and tested in a wide range of applications in over 25 countries. The wireless system offers the user an outstanding level of flexibility - both in the installation of components, such as sensors and actuators, and in the logical connection of these components. A striking example of its flexibility is demonstrated when making modifications: almost every private developer knows the situation when, despite detailed planning for new buildings, alteration or expansion

measures become necessary at some point and frequently require changes to the electrical installation. However, alterations following the preliminary building works stage usually involve either unsightly surface-mounted cabling or even milling and cutting work for the flush-mounted installation. The Eaton wireless system provides an elegant solution to these problems.

Figure 2: In addition to intelligent energy meters, the Eaton xComfort wireless system is another basic feature of a Smart Home

xComfort offers an impressively simple installation - any electrician can connect the wireless system with only a few steps and without producing any dirt or dust: users simply attach the switches in any position as required and install all the sensors completely unobtrusively. The wireless system also cuts installation costs to a minimum. In addition, the system can be expanded with further sensors or radio switches as required at any time, and is therefore offers a future-proof design. The is no pollution from “radio waves”, as a signal is only transmitted for 0.1 s on activation and the transmitting power, at 0.001 W, is far lower than that of a cellular phone. The Eaton wireless system operates in the 868 MHz frequency range and is designed to be completely interference-free.

Figure 3: Safety is top priority. The Eaton smoke detector saves lives - the loud alarm of the smoke detector also warns sleeping residents of a fire risk in good time and gives them the required head start in getting themselves to safety.

Eaton Room Manager - the "Smart Home Control Center"

A key element in the Eaton "Smart Home" is the Home and Room Manager.

As the central display and operating unit, the Home Manager communicates with all wireless components and visualizes their respective operating states on a display. It serves as a control center for detached family homes or apartment buildings, offering a high level of operator convenience. The user can control all house functions via this interface. These include security and alarm functions, heating, climate and ventilation control systems such as solar control, as well as water heating and boiler heating control, lighting and light scenarios, blinds / shutters / awnings, timing circuits for various functions, extensive logic and comfort functions, telecontrol and diagnostics by telephone, information and service via text message.

The Room Manager on the other hand is a display and operating unit designed for use in detached family homes as well as rented and owner-occupied apartments. With its attractive, modern design, the device fits harmoniously in living areas. Ultramodern tactile sensor technology allows the user easy local operation as well as enabling the setting of all the individual parameters. The backlit graphic display visualizes the most important information simply and concisely. Just like the Home Manager, the Room Manager also communicates with all the components of the Eaton wireless system. As a result, security functions, lighting scenarios, blind control or room temperatures can be activated or adjusted locally at the press of a button.

Figure 4: The Eaton Room Manager also provides information on the energy supplied by a photovoltaic system over 24 hours.

With its integrated Bluetooth functionality, the Room Manager not only reports any security or limit value violations, not only locally via acoustic or optical signals but also by sending an appropriate message via SMS to the house or apartment owner - if desired to one or several cellular phones. Ready-made software components are used for this hazard warning function. When required, only a single command is needed to trigger certain logic functions, such as when leaving the house: Using the wireless link to the Room Manager, the various wireless sensors of the xComfort series can give warning of uninvited intruders (via motion sensors), defective equipment (via the leakage current indicators of the PDIM series), open doors and windows (via corresponding magnet contacts), water discharge (via the leakage sensors), fire (via smoke sensors) and/or any undesirable drop in temperature inside the building. Binary inputs enable sensors without any wireless capability as well as commercial switches from other manufacturers to also be integrated within Eaton's wireless system.

Comfort as Top Priority

A 12-channel remote control with LCD display and three timer provide a high level of comfort in the Eaton wireless system. The display clearly and comprehensively shows all controlled devices. The relevant actuators, such as light dimmers or blind controls, are controlled via four navigation buttons and a confirmation key. Message confirmations are displayed via LED. The remote control also integrates three automatic timers which can be used, for example, to simulate presence or activate outdoor lighting.

Saving Energy Sensibly

The time of thoughtless and unnecessary energy wastage at the expense of the environment is long past. As an energy management company, Eaton is helping to save energy sustainably and identify cost drivers.

In the near future, energy supply companies will be obliged to meet more stringent requirements. Up to now, their business models did not provide for what happens beyond the main energy connection - with the European Union's Energy End Use Efficiency and Energy

Services Directive, they will soon be committed to the active provision of information. This means that energy supply companies will in future have to provide information at regular intervals - less than one year - on who is consuming how much, at the same time supplying suggestions for improvements.

