Basic Principles of Energy Managements

and

Approaches to Technical Implementation

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The efficient use of available energy is becoming more and more important for industrial firms in Germany. The basic sources of energy including electricity, gas, water and steam are available in almost all industrial operations. More than 15 different types of energy are used in some cases for complex production processes in, amongst others, the chemicals industry.

Together, GOSSEN-METRAWATT GmbH and Klein & Partner Engineering offer a complete spectrum of products ranging from energy consultation, right on up to turnkey installation of data logging, optimization and billing systems.

The Status Quo

For all intense purposes, zero potential savings remain for many companies from today's point of view. They have already drastically reduced material and personnel costs by means of rationalization and lean personnel policies.

The energy costs incurred for the manufacture of a given product had previously been perceived as having subordinate importance. It is precisely this aspect which now demonstrates new potential savings in the face of ever increasing energy costs.

Well founded knowledge regarding energy consumption and load profiles for the entire plant are, generally speaking, available. These are the basis for the contractual relationship with the power utilities, and are acquired at the point of transfer. Beyond this, allocation of energy costs within the plant, usually broken down on a building to building basis, is commonplace as well for historical reasons.

At the end of each billing period, the individual meter readings are recorded in a time-consuming fashion, and are then entered to the computer system. After performing plausibility checks and correcting errors, consumption is allocated on a percentage basis to the various cost centers.

This flat-rate allocation of energy consumption leads to reduced energy efficiency because it does not reveal cost intensive production processes and bad energy consumption habits. Potential savings for the individual cost centers cannot be exploited due to a lack of transparency.

Process-Related Acquisition and Reduced Consumption

Well founded approaches to the efficient use of all energy media only become apparent if precise knowledge is available concerning energy consumption patterns for the individual production processes. This information provides a basis for process optimization which results from optimized sequences and manufacturing lot quantities. Investment decisions involving new systems with minimal energy consumption can be rapidly evaluated with this knowledge as well.

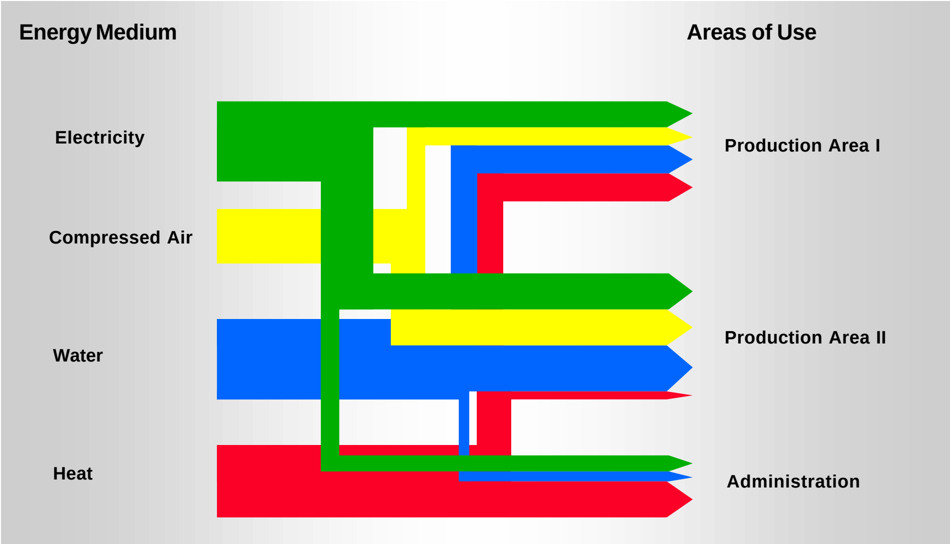

Figure 1: Energy Flow within the Company

Process oriented recording of energy consumption is easily taken into consideration during the planning stage for new production systems. Older systems can either be retrofitted, or equipped with additional measuring equipment. Consumption data acquired in this way can be taken advantage of to generate characteristic figures, which in turn can be used for energy efficiency comparisons with similar, or differing manufacturing methods.

If obtained consumption figures are viewed relative to time, conclusions regarding energy consumption habits can be arrived at quickly. High rates of consumption at times during which the production lines are idle frequently indicate leaks or inefficient energy use.

