



**European Commission
'Intelligent Energy –
Europe' programme**

**Energy Savings from Intelligent Metering and
Behavioural Change**

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Comparisons of existing monitoring systems (Deliverable 4)

**Work Package 1: Monitoring Specification
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1. Summary

Monitoring systems can originate from three different points of view. First will be from the loading management, second from building management systems and third from accounting departments. So the request and possibilities for the monitoring systems are very diverse. The producers of energy accounting software also changes quickly. If you want to choose a suitable system and software it is highly recommended to ask other users of this software first about their experiences and the unsatisfactory details.

2. Introduction

Please read monitoring needs (Delivery 1) first. Also Deliverable 2 monitoring specification can give you useful hints to find out which system may fit for your requirements.

3. Comparisons between existing monitoring systems

Generally there are three start points for monitoring systems.

On the one hand there are approaches of the loading management - , building control – and of energy accounting systems.

Generally the project „Intelligent Metering“ is an intelligent mixture of all approaches.

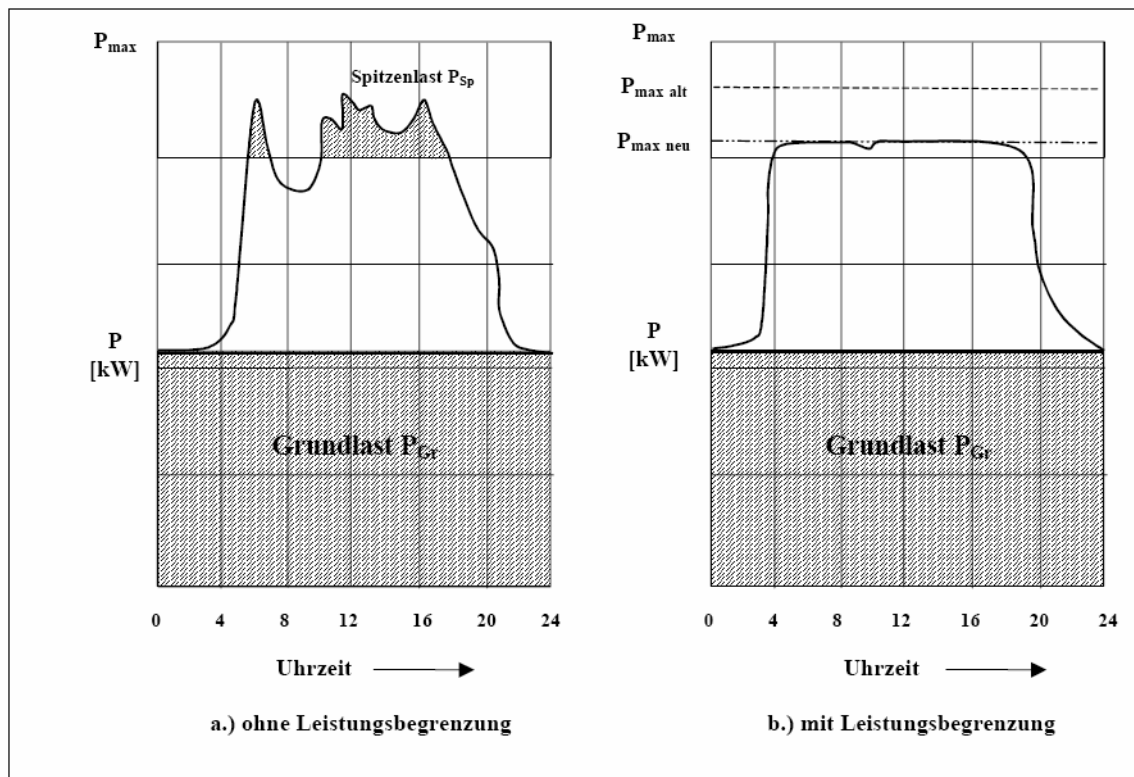
3.1 Loading management:

In loading management it is necessary to minimize the energy peaks to a predetermined value. The background is to compensate the peak demand, as energy peaks are more expensive and the lines have to be dimensioned for a higher energy transport.

