УДК 621.3

M. Voloshyn, *candidate of Agricultural Sciences, associate professor State Agrarian and Engineering University in Podilya,*

S. Voloshyn*, candidate of Technical Sciences, associate professor National University of Life and Environmental Sciences of Ukraine*

THE SYSTEM OF POWER CONSUMING MONITORING AND MANAGEMENT

The description of a system of monitoring and managing power consuming of an object is given. The system enables effective administration of power consuming systems that, in its turn, decreases the expenditures on energy.

Keywords: *monitoring, energy supply systems, system of energy consumption, management of energy supply systems, the power mediums.*

М.М. Волошин, *кандидат с.-г. наук, доцент ПДАТУ,*

С.М. Волошин, *кандидат технічних наук, доцент НУБіП*

СИСТЕМА УПРАВЛІННЯ ЕНЕРГОСПОЖИВАННЯМ ТА МОНІТОРИНГУ ВИТРАТ ЕНЕРГОРЕСУРСІВ

Описано систему моніторингу та управління енергоспоживанням об'єкта. Система надає можливості для ефективного керування системами енергопостачання, що, в свою чергу, скорочує витрати на енергоносії.

Ключові слова: *моніторинг, енергоспоживання, управління системами енергопостачання, енергоносії, енергетичний менеджмент, енергетичний аудит.*

Problem in general view and its connection with important scientific and practical tasks. In modern industry Energy Saving and energy saving technologies are considered to be investment projects of top-priority. The transition of businesses to new costs on fuel, water and energy demands to review existing approaches to projecting and using power plants. The optimization of systems of producing and distributing energy and the adjustment of power and water balances enable to increase the prospects and then to increase technical and economical rates of enterprises functioning.

Analysis of recent research and publications concerning the solution of this problem. The high energy consuming by existing en-

terprises is greatly determined by using old producing fund, worn-out equipment, imperfect technologies and other objectives causes. On the other hand the situation is complicated by subjective factors, that is, mismanagement, the lack of unified system of accounting and controlling, the fact that energy saving technologies are not used and the main factor is imperfect administrative mechanisms to eliminate which low cost is required. Obviously we should pay more attention to fast payback energy saving measures that will in the nearest future will be able to show high economic effect [1].

Definition of the problem. The main instrument of decreasing energy use and increasing the effectiveness of its use at the enterprises is working out a system of monitoring and managing energy consuming. The existing systems are parts of the system of energy management that is the system of management that is based on carrying out ordinal measurement and audit to provide effective use of energy resources. Energy management provides the constant information updating about the distribution and the conditions of energy consuming at an enterprise as well as its consuming effectiveness [2].

Presenting the basic information. There are four main reasons for being interested in the controlling and managing energy consuming thus facilitating [3]:

– service staff to work more effectively;

– to increase the expenditures on energy;

– to optimize and increase the terms of operation of main equipment which is connected to the power supply;

– productivity growth process (producing process, administrative management or dispatching the engineering systems of a building by preventing or reducing downtime or providing the consumers with energy of better quality).

One of the main demands to the personnel operating the power supply network is to take right technical decisions and take measures in the shortest possible time [4]. To do it the personnel must be informed fully about what is done in the network moreover from any place on the territory of an object. Such a transparency on the territory of an object is the main peculiarity that enables the servicing staff:

– to know about energy flows, to make sure that the network of energy supply is well balanced and to understand which objects are main energy consumers which day of the week of part of the day;

– to know about the schedule of network work that is it is easier to understand disconnecting the cable if you have an access to the information about the consumers who are connected to it;

– to receive urgent information with the help of modern means of communication about the state of the network of energy supply even without being present on the territory of an object;

– to come immediately to the needed place on the territory of an object with the needed spare part understanding the general state of the network;

– to start a technical service taking into account factual use of an equipment not too early and not too late.

Giving an energy manager an opportunity to control the work of energy network we receive an effective way to optimize and in some cases to reduce greatly the expenditure on energy.

We give some examples how to use the easiest systems of monitoring:

– a comparative evaluation of different zones in order to reveal the plot with high energy consumption;

– monitoring cases of unpredictable energy consumption;

– an opportunity to demand a refund for damages caused due to low quality energy supply by an energy system.

Whereas energy supply is constantly increasing the following question is inevitably raised and this question is if an existing network is able to provide this new expansion. It is here where the system of controlling and management can help the service of energy management to take the right decision. Registering events and process in the network it can archive the factual use of main equipment and them more accurately assess the reserve power of the network or a switchboard or a transformer.