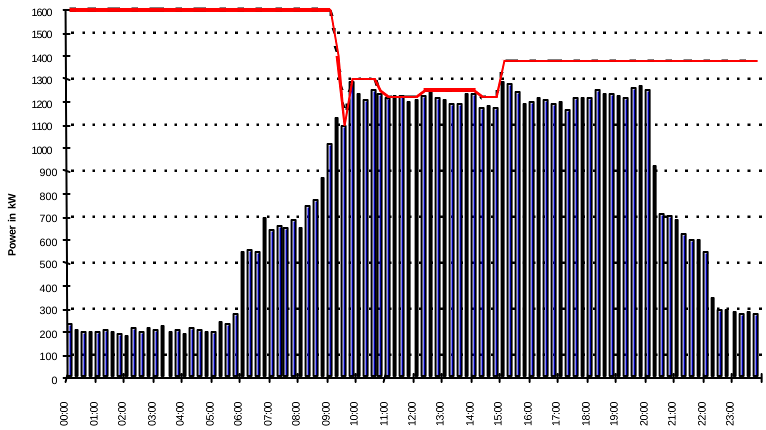

Figure 2: Consumption Pattern Relative to Time

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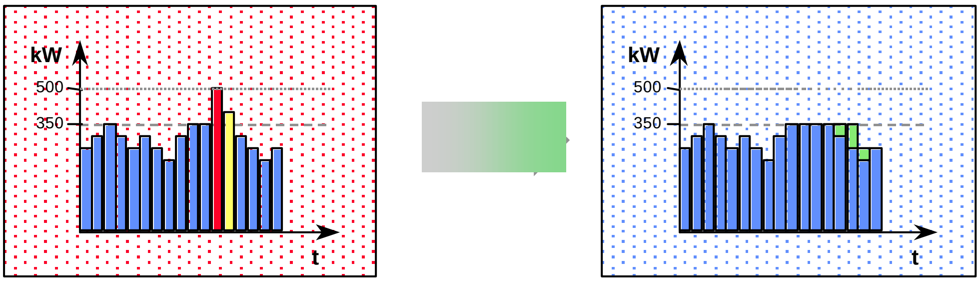
Reducing Peak Loads

Above all, substantial potential savings result from the reduction or suppression of peak loads. This fact results from tariff structures for electricity or gas, which include a component for the amount of power made available as well as for actual consumption. Mean power is recorded by the power utility over a period of 15 minutes, and is used as a basis for calculating the demand rate.



Without Optimization

With Optimization

Figure 3: Peak Load Optimization

Simple maximum value watchdogs and shutdown functions are integrated into the decentralized summators included with intelligent energy logging systems, which can be programmed by the customer with a simple programming language. Complex optimization tasks are generally accomplished with a special optimization computer which uses the existing logging system as a data source, and shuts down consumers based upon complex trend calculations and priorities.

In order to bill peak loads to the user who has actually caused them, interval values must be stored to memory for lengthy periods of time. If this function is already included in the existing system, the user only needs to read out and archive the respective data once per month. After being confronted with this clear-cut substantiation of consumption, users are more than willing to look for ways to reduce their peak loads, and to implement appropriate measures.

More and more frequently, internal energy suppliers at plants which are equipped as described above, are making the transition to global energy service providers. They record interval values for mean power or work, and generate load profiles based upon this information for individual production processes and cost centers. Industrial engineering utilizes these data to evaluate and optimize production processes. Effects resulting from changed parameters can be substantiated immediately.

The Effects of Market Liberalization on Peak Load

As a result of the liberalization of the German electrical power market in April 1998, electricity has become a commercial commodity which can be procured from any desired supplier. Incoming supply, transmission and billing are regulated by means of schedules which, as a rule, can be changed until 12 noon for the following day. These represent the anticipated daily energy requirement broken down into 15 minute intervals.

The following graphic shows a user load profile, as well as requirements coverage with various suppliers and products.