Loading management systems are used in the industry, in the hotel and restaurant industry, in hospitals and so on.

Basically consumer loads are switched on and off so that peak power is avoided or reduced. In these systems it is essential to meter the current peak power. The consumer loads are classified due to their priorities and are switched off in stages according to this classification.

Generally each building has energy consumption, called base load (P_{ge}), which stays constant the whole day. For example this could be standby devices, heating pumps in winter, emergency lightings, ventilation (server), and server in computer arrangements, monitoring devices and so on. In the course of the day, for example at the beginning of the work schedule, or production, the energy demand increases. At specific



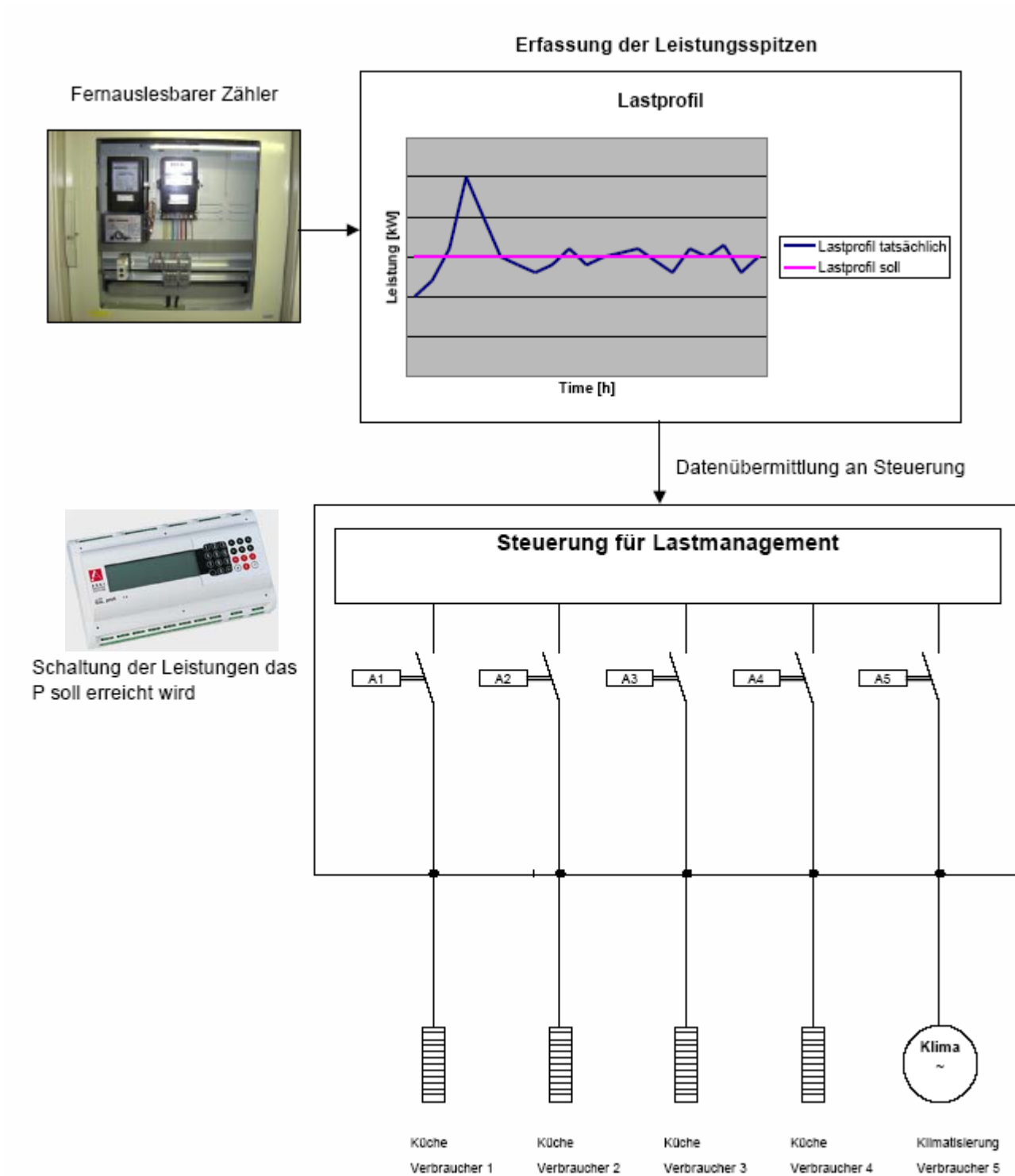
times it comes to peak demands due to operating processes. These peak powers P_{Sp} which are shown in the figure, are reduced at P_{neu} . This happens by periodic, prioritized cut-offs, which are stored in software.