The EU adopted the following targets in 2006: 20 percent CO_2 reduction by 2020, 20 percent share of renewable energy in the power mix and a 20 percent increase in energy efficiency.

To approach these targets Eaton is already offering innovative solutions: the main elements are the Eaton wireless system (Home Automation), intelligent meters (Smart Meters) and data connections to energy suppliers (Smart Grid).

Smart Grid or the "Intelligent Network"

The principal difference between a Smart Grid and the current power grid is that the electricity is not only transported from the energy generator to the consumer, but the consumer can also act as a supplier. In this way, electricity from renewable energy sources such as photovoltaic or wind power plants will be generated to a greater degree by the consumer and fed into the grid from remote locations.

The highly intermittent feed-in - in terms of both time and amount - produces the problem of keeping the voltage, frequency and output of the grids stable. In order to safeguard grid stability, both suppliers and consumers will be required in future to make adaptions to grid conditions. In the approaching "internet of energy", this requires equally intelligent control mechanisms at the terminal device and in the power grid. Together with its partners, Eaton is already offering tomorrow's solution today.

The Eaton Smart Home

By "Smart Home", experts understand not only the fully automated house in which all electrical devices are networked: a genuine Smart Home, together with a "Smart Grid", offers a completely new, dynamic form of energy management and opens up previously undreamt of possibilities.

For years, flexible tariff structures between energy suppliers and consumers/purchasers have existed in the high and medium voltage field for major electricity buyers. However, the proverbial last section up to the private consumer has previously never provided a bidirectional, continuous exchange of data between end consumer and power supply company, so that only an annual cost settlement on the basis of part payments was possible.

In a Smart Home, electricity from renewable energies such as a photovoltaic system or a mini combined heat and power plant, for example, can be fed into the grid via an "intelligent" meter, a Smart Meter, and the data sent directly to the relevant power supply company for settlement. Billing can thus be updated daily.

Improving Energy Efficiency - Smart Metering

According to the Energy End Use Efficiency and Energy Services Directive 2006/32/EC, suitable measures must be implemented to achieve an energy saving potential of 20 percent by 2020. This directive states the following as one of the measures: establishment and

development of services for the efficient use of heat, power and lighting for end customers. Energy supply companies will in future have to provide information at regular intervals - less than one year - on who is consuming how much, at the same time supply improvement suggestions. This requirement laid the foundation stone for Smart Metering with intelligent, electronic electricity meters.

A particular advantage for the resident of a Smart Home is the ability to buy electricity, gas or water from the supply network at different time-dependent or quantitatively graduated tariffs.

The fact that the consumer's energy consumption is constantly recorded, for the first time enabling data transparency, is a further benefit. The consumer can call up the relevant data, such as utilization period / costs / CO_2 emissions, at any time from the Eaton Room Manager: either the last 24 hours, the last seven days, periods from the start of the week, the last 30 days or other predefined time periods.

Individual or summarized data can be visualized at home, either on the TV or the Eaton Room Manager/Home Manager. Users are also provided with convenient remote access via the Internet/PC or cellular phone in order to view their energy consumption. When set limit values are exceeded, for example if the freezer in the basement was not shut correctly, the home owner receives an automatically sent alarm message.

Once energy consumption is known and energy guzzlers are identified, experience shows that it is easier to introduce energy-saving measures, for example a room temperature control matched to the usage habits of residents. With energy-intensive appliances such as temperature-regulated pools, cold stores or “white goods” (washing machines / dryers), money can be saved by choosing an affordable tariff. Special tariffs with the energy supply company can also be agreed once the habits of residents are known - storable user profiles also help here.