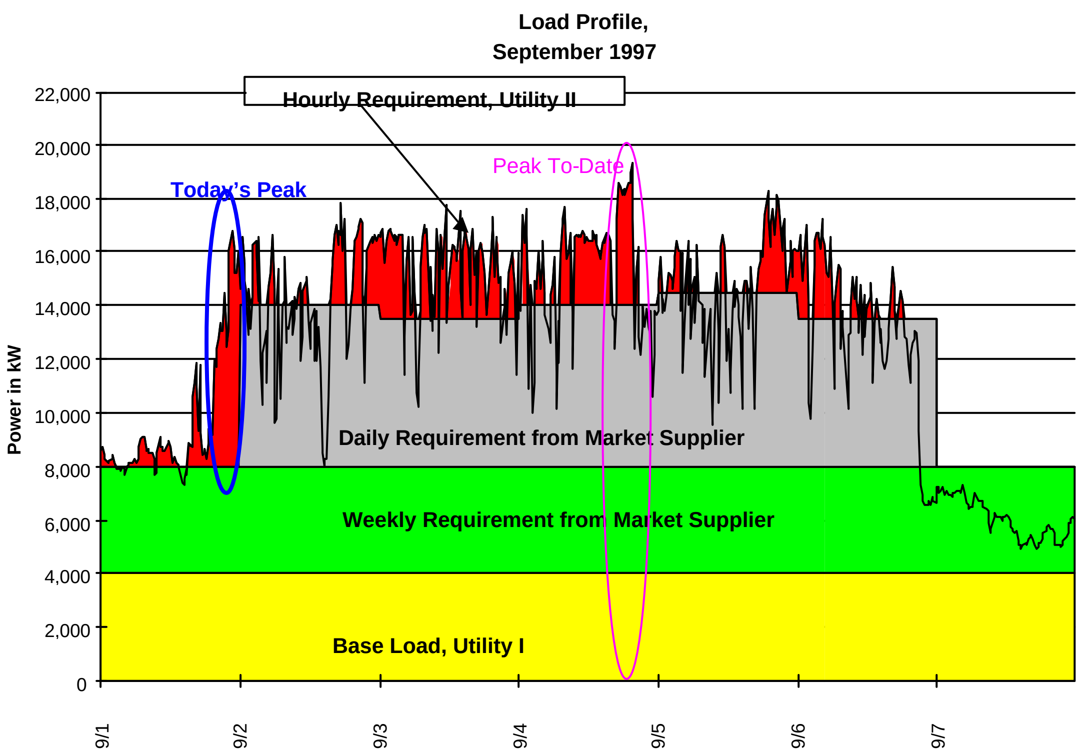


Figure 4: Energy Supply in the Liberalized Market

Peak load is affected as a result of the fact that these energy schedules are processed by a time sensitive optimization system, and optimization is no longer based upon a fixed maximum value. The system is thus provided with a new maximum value every 15 minutes which has to be maintained as accurately as possible, because under-importing leads to minimal rebates in liberalized markets, and over-importing to excessive costs.

Automatic Billing

As an additional benefit, the energy management system relieves the energy department from the time consuming, cost intensive, error-ridden task of manually reading the meters at the end of each billing period. All meter readings can be accessed without delay from a single computer.

Cost center billing can be prepared automatically for all types of utilized energy media in consideration of various tariffs at the end of the billing period with the help of suitable analysis software. Plausibility checks recognize defective meters, and values from commonly used meters are allocated to predefined cost centers. The transmission of billing data to the company computer system is the basis for the billing of operating costs within the company.

The use of certified meters is recommended for the billing of energy costs to outside companies who rent space on the company grounds.

Energy and Process Data Visualization

All measured values are available at each data logger within the energy monitoring system. It is thus highly advisable to represent all relevant values for a given process in a clear-cut fashion, to save them, and to monitor them in comparison with limit values. Causes of error can be analyzed initially from a centralized location, and troubleshooting personnel can be dispatched in a targeted fashion. In this way, time relationships can be acquired within a common screen display.

The Implementation of Energy Saving Measures

Energy saving measures can only be realized through the use of targeted, systematic procedures. The following four-stage concept is highly recommendable.

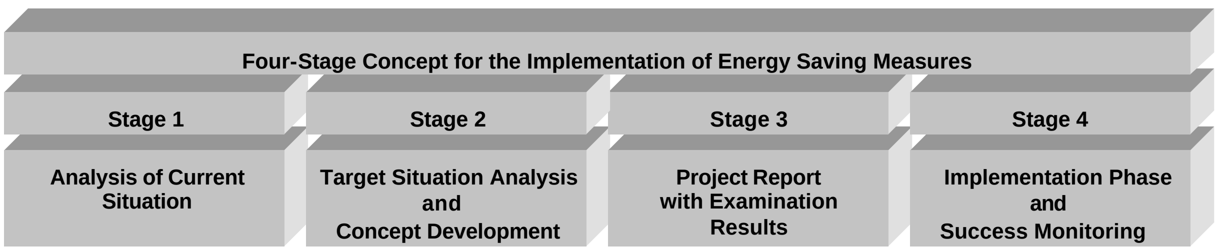


Figure 5: The Four-Stage Concept

The Complexity of Energy Management Projects

As a rule, it quickly becomes apparent during implementation of the four-stage concept that internal company capacities are insufficient for the planning of such complex systems. Mere procurement of the required hardware and software, which often appears to be a cost-effective solution at first, seldom leads to the desired success.