Reasons for the peak demand are for example, at electric energy, lunchtime in course buildings with canteen kitchens:

On the one hand the meal is prepared for the course guests, and on the other hand the aircondition is turned on, as during lunchtime the course rooms are heated to the greatest extent. A remedy is to switch off the hot plates minute-by-minute, which leads to a minimal disturbance of the progress of work. Furthermore the aircondition is switched off for 30 minutes summed up in the next 2 hours.

Example:

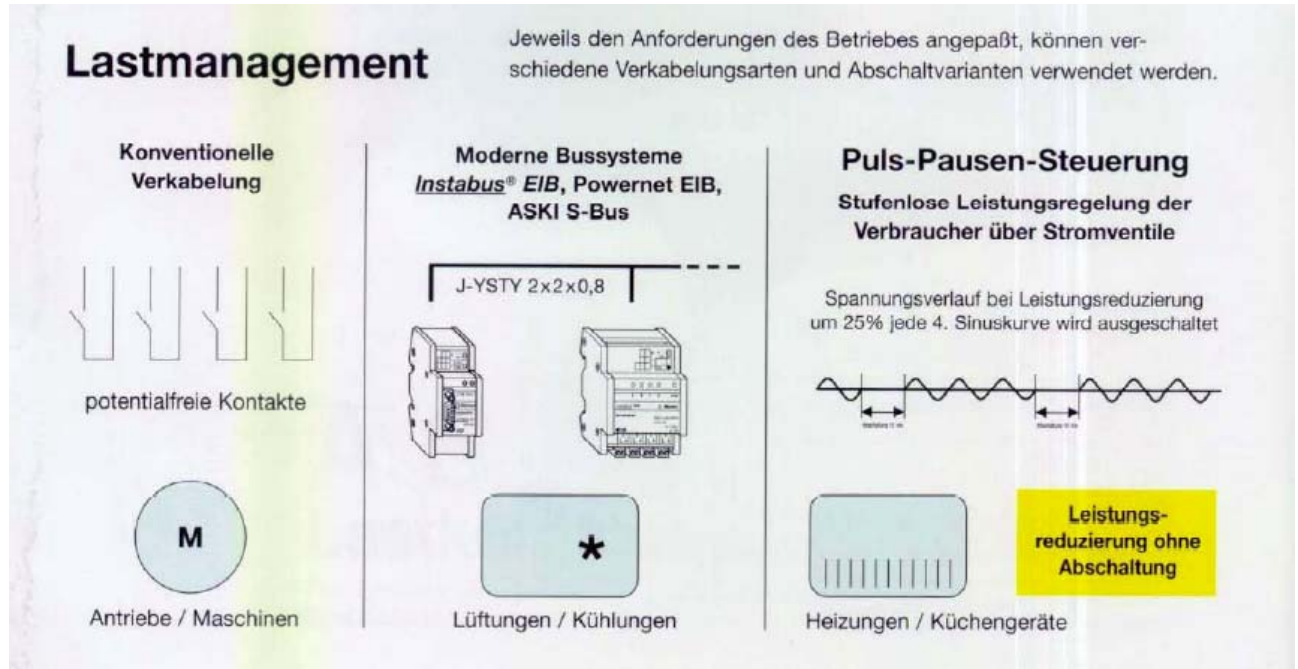
The readout happens every 15 minutes.



