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FORMATION THE SYSTEM OF SERVICING PRODUCTS BY THE ENTERPRISE (ON THE EXAMPLE OF PJSC “SUMYOBLENERGO”)

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Transmission of electricity from power plants to consumers is one of the most important tasks of energy. In the conditions of increasing costs of energy consumption, the decreasing of energy costs is an important factor of economy and finally reduce prime cost of production enterprises and increase its competitiveness.

Recently, with the increasing cost of energy and the development of the wholesale electricity market managers of industrial enterprises dramatically increased interest in implementation of automated information-measuring systems of commercial energy metering (ASMES), providing carrying out payments for electricity.

Simulation modes of power devoted to the works of many scientists: Arzamastsev D. A., Bartholomew P. I., Venikov V. A., Gamm A. Z., Gornshteyn V. M., Krumm L. A., Markovic I. M., Manusov V. Z., Zhelezko Y. S., Merill H. M., Erickson B. W., Shweppe F. C., Caramanis M. C. etc. Based on these programs were created by industrial design and optimization modes for existing conditions at the time.

The purpose of work is to analyse the effectiveness of implementation the automated system for measurement of electricity provide cost savings for residents of the 14-floors appartments.

In this work we will deals with automated system for measurement of electricity and its branch PLC within the service PJSC "Sumyoblenergo".

Electricity is a leading energy industry. Application of electricity and the use of electric energy are the greatest discoveries and achievements of the XIX century. Now the electric energy is the most convenient form of energy.

Electricity power system is the set of power plants, electric and thermal networks, interconnected and related with the common mode in a continuous process of production, transformation and distribution of electricity and heat in the overall management of the regime.

The model in Ukraine is based on the fact that the generators produce electricity and sell it to GP "Energy", which will continue to sell its distribution companies (power companies and independent suppliers). More power companies and independent vendors distribute power between retailers and large industrial consumers.

The electricity market in Ukraine is built on the model of "single pool" or "single buyers. Generating companies produce and sell it electricity GP "Energy", which later sold its distribution companies (power companies and independent suppliers). More power companies and independent vendors distribute power between retailers and large industrial consumers. Suppliers of electricity at regulated rates are power companies on the wholesale electricity market, they make up the majority (85% market share) [6].

Service center is an important part in the electricity sector. Service spectrum covers the entire energy supply path from the power plant through transmission, sub-transmission and distribution. The primary goal is to minimize the consumption of companies resources and the amount of capital tied-up.

The world experience shows that the energy efficiency of electric power can only be achieved in the implementation of the system, professional activities in the field of energy accounting and energy efficiency, especially in large industrial enterprises, which substantiates the emergence of a new type of economic activity. It is energy service.

One of the important system of servicing in the sphere of electricity is Smart Grid. Today the development of Smart Grid ideology includes virtually every major area of activity in the electricity and related technology and information and communication links between them [5].

The term «Smart Grid» has not received a single definition. To characterize the diversity embedded in it, we give a number of definitions of the leading organizations in the U.S. and Western Europe in the development of the ideology of Smart Grid [7].

Smart Grid is the totality of energy, communication and information technologies for improved electricity infrastructure, providing a continuous evolution of end use devices [10].

Functional model of Smart Grid identifies the main areas of activity in the power sector, represented seven provinces domains, combined technological and communication links (Figure 1)[8]:

– wholesale generation (Bulk Generation);
– electricity transmission (Transmission);
– electricity distribution (Distribution);
– operational management (Operations);
– customer (Customer);
– markets (Markets);
– service organization (Service provider).

Stimulating the development of Smart Grid in different countries [1]:

– China - $70 billion;
– India - $19 billion;
– The U.S. - $10 billion;
– European Union - $7 billion;
– UK - $3 billion;
– Australia - $1 billion;
– Canada - $0,5 billion;
– South Korea - $0,3 billion.