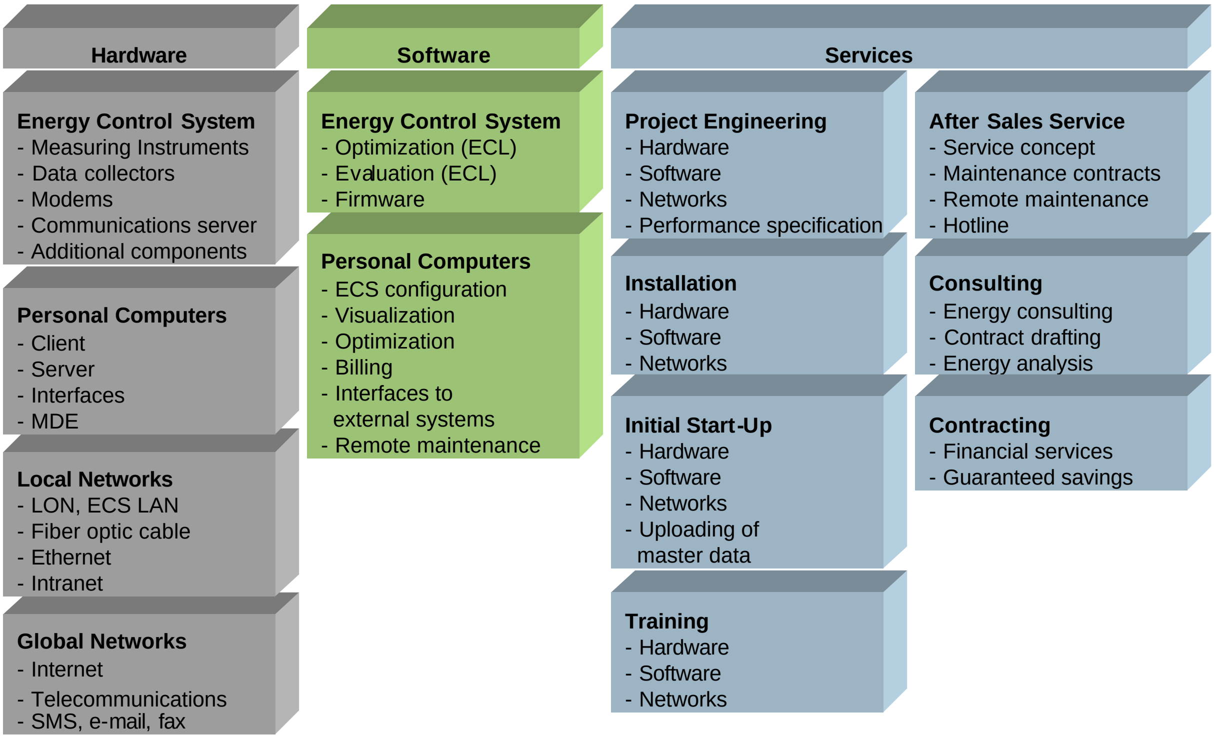


Figure 6: The Complexity of Energy Management Projects

The best approach to this problem involves a mutual effort in cooperation with a partner who has the experience and consultation expertise required for the planning and implementation of a system of this type. In selecting a partner is must also be assured that the service provider is capable of covering all of the user's complex requirements, as completely as possible.

Amortization

Energy logging systems pay for themselves within short periods of time thanks to reduced peak loads, exploitation of potential savings and accelerated energy billing procedures. Serious service providers guarantee potential savings after a precise analysis of the user's current situation, and implementation of recommended corrective measures.

A Practical Approach to Technical Implementation

The structural layout of an energy management system is described below, based on the example of GOSSEN-METRAWATT's Energy Control System.