The described structure is a simple single solution for a building. Furthermore it is possible to expand and administrate such energy optimization systems over multiple buildings or companies. The data is distributed over the internet via the TCP/IP-protocol with all local networks.

Loading management doesn't necessarily mean turning off devices, but could be controlled so that peaks are avoided. For example to run machines with lower loading -> speed control and so on.

Furthermore, also pulse-, break-control systems can be used, which allow a continuously variable load control of the consumer via flow-control valves (phase angle modulated power). See diagram below.



3.1.1 As example the monitoring system from Aski is explained:

In general the system from Aski is a loading management system which avoids peak demands. This system is often used in independent supply networks (isolated operation). As for example in photovoltaic facilities, windmills, hydroelectric power plants and so on. In these isolated systems it depends on a stable energy demand, so that the generator isn't overloaded. Further fields of activity are the **power supply** for canteen kitchens, hotel business, gastronomy, trade, industry, communal institutes, nursing homes, hospitals and so on. There it also depends on load distribution. The aim is to reduce the expensive peaks to a minimum to reduce costs.

The consumers are switched off periodically and after a prioritizing scheme, to reduce the power rating.

Function:

The ordered electrical power is determined synchronously to the metering of the energy supply company (in most cases the metering via load impulses is offered from the energy supply company). The determined actual output is monitored via microprocessors and is compared with the calculated reference graph steadily. The load ratio is rated via trend calculation, and the consumers which are connected to the "ASL-multi" are switched on or off in consideration of the preset parameters (e.g. priorities). The microprocessor calculates the necessary switching operations and avoids that the device is switched off unnecessarily, and allows the optimal utilization of the preset reference load.

Data recording, energy management function

The "ALS-multi" comes with a big data memory, in which performance data, consumption values, alarm messages and manipulations are stored over a long period. Besides the performance and consumption data of the main meter, data from two additional impulse counters can be recorded. These can be, besides the

current meter, impulse counters of gas, long-distance heating or water. All recorded data can easily be shown or printed in graphical or in table form over the integrated interfaces via PC or modem.

PC – handling / visualisation / modem

With the help of a PC handle – or visualization program the recorded data can be read out of the „ALS-multi“, and on the screen consumption and performance statistics and energy billings can be created.

The connection between the ”ALS-multi“ and the PC occurs via a RS- 232 / RS – 485 interface or via a modem.

All parameters and settings of this system can be read out and consumption and performance statistics and energy billings can be created on the screen.

The software works under Windows 95/98 or newer operating systems.

Further applications:

Load monitoring in facilities without load impulses of the energy supply company
Continuously variable loading management in small power stations in isolated operation
Zero supply control, load monitoring and / or data recording in force- / heat coupling, wind energy, photovoltaic, heat pumps.
Special applications are programmable

Temperatures can be recorded, current supply or delivery or frequencies can be monitored and limits with alarm messages on digital egresses for all measurands can be set.

All these information get via the integrated modem interface per telephone and PC remotely controlled.

3.2 Building control:

Building control systems meter and count data and control, due to these results, certain operating processes. Metered and controlled are for example: ventilation systems, heat pumps, control of (electrical operated) roller blinds, жалousies, clouding, curtains, awnings, and similar, (single room) temperature controls, light controls, alarm- and monitoring technique, irrigation, water, baths techniques and further building control;