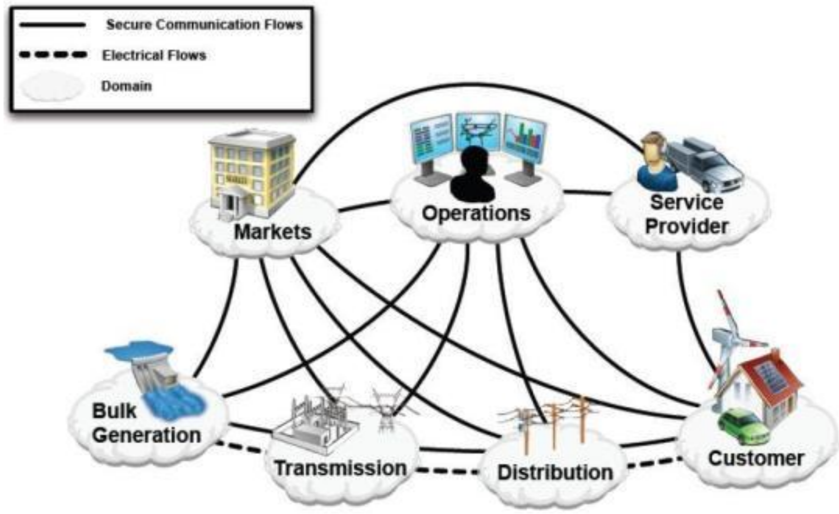

Figure 1 - Combination of technological and communication links

In world practice, it is a leading business service support for the innovative development of the industry. In the energy service industry enterprises are concentrated necessary competence to implement the proactive development and implementation of new technologies in the field of automation, information systems, diagnostic equipment status, etc [9].

Energy service market is a system of economic relationships between customers (utilities and other consumers, who may be industrial enterprises, businesses, and individuals) and service organizations, based on the principles of competition and active cooperation of market participants, and related to the development, sale and consumption of professional services in the field of energy service. It is specificity of service activities in the power due to the technological features. As the object of service activities in the electricity acts as the main product is electricity and energy production system that allows the user to supply this product with the necessary physical parameters.

Energy Service Company:

1. Checks the building or industrial enterprise for finding opportunities for energy savings.
2. Recommends saving measures (RSMs).
3. ESB implements those that are acceptable to the owner (without start-up costs).

One of the basic concepts of the concept of service is the service flow is a set of unidirectional types of services [11]. In the energy companies, there are three service flow (Figure 2).

Systematization of the structure of the electricity service activity allows you to create enterprise service strategy [13].

Automated control system and energy accounting is a kind of tool for any modern enterprise not only to obtain a comprehensive picture of energy consumption but also to achieve sustainable consumption of each energy (electric energy, hot water, steam, gas) [14].

After analyzing the possible alternatives and new systems, we can conclude that automated control system and electricity metering is the one with the best systems in our time.

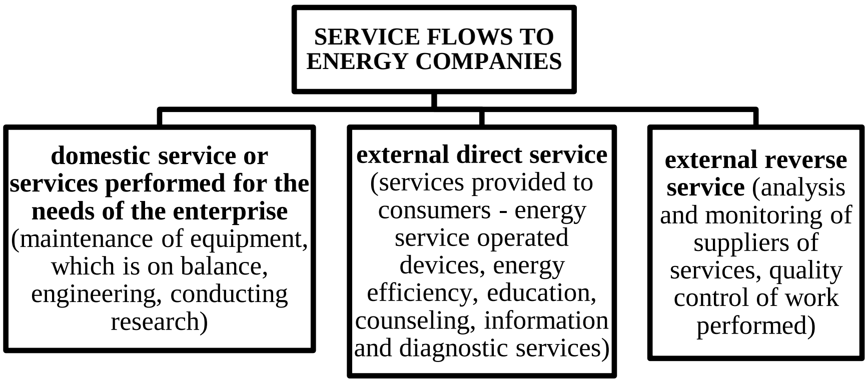

Figure 2 - Service flows in energy companies

Table 1 - Description of different links of the automated monitoring system and electricity metering

Link	Advantages	Specification	Important equipment
1	2	3	4
Multi-Accounting (power line communications (PLC))	-extremely high reliability; -simple system implementation; -secure data transmission; -prepaid mode; - load management;	- proprietary modulation technique; - automatic routing; - strong encryption; - counters with outputs to control	- base station with a modem; - electricity meters with integrated modems; - software
Multi-Accounting (power line communications PLC+RS485/CL)	-flexible system; -stable connection; -infrastructure for several energy saving companies	- the ability to use already installed energy meters; -reliable wired solution in combination with cost-effective PLC; - collect data from various sources (electricity meters, gas, water)	- base station with a modem; - electricity meters; - electricity meters with integrated modems; - software
Gated development (radiosystems)	-connection with location without access to the premises of the customer; -radio can easily be converted into a fixed; -large-range communication	- reliable two-way communication; - high sensitivity with low consumption; - advanced algorithms networking	- radio base station with a modem; - electricity meters with internal radio modems; - hand-radio terminal or computer; - software
Suburb (power line communications (PLC))	-rapid-deployment systems; -scalable; -reliable and cost-effective solution; -providing two-way communication with meters	- function "Plug and Play"; - each station supports up to 2000 modems; -consistent with international standards; - patented modulation technique	- base station with a modem; - electricity, with internal and external modems; - software