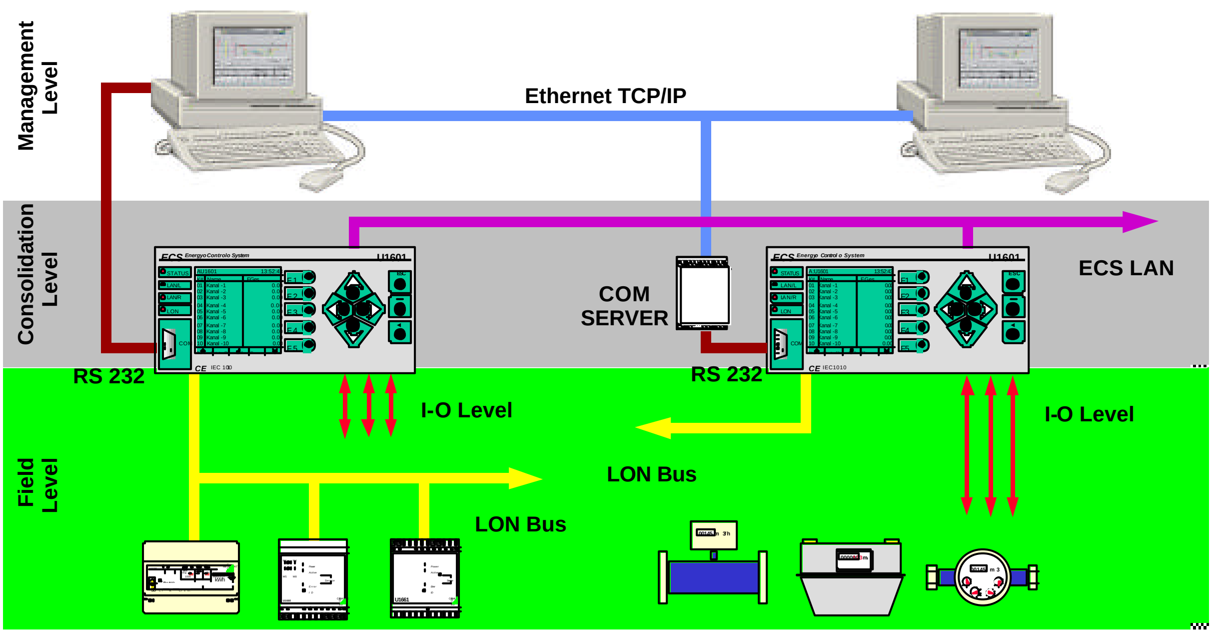


Figure 7: Energy Management System Structure

The energy management system can be subdivided into three levels. We speak of the field level at which data are acquired, the consolidation level and the management level.

The Field Level

The installation of energy and consumption meters which are assigned to individual users or user groups fulfills the prerequisites for the precise allocation of costs, and thus fosters a willingness to consume resources as economically as possible.

As a rule, instruments for the measurement of work, power or consumption can be equipped with a current interface which allows for pulse transmission (DIN 43864). Measured values are sometimes transmitted as standard signals as well, i.e. 0/4 to 20 mA or 0 to 10 V.