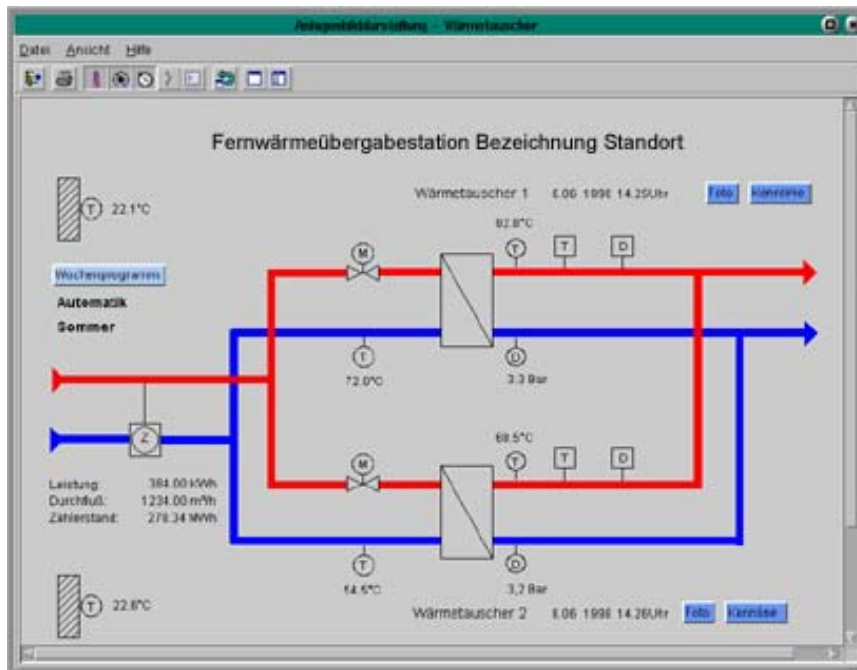
Often there are combinations of load management and building control.

Function:

Automatic-read-out counters are read out and the actual energy demand is determined. Additionally further parameters are determined, like outside temperature, position of ventilation flaps, room temperature, controls of heaters, air-conditioning systems and process dependent procedures. These determined data are compared with ideal settings and due to this, control actions are set for example on and off switching of facilities and facility parts, alternating flap positions, alternating productions, and so on.

These control actions have to be carried out via controlling software. The software producers often offer open systems. That means, to try to imitate the real facility via software, and from there control signals are carried on to external devices, which carry out the wanted settings. The imitated facility can be assembled via a modular system. For example a heat pump is taken virtually from the building block and receives the actual data, like power, delivery height and discharge flow. With this data and the real measurands the speed regulation of the pump is set.

The figure shows a visualization of a long-distance heating delivery station with heat exchanger, magnetic valves, temperature sensors, and so on.



As the energy and water demand is essential for the settings, those values are recorded in some cases and are consulted for the analysis. The further use of the consumption data in this system is not designated. Building control systems are in the broadest sense only single solutions. The levied and analyzed data only affects several facilities and limited networks.

Comprehensive possibilities of comparison can be achieved via energy accounting systems.

3.3 Energy accounting:

The third consideration originates in the accounting department. The energy accounting is in general a database, in which object specific data is processed. The data consists of basic claims data and consumption data. Basic claims data is for example year of construction, area, volume, installed power of objects. Consumption data refers to the energy consumption. The ratio of basic claims data and consumption data results in energy key data, which are consulted for the valuation of the objects. For example kWh/m²a (see figure 1).

Objects can be buildings, street lightings, producing facilities, indoor swimming pools, etc. The essential details were already described in part „Monitoring needs“.

3.4 Means of energy accounting

Please see the chapter 3.2. in delivery 1 – monitoring needs for the details of the different types of energy accounting.

3.4.1 Sheets of paper - the simplest way

Someone writes down the counter reading to collect them. From time to time the consumption will be calculated. Costs are the working hours of the person. The assessments are simple, but it can be done everywhere by everyone.