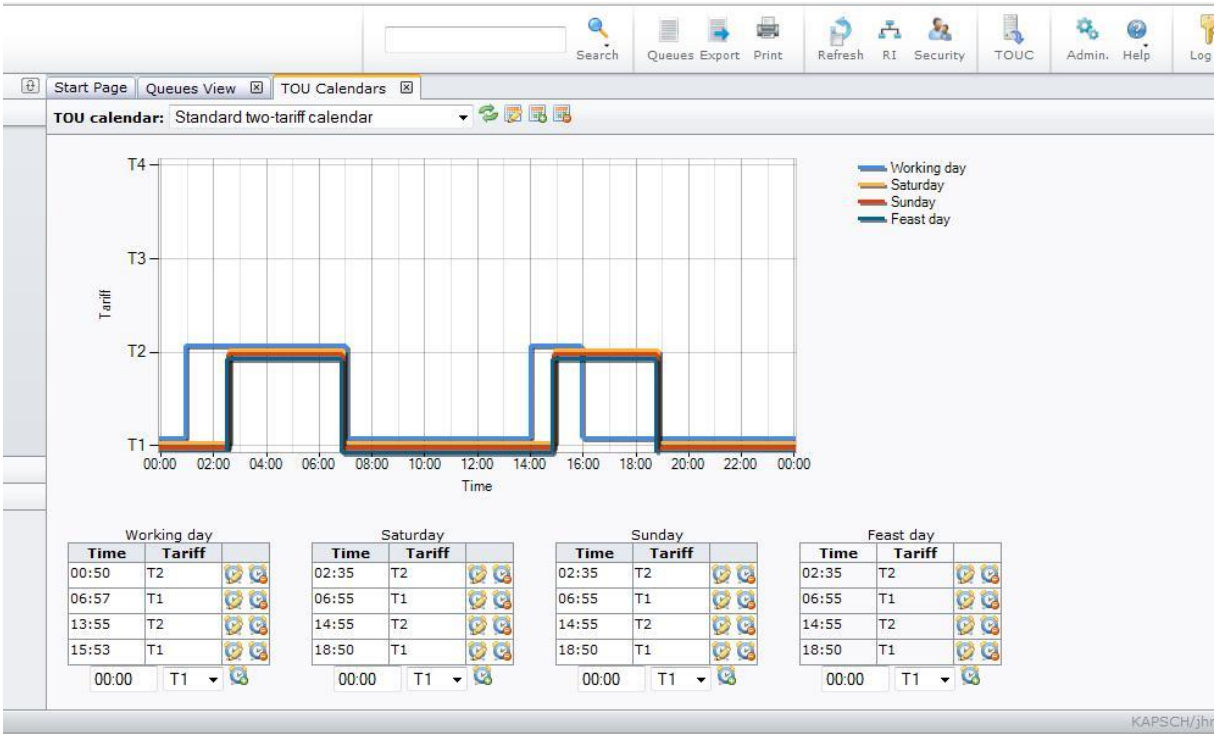


Figure 5: The Smart Home user can define up to four different tariffs, allowing him to purchase the cheapest electricity for the respective time of day.

Eaton's vision of a Smart Home also includes the option of integrating automatic charging stations for electric vehicles in the system. Every charge of the vehicle battery then automatically takes place at the cheapest tariff. Conversely, the vehicle battery could also feed electricity into the grid, for example when the vehicle is not required and the energy feed-in tariff is particularly attractive.

Eaton's Smart Metering Solution

Eaton is merging the Smart Home and the Smart Grid. Alongside "home automation" with Eaton xComfort wireless technology, the "Smart Meter" forms the data control center for recording energy consumption.

In the field of Smart Metering, Eaton works with a range of partners, including the Echelon Corporation in the U.S. With its NES (Networked Energy Services) system, Echelon has been successful for several years. Almost 30 million households are already connected to an intelligent power grid via the technology based on the NES system. Echelon supplies the basic expertise and the NES infrastructure for intelligent meter and metering technology.

Figure 6: The Smart Meter not only measures the amount of energy purchased but also controls connected appliances according to electricity tariff via the integrated xComfort interface.

Echelon's intelligent electricity meters were specially designed for use in the residential market. Alongside remote reading via the integrated Powerline Communication (PLC) modem, the meter offers up to four tariffs and multichannel consumption logging. Corded or wireless connection of gas, water, and heating meters is ensured by means of an integrated

M-Bus interface (Meter-Bus as per EN13757). Data is exchanged with the Eaton xComfort wireless system via a special interface connection at the Multipurpose-Expansion Port (MEP) of the meter. This therefore already makes it possible today to use a range of electricity tariffs. Depending on the tariff, the meter is also able to automatically switch on or off predefined appliances.