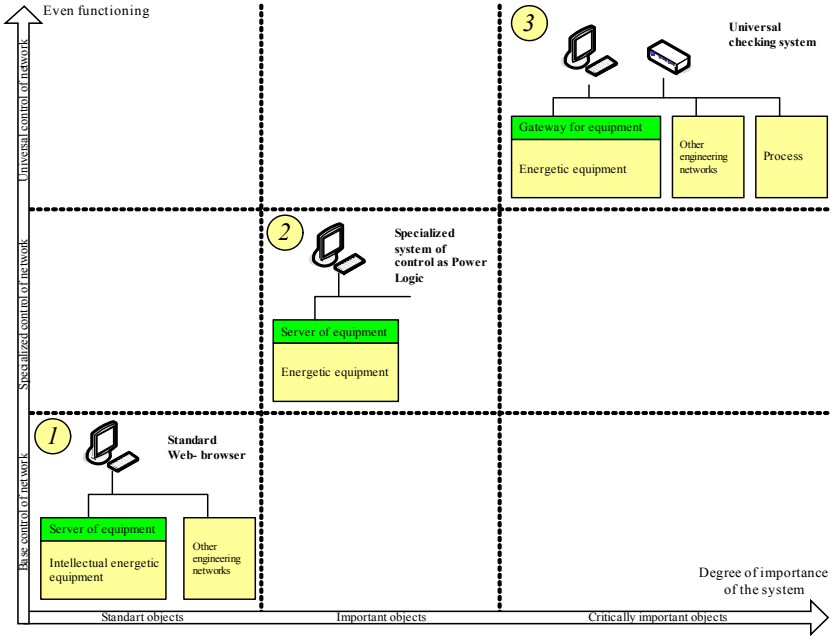
The more effective use of the equipment will enable to increase its period of operation. The systems of controlling the energy consuming can give accurate information about the factual use of an equipment and after that the staff of technical service can take a decision of performing

the corresponding service in the shortest time, that is not too early and not too late.

Traditionally the systems of controlling and managing the energy consumption were centralized and were based upon systems of automation of supervisory controlling and data acquisition (SCADA).

Because of high cost the use of such systems (item 3 in pict. 1) was limited by greatly important facilities as they were either greater energy consumers or their technological process was very sensitive to the reduction of quality of energy supply [3].

Such systems were based on the technologies of automation and very often were projected b a system integrator due to a customer's demands and then delivered ready to an object. However, bigger starting price high qualification requirements for an operational personnel and the cost of modernization were often hardships for potential customers while expanding energy supply network.



Pic. 1. Positioning of the system of monitoring and managing energy supply

Another approach (item 2 pict. 1), that is being realized by a specialized technical decisions meet the specific demands of energy supply in a much better way and that actually increases the profitability of such systems. But because the use of a centralized architecture, the starting expenses remain as high as before.

At some objects systems of the kind (2) and (3) can be used together providing if necessary the service of energy management with the most accurate information.

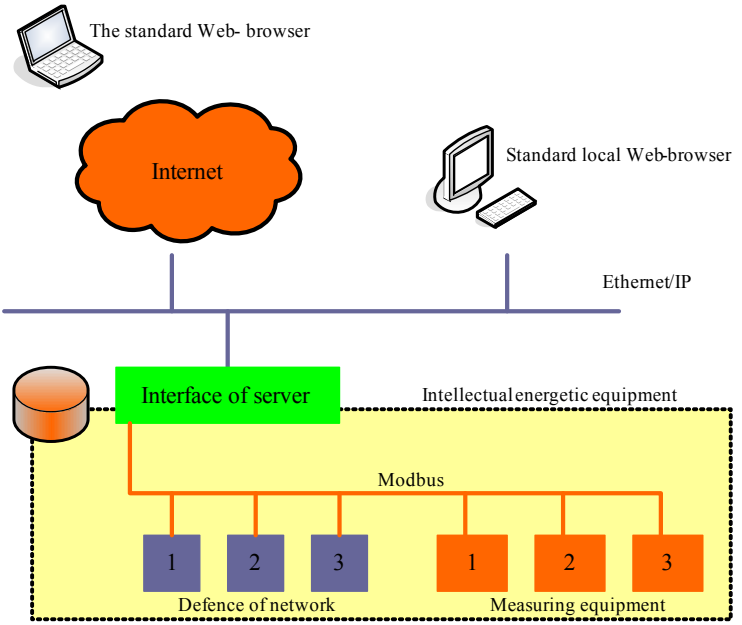
At present there appeared a new concept of intellectual energetic equipment (item 1 pic. 1). Based upon the opportunities of Web-technologies, it indeed offers acceptable by means decision for most customers. Moreover, the owner of an object can gradually invest in more complex systems of monitoring.