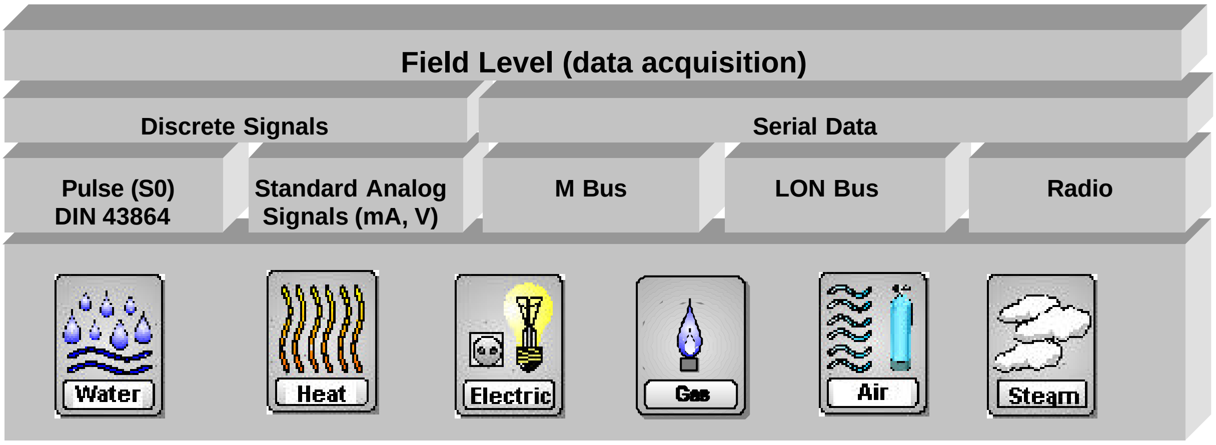


Figure 8: Field Level Signal Types

Energy and consumption meters which are equipped with a serial bus interface offer the advantage of transmitting meter readings instead of energy quantities. Re-acquisition of lost energy quantities is thus no longer required after the occurrence of a bus failure. Wiring expenses are also substantially reduced in this way, because all of the users within a given segment are connected by means of a two-conductor cable. The M bus (meter bus) has become well established for applications involving piped media, and the LON bus is becoming more and more prevalent for building management technology. Metering devices with radio transmission for energy consumption billing and piped media are already available for various real estate objects.

The GOSSEN-METRAWATT system utilizes LON bus technology at the field level. The electrical energy meters are connected to this bus system via LON direct, or other products with pulse or analog outputs are connected to the bus via special multi-adapters. Other bus systems which have already been installed at the customer’s facility are incorporated at the management level via the communications server.

The Consolidation Level

It is the task of the consolidation level to collect and transmit all energy and consumption data, and to make them centrally available. The output signals from the measuring instruments at the field level are processed, stored and transmitted by interlinked data collectors. The serial RS 232 interface is used for data transmission. If special timing requirements exist, the overall system is segmented and data are made available directly to the management level network (Ethernet). In this way, data throughput times play an insignificant role thanks to high transmission speeds.

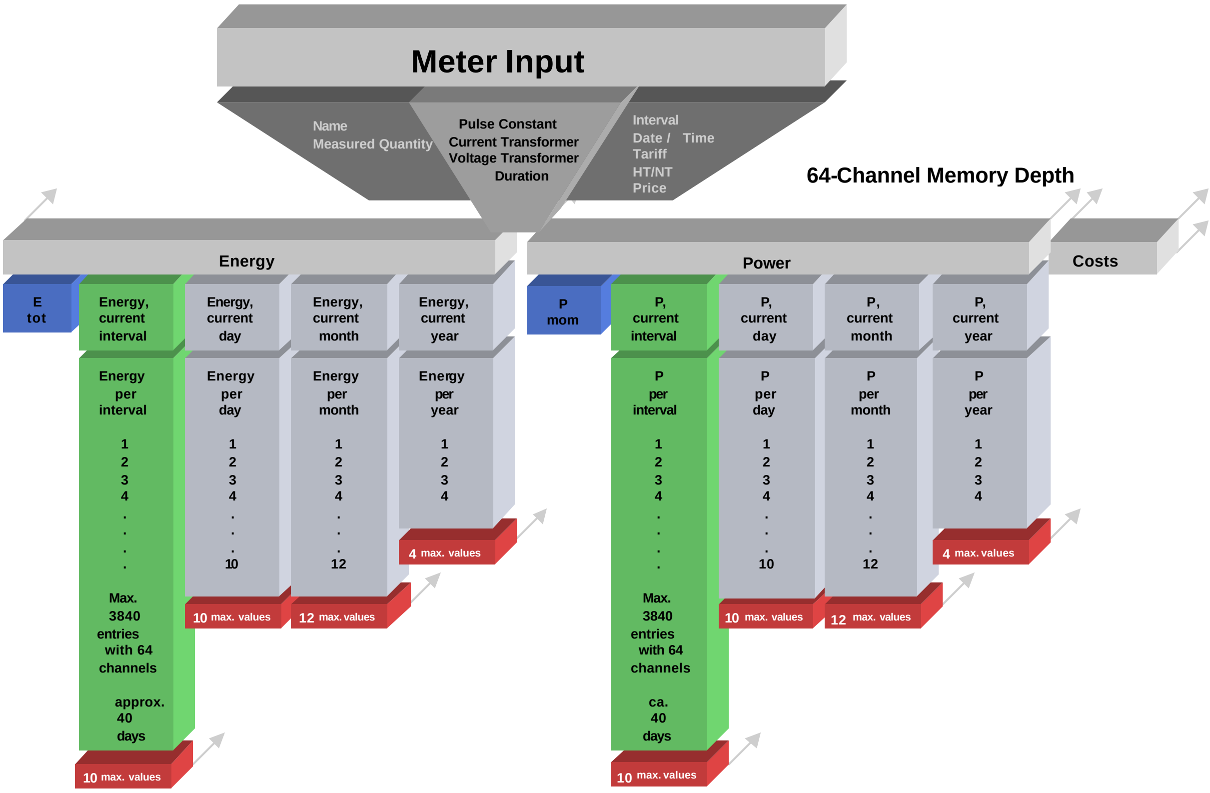


Figure 9: Energy Database at Data Collector

The following requirements should be taken into consideration in the selection of a suitable system for the consolidation level:

- The data collectors must be capable of processing the various output signals which are generated by the consumption meters.
- The data collectors should pre-process and store the measured values so that no data is lost if a network or an analysis computer failure should occur.
- The selected system must be expandable, and must be able to handle the required number of meters when the final expansion stage has been reached.
- Load profiles, daily, monthly and annual characteristic values and tariffs should be pre-loaded to the data collectors.
- In order to assure that energy and consumption values can be queried on-site, it must be possible to query all data within the system from any point within the network, and data collectors must be easily user-programmable.

- If peak load optimizations are to be performed in a decentralized fashion, the data collector must be programmable, must be able to access all data, and must be equipped with suitable switching outputs.

- In order to minimize costs, the network should make use of communications lines which have already been installed in the building, and the system must thus be adaptable to prevailing local conditions.

- It must be possible for the system to acquire values from physically distant summators or other locations via public telephone lines.

- Energy and consumption data acquisition should be consistently isolated from previously installed control systems so that energy consumption changes resulting from their failure can be recorded and analyzed uninterruptedly.

The GOSSEN-METRAWATT energy management system fulfills all of these requirements. It consists of various intelligent summators which are interconnected by means of a flexible bus system.

The Management Level

It is the task of the management level to process all energy and consumption data in a centralized fashion. Extensive knowledge of PC technology, network systems and database techniques are required in order to realize the management level. Interfaces to other systems such as internal company billing via SAP / R3, or to systems at remote locations are incorporated to this end.

Standard packages for peak load optimization, consumption optimization, billing and data visualization are provided based upon available measurement data. As opposed to individual company solutions, these standard programs off the advantage of automatic adaptation to changing market requirements. Customer specific requirements are relatively easy to satisfy thanks to modular software design.

The management level is provided by Klein & Partner Engineering, who offer various software products for the specified requirements under the designation BDE 2000. BDE 2000 – Optima is capable of handling complex optimization tasks with the help of various algorithms and priorities. Network parameters configuration and cost center energy billing based upon various tariffs is accomplished with BDE 2000 – E2. Measured values can be visualized online with BDE 2000 – E2 as well, and various display formats, limit values and log files are possible.

The following example represents a complex energy management system used by one of our customers. You could have a similar system – let us provide you with complete consultation and take advantage of the experience we have gathered during the course of innumerable energy management projects.

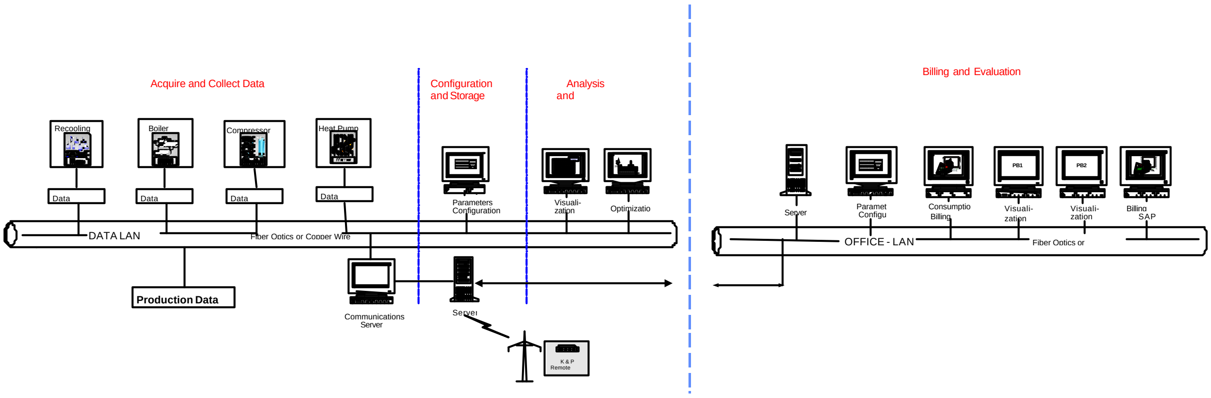


Figure 10: Complex Energy Management System

Additional information is available from:

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