3.4.2 Spread-sheet calculation program

Here someone reads again the counters and writes it down. The data are entered into a spread-sheet program, e.g. like the Microsoft-program Excel[®]. The software costs are low, but you have to use your own brain to develop calculation procedures. You can program very complex assessments. There is no fixed structure, the quality depends on the user, and the calculations can be simple to comprehensive for other users. Data exchange is easy, but it is recommended to exchange the raw data, because processed data can be manipulated in many different ways, often you don't know the story of a processed „value“. Some cheap or free energy accounting programs on the market are based on spread-sheet calculation.

3.4.3 Stand alone energy accounting programs

Especially for the purpose of energy accounting programmed, usually combined with a database for collecting the data. Quality and price vary from simple to expensive. The simple programs are often made for the non experienced user, the complex programs are only made for skilled professions. In some cases the exchange of the data to other programs can be a nightmare. Some complex programs have other tools included, like economy calculation of redevelopment measures (*a calculation of the economics of energy efficiency measures*), facility management or calculations of the heat demand. Sometimes the program can be used locally as a client – server solution in a LAN (local area network).

The counters can be read manually, but in some programs there is also the possibility of remote data transmission. There are also some energy accounting systems which use data communication by email or exchange of hardware devices (floppy disks, CD-rewriteable or USB-sticks), but this data import seems a bit inconvenient.

3.4.4 Own network solution of energy accounting:

Here a WAN (wide area network) provides all users with energy accounting. The users log in at the server, where the database for all users (clients) is situated. This brings advantages: The data of different objects at different locations can be compared easily; they all have the same data structure. Benchmarking is possible and usually made only by a special administrator, so the assessments in benchmarking can be anonymized. Support and central updates provide more help to the user/client. Data input can be done manually at different places at client computers, and remote data transmission is often possible too.

If the client needs his own software on his personal computer to use the energy accounting we name it an Intranet-Energy-accounting. The data can be transmitted by phone line (expensive) in analogue way or by ISDN, but it is also possible to use the Internet as a transport media.

3.4.5 Application service providing (ASP) of energy accounting

This is the modern form of energy accounting. The client does not need his own software-program but uses the standard software browser of his personal computer. The administration is sold as a service. The clients get a password and use the program. Often adaptations of the software to the special needs of their clients can be made, but are often expensive. Some of the ASP-energy accounting can also manage automatic remote sensor data input.

3.4.6 Network with automatization of data input from remote sensors

The project intelligent metering uses this type of energy accounting. The data are collected from the sensor in data logger or substations of building management systems. The time intervals of the data can be very short (one minute or 15 or 30 minutes). In intervals the data are transmitted in an automatic way to the server with the analyzing software. Often the analyzing tool compares the consumption data and gives warnings by email or text message (SMS) if larger aberrations from target values are reached in consumption. Billing by electronic data interchange (EDI) is an extra feature avoiding any manual data entry. With this system real-time pricing as it starts now in the liberated electricity market in the United States is possible.

3.5 Overview about the different types of energy accounting:



Rating of different ways of energy accounting

	costs for building up the system	costs for running energy accounting	needed working time for energy accounting	homogeneity of data	Benchmarking	Support	capability of different reports	userfriendliness, simplicity	data security	data input (amount, plausibility, completeness)	(additional) benefit, savings	adaption, enlargement
manual energy accounting	green	green	purple	red	red	red	red	red	green	red	red	red
EA using a spreadsheet	teal	teal	purple	purple	purple	purple	teal	purple	purple	purple	purple	teal
single place commercial EA software	purple	purple	purple	purple	purple	purple	teal	purple	green	purple	purple	purple
own EA network solution	purple	purple	purple	green	teal	teal	teal	purple	teal	teal	teal	green
EA application service providing	purple	purple	purple	green	teal	teal	teal	purple	teal	teal	teal	purple
EA (ASP) with remote meter / BMS	red	purple	green	green	teal	teal	teal	teal	purple	green	green	purple

system costs	running costs/time	all other aspects:			rating general
very expensive	very high	very low			very bad
expensive	high	low			bad
medium	medium	medium			medium
cheap	low	high			good
very cheap	very low	very high			excellent

Comparison of different types of energy accounting (EA) by the main characteristics.