Level 1 can then be considered to be the starting step for transferring to level two or three thanks to these technical decisions being used together within the same object.

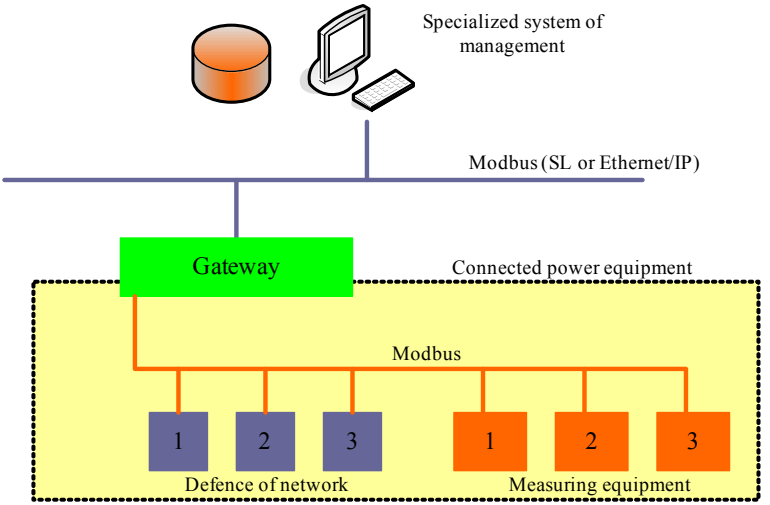
The architecture of intellectual equipment (pic. 2). Based upon Web-technologies, it gets a great benefit using standard services and protocols of communication and non-licensed software. The access to the information about energy consumption is possible from any plot of the object, due to that the effective work done by the staff of energy managing service can increase greatly. Besides, there is the access through the Internet provided for services that are not present at the object.

Specialized centralized architecture (pic. 3). This architecture is based upon the use of specialized monitoring equipment that fully meets the demands of controlling electric networks. It has lower qualification requirements for personnel while its installing and servicing as all elements are standardized. And at last, the expenses for this system are truly minimized due to limited in time participation of a system integrator.

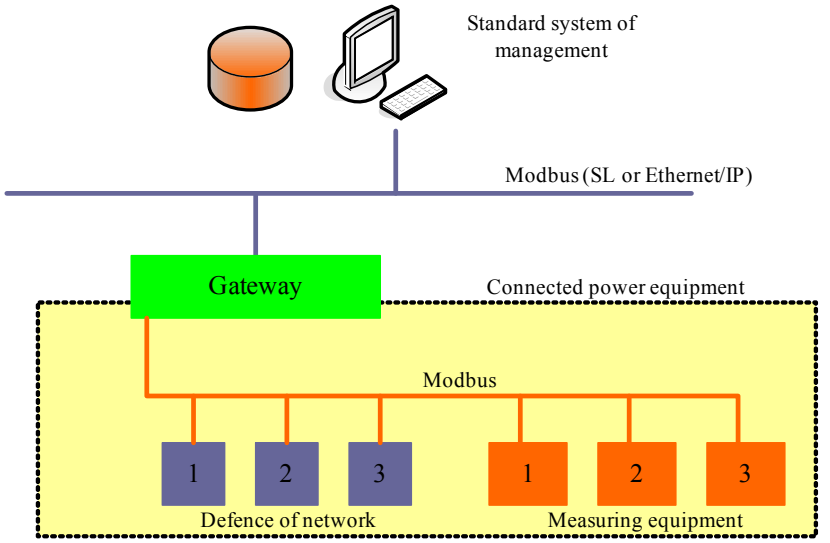
Traditional versatile centralized architecture (pic. 4). It is based upon standard elements of systems of automaton such as systems of supervisory controlling and data acquisition (SCADA).



Pic. 2. The architecture of intellectual equipment



Pic. 3. Specialized centralized architecture



Pic. 4. Traditional versatile centralized architecture

Despite its efficiency such an architecture has a number of drawbacks such as:

– high qualification requirements for working staff
– limited possibilities for modernization
– and, at last, a large payback period of such systems.