The Meter Data Management System

The communication and data exchange between the Smart Meters and the energy supply company is implemented via a Meter Data Management System (MDMS).
As a leading system integrator for solution in the telecommunications and network field, Eaton is working with the Kapsch group based in Vienna. Kapsch offers a complete Smart Energy Management (SEM) solution, via which all relevant Smart Meter data is available to both the end user and the energy supply company.
As an example, the end customer can view his energy consumption with a standard web browser and adjust individual tariff profiles.
The SEM software solution covers all Smart Metering functions in one automatic process, including the integration of new meters, teleservice, remote reading, data processing and remote control of the Smart Meter (tariff change, load shedding...). Alarm and event management also form an important part of the system. The system furthermore provides a solid basis for the implementation of future requirements in the Smart Grid.
With its xComfort wireless system available across Europe and with partners like Echelon and Kapsch, Eaton is offering a reliable Smart Home solution.

Smart Metering in Europe

The transition to electronic meters is progressing at very different rates in the various countries of Europe: While a majority of households have already been converted or upgraded in Sweden or Italy, the old Ferraris meters are still on the market in Austria and Germany. The range of functions in available meters is equally disparate. Although the design of an electricity meter for invoicing consumed kilowatt hours in four tariffs is governed by the European Measuring Instruments Directive (MID), all the further provisions are left up to the individual countries. Depending on the features provided, intelligent meters can in principle be used for displaying current consumption and history over a specific period, as well as for automatic meter reading with the current tariff. However, they can also be used for detailed functions, such as storing and evaluating consumption data, displaying and storing supplied energy (for example from photovoltaic systems) and even for the remote control of electrical appliances (by consent of the customer). In accordance with the Energy Efficiency Directive of the EU, Eaton developed an integrated solution - the portfolio ranges from the meter to the visualization of consumption, all the way to the controlling of devices in the residential building.

Avoiding Peaks

A general rule of energy saving is to avoid power output peaks. For the energy supply company, this involves the expensive operation of cushioning peaks on the spot market and protecting networks from unpredictable overloads. The end consumer, on the other hand, sees the consequences of peaks in his bills, in the form of system crashes or even as total outages. The arrival of intelligent systems supports both parties: energy suppliers can better plan their services and in designing their tariffs, and create incentives for using electricity outside the peak load times for defined target groups. With help of modern technology, end customers can identify the power consumption of their specific appliances and implement

countermeasures themselves or have them implemented by granting the energy supply company direct access to certain appliances - at attractive tariffs.

Data Transfer between Meter and Data Center

The topology of Eaton's Smart Meter solution can be implemented in different ways according to requirements. A gradual introduction of smart metering is easily achieved. For example, the first stage of home automation can be implemented with the Eaton xComfort wireless system. The second stage comprises the interface connection from xComfort to the Smart Meter. In the third stage, a bidirectional data connection with the energy supplier can be set up.