The main aspects of a successful energy accounting are

- To choose the right software for the own needs
- To calculate staff time as the most important factor
- To communicate the results to the right people
- To choose user friendliness and support quality as main aspects of the software

3.6 Survey of different software for energy accounting

characteristics	Dynamat software	EMC	Audit Gema	ASKI Load Control System	Akropolis	energo	consumption control	SEKS
energy accounting of buildings	yes	yes	yes	yes	yes	yes	yes	yes
energy accounting of plants	yes	yes	yes	yes	yes	yes	yes	yes
energy accounting of car pool	yes		yes			yes	yes	
economy calculation of redevelopment					yes	yes		
calculation of presumable demand of heat of objects					yes			
generation of data sheets for input data	yes	yes			yes	yes	yes	yes
automatized energy reports	yes	yes		yes	yes	yes	yes	yes
actual value/target value analysis of consumption	yes	yes		yes	yes	yes	yes	yes
facility management				yes	yes	yes		
remote meter reading integrated	yes	yes	Extra costs	yes	yes	yes	yes	yes
client-server solution in LAN possible	yes	yes	yes		yes	yes	yes	yes
client-server solution in WAN possible	yes	yes	yes		yes	yes	yes	
type of network	Internet, Intranet	Internet	Intranet		Intranet	Internet, Intranet	Intranet	LAN Intranet
access rights for data base can be defined	yes	yes	yes		yes	yes		yes
software of data base	SQL	SQL	Oracle	n.a.	Oracle	SQL, Oracle	SQL	Excel
objects with new parts of buildings expandable	yes	yes	yes		yes	yes	yes	yes
different key figures for energy possible	yes	only m ²	yes		yes	yes	yes	
key figures can be defined as desired	yes	in future	yes		yes	yes	yes	
allocation of more sub counters to one counter possible	yes	yes	yes	yes	yes	yes	yes	yes
maximum accuracy for consumption data	30 minutes	15 minutes	day	15 minutes	15 minutes	15 minutes	day	day
adding counter	yes	yes	yes	yes	yes	yes	yes	yes
subtracting counter		yes	yes		yes	yes		yes
value counter (eg. kVarh)	yes	yes			yes	yes	yes	yes
load and energy collected (kW, kWh)	yes	yes	yes	yes	yes	yes	yes	yes
changes of tariffs/rates registered	yes	yes	yes		yes	yes	yes	
automatic alert at high/low consumption	yes			yes	yes	yes		yes
calculation of energy costs	yes	yes	yes		yes	yes	yes	yes
cost components registered	yes	yes	yes			yes	yes	
heat degree correction (HDC) possible	yes	yes	yes		yes		yes	yes
maximum accuracy for HDC-data	30 minutes	day	month		month		day	day
greenhouse gas emissions calculated	yes	yes	yes		yes		yes	yes
other air pollutant parameters possible	Sox and Nox		yes		yes			yes
results in tables possible	yes	yes	yes	yes	yes	yes	yes	yes
file type for table export	csv, HTML	csv	xls, txt	n.a.	xls, ascii	xls, txt, xml	xls	xls, dbf
results in graphics possible	yes	yes	yes	yes	yes	yes	yes	yes
file type for graphics export	jpg, bmp, Chart FX object	pdf, html	bmp, jpg	jpg	yes, n.a.	wmf, jpg, bmp		
graphics can be edited in the energy accounting software	yes				yes	yes	yes	
program specialties	Tracker module self-learns energy consumption profile and uses it as target.	.		load management; trend calculation	complex calculations			works with an additional program "saave"

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language	English	can be chosen	German	English, German	German	English, German	can be chosen	German
Energy Accounting type		6, 5, 6	4 (6)		6, 4, 6		6, 4, 6	4, (6)

The type of the software system in the table can be allocated with the following numbers possible, but not done (6)
software network 4
ASP 5
network with remote sensor reading 6

The table of software for energy accounting is only a small excerpt from the market but shows some very interesting and more often used monitoring systems. The table above shows some program characteristics which may be of importance for users. If you are interested in energy accounting software ask for references and control these references. In our research we found out, that some references of energy accounting software are very old, some not even real and some users are not very satisfied with their software.