However such systems have no alternative for highly important objects and their use is especially efficient at central supervisory controlling points.

Suggested for implementing in National University of Life and Environmental Sciences of Ukraine system of energy controlling and managing is hardware and software complex for automatic accounting and monitoring of consumed energy. The system supports seven types of measurable characteristics such as electricity, thermal energy, voltage, the consumption of hot and cold water, the consumption of natural gas. The system enables to collect data from mentors and sensors manually or automatically and present collected data in tabular or graphical forms. The unit of collecting and keeping data can be staffed with additional expansion slots of analog and intermittent inputs.

A widespread use of voltage sensors instead of electricity meters helps reduce the system price when a slight amount of data is lost and the accuracy of calculation of consumed energy is reduced acceptably.

Hardware and software complex includes:

1) software complex (PC):
- the system of collecting, keeping and rendering data;
- a driver of connection with the meter;
- a driver of connection with the unit of collecting and keeping the data;
- a driver of connection with the meter of thermal energy;

2) hardware:
- a switching device output to telephone modem through port RS232 and into network RS485;
- the unit of collecting data from sensors and devices;
- the meter of thermal energy;
- electronic meter of energy;
- the meters of cold water with intermittent output;
- the sensors of voltage with analog output 0-20 мА;
- sensors of temperature with analog output 0-20 мА.

Functional opportunities of software complex while working with external devices connected are supported by drivers that devices are equipped with. Modular structure helps to increase reliability and performance of an installed system easily (connection of other physical devices).

There are two main functions the developed system an fulfill:

1) collecting and keeping the data;

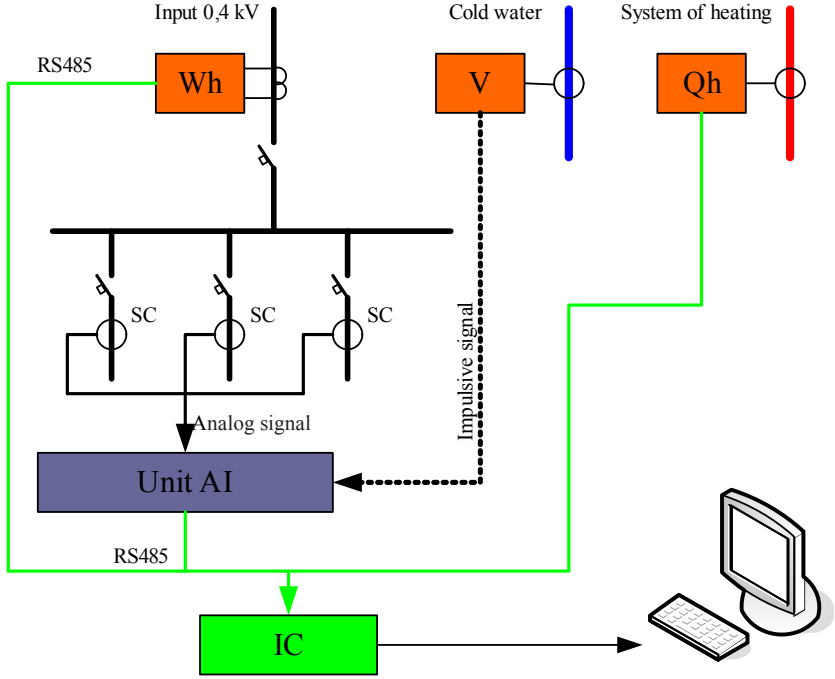
2) the analysis of the received data;

The data is collected and kept in two possible variants. The first variant is that the data comes from analog and intermittent sensors in a unit. The second variant is the data comes from the meters. In the first variant the unit does the collection and keeping data from the sensors and in the second variant the meters of thermal and electric energy have their own memory and accumulate data in it. Then all data goes to the computer through the interfaces convertor where the data is handled.

The software complex supports the service up to 32 customers in network RS485. Besides approximately 64 sensors are connected

through the unit of collecting and keeping data from sensors and devices. The number of units in the network is limited only by the number of customers. The unit enables to connect 64 analog sensors or 64 intermittent sensors simultaneously, it is also possible to connect 32 analog sensors and 32 intermittent sensors as well as additional devices with interface RS485 up to 255 items can be connected. If it is necessary a number of analog and intermittent inputs can be increased.

Simplified structural scheme of the system is given in pic. 5.