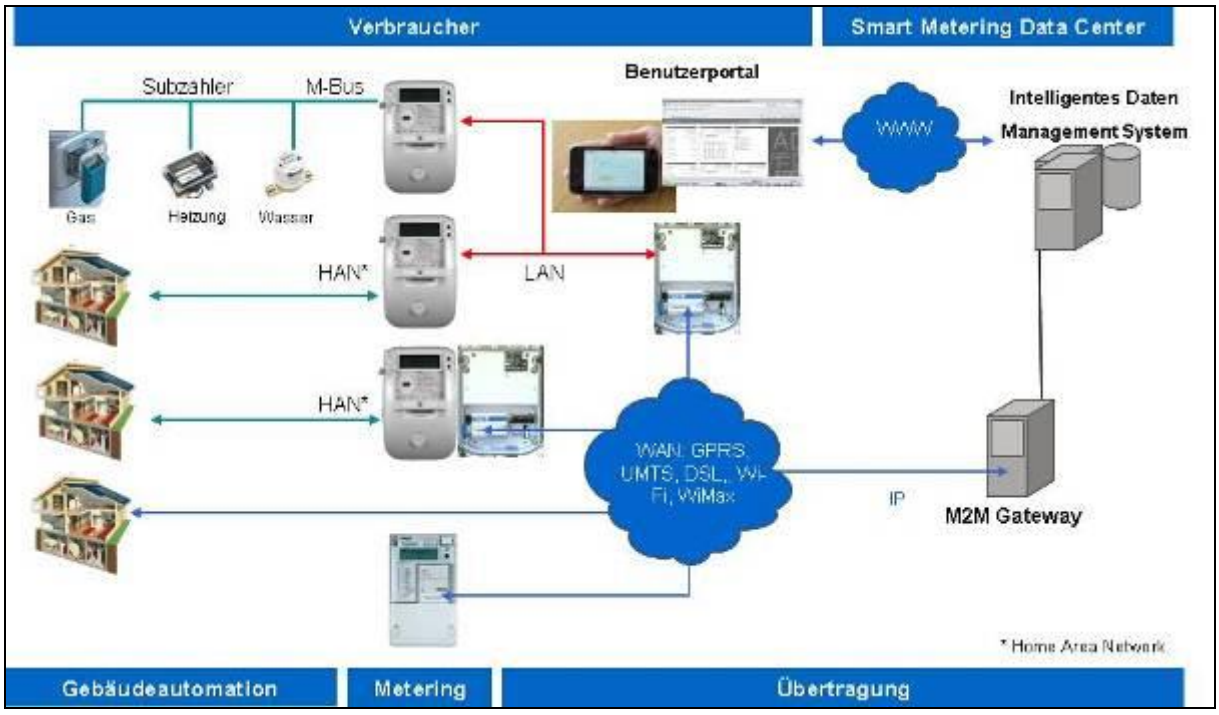


Figure 7: The Smart Metering communication topology.

As described above, M-BUS provides the general interface between the measuring sensors (gas, water, heating) and the meter. The xComfort wireless system is connected to the meter via MEP. Meter data is routed via the PLC (Power Line Communication interface) to the Echelon data concentrator (DC1000/SL), which is integrated for example in a local distributor unit and to which up to 1,000 meters can be connected. The data connection between the data concentrator and the M2M gateway is implemented via a secure VPN (Virtual Private Network) connection, which can be established via GPRS, UMTS, DSL, LAN or Wi-Fi, depending on local conditions.

Figure 8: Smart Home users can now access the Smart Energy Management Server via a web browser and view consumption data, tariffs or profiles.

Summary: Everyone can Benefit from Smart Grid and Smart Metering

For energy supply companies and/or network operators, Smart Metering and Smart Grid mean more stable and efficient use of network infrastructures. As the consumption profiles are largely recorded on a daily basis and would be available in the future, network operators or power supply companies can make the required energy amounts available for certain network sectors in advance without having to increase their prices in the short-term. A contribution to a safe and reliable energy supply is equally made, using all or some of the process stages of forecast, planning, optimization, control, monitoring, recording and communication.

A Smart Grid also enables the development of new, additional services for power supply companies. As an example, set amounts of electricity could be purchased via prepaid cards, say for electricity supply in a holiday home. After the set amount of energy is consumed, the Smart Meter automatically cuts the user off from the grid.

Smart Metering and Smart Grid also present the end user with new opportunities. On the one hand, they naturally benefit from a safe and reliable power supply. On the other, they can order extra services from their suppliers, which themselves can be tailored to local and individual needs. Other integrated added-value services from third-party suppliers are also conceivable, including ambient assisted living, comfort & security, demand & respond energy trade in the Smart Grid, and many more. Customers will have more choice and want to exert

greater influence than previously - the simple meter has had its day and is becoming a sales product: customers purchase energy, use and manage it. Not least, they ask how environmentally-friendly the generated energy is.

Eaton sees itself as a partner in the triangle formed between energy supply companies, electricians and end customers. Alongside extensive expertise and its long-standing competence, Eaton offers not only innovative components but equally mature and graduated solutions as well as solid service and training. Electricians serve as system integrators, optionally with an Eaton certification.

Eaton Energy Control in Smart Homes

- A global partner for all-in-one solutions
- Metering systems, e-mobility, renewable energies, energy management
- Open system architecture for integration of third-party products
- Meters, communication, software, home automation
- Proven components for a future-proof solution
- Echelon NES, Eaton xComfort, Kapsch communication and software
- Designed for the gradual evolution of the Smart Grid

About Eaton:

Eaton's Moeller Business
Since April 2008, Moeller has been a part of the Eaton Electrical Sector of the Eaton Corporation, a diversified power management company with 70,000 employees and an annual turnover of about US$ 11.9 billion in 2009. www.eaton.com/moellerproducts

Eaton´s electrical sector
Eaton's electrical sector is a global leader in power distribution, power quality, control and industrial automation products and services. Eaton's global electrical product lines, including Cutler-Hammer®, Moeller®, Powerware®, Holec®, MEM®, Santak®, and MGE Office Protection Systems™ provide customer-driven PowerChain Management® solutions to serve the power system needs of the data center, industrial, institutional, government, utility, commercial, residential, and OEM markets worldwide.

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