Other energy accounting software is following here. The software is not always in use anymore and not tested by us. The list should give only an overview.

GMS-ECS, Energieversorgung Offenbach AG, Germany, not in use anymore

Ebook Gold + G2, Josef Zehentmayer, Austria, not in use anymore

E-Buch, Arbeitsgemeinschaft Erneuerbare Energie AEE, Austria, not in use anymore

MEMS (Münchner EnergieManagementSystem), LZH München, in combination with building management systems

Gedeva, Energie- und Umweltbüro e. V. Berlin, Germany, Excel based, in combination with building management systems

Ekomm, ages GmbH, Germany, Stand alone software

Unidoku 32, DCS Ingenieuresellschaft mbH, Germany, in combination with building management systems

E-Bilanz, Synergetic, Germany, more a stand alone software with SAP-connector

EBHUAK, Oberösterreichische Umweltakademie, Austria, Excel based, very simple

E58 Energiemanagement, Solar Computer GmbH, Germany, Stand alone software

Energiebericht Basis/Service-Energy data plus, EnBW Kundenservice GmbH, Germany, access based, only for electricity, useful for electricity suppliers

Kenerdat, Azimut Ingenieurbüro, Germany, not in use anymore

Excel Software G00, Energie-Controlling, Austria, Excel based stand alone software

Metropolis, Günther Energie Software, Germany, Excel based stand alone software

Cebra, Oberösterreichischer Energiesparverband, Austria, simple program

TGM Gebäudemanagement, Technisches Gebäude Management GmbH, Switzerland, stand alone, simple but expensive, in combination with building management systems

ÖEKV-Software Energiebuchhaltung EBU, Österreichischer Energiekonsumenten Verband, Austria, cheap Excel based stand alone software

VEC – Visual Energy-Center, ennovatis GmbH, Germany, for large single objects, with CAD-import

CEC (Caliqua Energie Controlling), Austria, in combination with building management systems
GA-Tec Energiecontrolling, GA-Tec Gebäude und Anlagentechnik GmbH, in combination with building management systems

Vartotojas; Lithuania

SMEU, Romania

CENef software, Russia

BEEP software, Serbia

MAJA tool, Latvia

ENSI software, Norway

ASE 2.3, Ukraine

MEEN energy database, Bulgaria

Stark Energy accounting software, England, EDI-modules and bill verification for electricity

The utility manager, United States of America, not in use anymore

Metrix, SRC Systems, Inc., United States of America

EEM Suite, Siliconenergy, United States of America

Faser, Omnicomp, Inc., United States of America

Energy Profiler online; ABB, United States of America, web based, ASP

Energy watchdog, United States of America, web based, ASP

Envision; Energard, United States of America, web based, ASP, realtime EA, feedback, autoreport

Portico, Honeywell, United States of America, web based, ASP, out of use (?)

4. Conclusions

The most important factors for monitoring systems are the people who have to use the software. Remember that they need extra time for this aspect. Also if everything runs automatically, there are persons necessary who have to understand the results and react to reduce the consumption.

Therefore the importance and advantages of energy accounting/monitoring systems must be understood by the higher administration levels of the companies, municipalities and organizations.

If you choose an energy accounting software/monitoring system it will be good to ask the users of the software about their experiences. This is really important because sometimes the references of the software producers are not real (anymore). Support, being adapted to your needs and user friendliness are the most important aspects in their use. If it is an intranet or internet system and/or remote reading of sensors transfer speed can be a limiting or cost expensive factor.

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(Lunzer Horst: Energy accounting for Vorarlberg. Specifications for the administrative unit of the federal government of Vorarlberg. Waidhofen/Thaya, 2003.)

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