Pic. 5. The structural scheme of a system of controlling and managing energy consuming:
IC – the unit of interfaces convertor from RS485 into RS232; Unit AI – the unit of handling the signals from analog and intermittent sensors; Wh – the meter of electrical energy; Qh – the meter of thermal energy; SC – the voltage sensors with an analog output; V – the meter of calculation cold water consumption with intermittent output.

The installed system consists of the following elements:

– the meter of electric energy installed at the input on a distribution board;
– the meter of cold water (with intermittent output);
– the meter of thermal energy installed at the input to the thermal unit;
– the sensors of voltage installed at the lines that go from the distributing board (are necessary for calculating the electric energy consumption at each line);
– the sensors of temperature, which are placed in a building in such a way that they provide monitoring the temperature in a greater number of buildings.

The carried out systems enables:

- to take into account the total consumption of energy resources (electric energy, thermal energy, cold water);
- to analyse the amount of consumed energy;
- to calculate the consumption (at a given period of time) of electrical and thermal energy by separate subdivisions in a building;
- to compare specified and real parameters of consumed energy resources.

The analysis of data about energy consumption can be done in two ways.

The first way – the analysis of energy consumption dependent on the temperature outside. The dependence of energy consumption for an object is calculated according the temperature outside. The dependence includes the specified consumption of thermal and electrical energy. The analysed period (recommended) is a week but this period can be changed. The real weekly electric and thermal energy consumption is adapted to the same units of measuring (for example kW·per hour) and is compared with the specified indexes. If a real consumption is more than the specified ten the possible causes for overconsumption are sought.

The second way is to calculate the balance of consuming electric and thermal energy for the given period. The sensors and the meters electric energy are installed in such a way that they can measure the greater number of buildings. As a result of such placement of sensors

there appears an opportunity to monitor the energy consumption in each room knowing the amount of energy consumption and the type of a room as well as the room space the real specific electric energy consumption (kW·per hour/м^2). The existing standard specific indexes are compared with the real indexes.

The algorithm of analysis of thermal consumption is done in the following way. The data base is loaded with all rooms their space and size. The sensors of temperature installed in the building help to record the temperature inside as well as the temperature outside. At the input the meter of thermal energy is installed. So having the data about the real total consumption of thermal energy, the temperature inside and the space area it is possible to calculate the consumed thermal energy in each room.

Conclusions. The analysis of the amount of cold water consumption is done in the following way. Installed at the input to the house the water meter helps monitor cold water consumption with 30 minute discreteness. The standard cold water consumption for a given period of time is calculated depending upon the number of people in the building. Comparing the real and standard cold water consumption it is possible to make conclusions about the effectiveness of cold water use.

The presented system enables the service of energy management to monitor and mange the systems of energy supply effectively that in its turn reduces the expenditures of an enterprise on energy resources.

Literature

1. Havrysh Valery. 2011: Perspektivi zabezpechennya agrarnogo sektora yekonomiki Ukraini ponovlyuvanimi yenergetichnimi resursami / Valery Havrysh // MOTROL. Motoryzacja i energetyka rolnictwa. − Lublin. − Tom. 13 A. − 107-117.

2. Praxovny'k A.V. Energy Management: Textbook / A.V. Praxovny'k, V.P. Rozen, O.B. Rozumovs'ky'j. – K.: Not. f-ka, 1999. – 184 s.

3. Gel'man G.A. A manual for installing electric devices. Technical decisions Schneider Electric / G.A. Gel'man. – M.: ZAO «Shnejder Elektry'k», 2007. – 395 s.

4. Malinovs'ky'j A.A. Controlling and planning of the energy use: Handbook for those who study Energy Management / A.A. Mali-

novs'ky'j. – L'viv: NU «L'viv. politexnika». Regional'ny'j centr z perepidgotovky' ta pidv. kvalifikaciyi kadriv u sferi energozberezhennya ta energety'chnogo menedzhmentu. – 2001. – 55 s.

5. Dubrovin V. Operational reliability of power contact connections of electric equipment / Krasowski E., Tarasenko S., Voloshin S. // MOTROL. Commission of Motorization and Energetics in Agriculture. – Lublin. – 2014. – Vol. 16. – No 3. – 303-312.

Аннотация. *Представлена система мониторинга и управления энергопотреблением. Система дает возможность для эффективного управления системами энергоснабжения, что, в свою очередь, снижает расходы на энергоносители.*

Ключевые слова: *мониторинг, энергопотребление, управление системами энергоснабжения, энергоносители, энергетический менеджмент, энергетический аудит.*