Continuation of Table 1

1	2	3	4
Individual registration (communication with GSM/GPRS)	-proven technology; -easy to install and use; -multifunction device; -fraud detection and alarm system	-supports transparent data; -installation under the contact cover; -one modem-checker allows you to connect up to 32 electricity meters; -input for sensor alarm	-electricity meters with a modem; -software
Industry (wired solutions RS 485/CL)	-reliability; -stability; -scale; -multi-system	-is the most stable for data transmission; -simply increasing counters in the system; -electricity meter data may be accessed by multiple users simultaneously	-hub data for electricity; -electricity meters with interface; -software

One of the tasks of this work is to create theoretical aspects for practical using this system in the service system of JSC"Sumyoblenergo".

The main activities of JSC "Sumyoblenergo" are local electric networks, supply of electricity at the regulated tariff, electricity own hydropower, which are carried out according to the license [12].

Besides the core activities, the company has paid services to the population and organizations of the region:

– for connection to electric grids newbuild reconstructed, technical re-equipment of electrical customers belonging to legal entities of all forms of ownership to individuals-entrepreneurs and the public;
– restore electricity;
– repair electrical consumers.

For improving services of PJSC "Sumyoblenergo", the company "converter" authorized system integrator of AdAstrA Research Group, Ltd in Ukraine, has completed implementation of an automated system of commercial electricity metering in the energy supplier of "Sumyoblenergo" [15].

The automated monitoring system and electricity metering is designed to provide automated accounting and supervisory control electricity consumption for the production needs of the individual sections and the enterprise as a whole and allows real-time to determine the current distribution and power consumption, as well as their integral values.

The main functional problem of the automated monitoring system and electricity metering PJSC "Sumyoblenergo" are as follows:

– calculation of the amount of electricity received by the network of energy supplier "Sumyoblenergo" of the wholesale electricity market (WEM);
– determination of the amount of electricity released from networks of "Sumyoblenergo" WEM neighboring entities;
– consideration of the magnitude of electrical energy flows through a network of "Sumyoblenergo";
– determination of the amount of electricity used for own needs for receiving returns and exchanges in electricity;

– Calculation of power losses in networks and substation equipment arising from the reception, impact and flow of electricity.

On the lower level the automated monitoring system and electricity applied electronic electricity meters «Indigo+», «SL-7000 Smart» and "Energy".

Automatic control from the control room covered 14 substations of 110/35/10 kW class energy from supplier, located in the territory of PJSC "Sumyoblenergo".

New hardware-level control system includes:

– 170 devices automatics HRC 6806 ("Electromechanics" in Voronezh, Russia) are the controller of one bay;

– 30 electronic meters SET-4TM ("Frunze");

– 23 meter of differential electricity metering landing (manufacturer “L and G”, Switzerland) and SL 7000 (manufacturer “Actaris”, France).

The main ideas of the work are indicated in Figure 3:

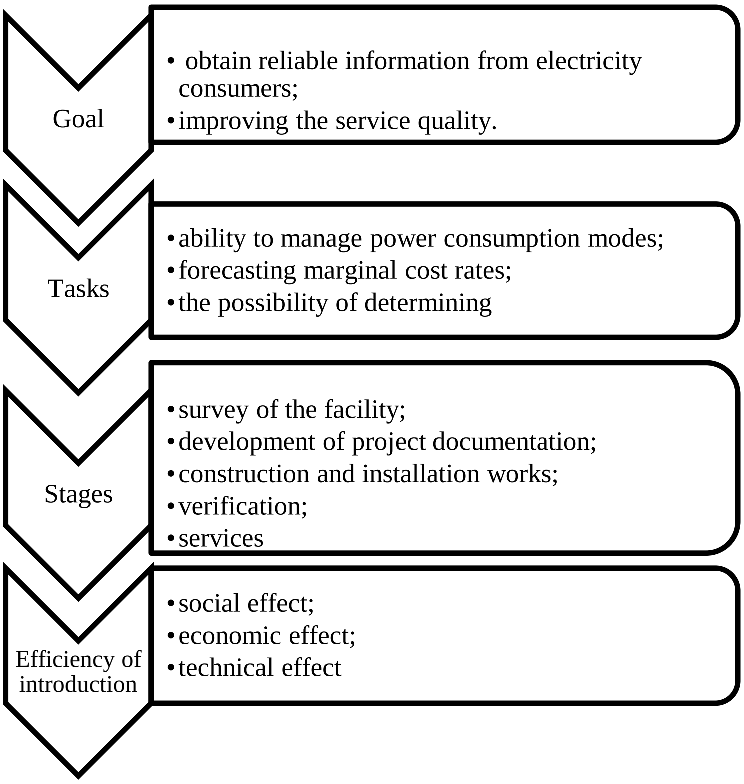

Figure 3 - Developing an implementation strategy of automated system for measurement of electricity(ASMES) system

The main purpose of energy accounting is to provide reliable information about the value generated (obtained in a network) of usable electrical energy released as well as the magnitude of losses in transmission of electricity for the following technical and economic problems at all levels of governance in the energy sector:

– financial (commercial) payments for electricity and power between the subjects of the wholesale and retail market consumption;

– power consumption mode control;

– identifying and forecasting of energy balance components (getting into the network, the useful output of the network, loss, etc.);

– identifying and forecasting specific consumption rates of energy enterprises;

– determination of the value and cost of production, transmission and distribution of electricity and power [2].

Economic efficiency of ASMES with the feature of the energy production is the continuity in time processes generation and consumption of electricity (capacity). In general, the introduction of automation gives primary effect (excluding other factors) as a saving of at least 5% of the cost of the enterprise where the automation is carried out [4].

The effectiveness of implementing ASMES for power supply companies and network companies is:

– ability to exit the WEM (for generating companies and major stations);

– increased accuracy in measurement (by reducing errors in manual data reading due to revision of meters and replacement of old types of meters to more modern and accurate);

– reduction of losses and energy theft by monitoring balances objects;

– control the declared capacity of enterprises (consumers) and billing actually consumed power;

– load balancing by switching consumers to rate and zone transfer of the power during the nighttime;

– reduce the cost of information processing economic unit by obtaining timely and accurate information about power consumption in electronic form [3].

We can calculate the economic impact of implementing programs to tools for multi ASMES newly built apartments in Sumy on example calculations for one of them.

To assess the economic effects it is obligatory to determine costs before and after the introduction of the example 14-floors newly apartments of Sumy:

I. Costs for implementation (per year):

1. Commercial losses amounted to 300 kW (11%) per month for the same apartment, and the average tariff to pay for losses is 0.37 UAH/ kW.

In terms of monetary terms:

$$\mathrm{CCm} = \mathrm{CL} \times \mathrm{Tf}; \tag{1}$$

SSm - commercial losses per month for one apartment, UAH;

CL - commercial losses for the month, KW;

Tf - average tariff to pay for losses, UAH/KW.

Given our data, we can determine how many UAH lost in one apartment:

$$\mathrm{CCm} = 300 \times 0{,}37 = 111\ (\mathrm{UAH})$$

Now we can calculate our commercial losses for the whole house per year:

$$\mathrm{CC} = \mathrm{CCm} \times \mathrm{m} \times \mathrm{k}; \tag{2}$$

CC - commercial loss per year for the whole house, UAH;

m - number of months, months;

SSm - commercial losses per month for one apartment, UAH;

k - number of apartments in the house, pieces.

$$\mathrm{CC} = 111 \times 12 \times 84 = 111888\ (\mathrm{UAH})$$

2. Labor to collect information from the meters and the verification of their operation need to figure out considering the fact that each apartment must be checked electrician at least once a year, and the controller must check the electricity meter every month:

a) First you need to calculate electrician labor costs per year (in UAH) for 14-floors apartments. To do this, we need to know the cost of time:

$$T = t \times k \times r; \tag{3}$$

T - time spent on checking the electricity for one 14-floors apartments, hours;

t - time costs for a check up on the counter for one flat, hours;

k - number of apartments in the same 14-floors building, pieces;

r - number of inspection in each flat for the year, times.

We know that each new 14-floors building with two entrances has 84 apartments. On average, for checking one apartment it is obligatory 0.5 hours (0.3 hours for direct examination and 0.2 hours for recording information).

Based on this information:

$$T = 84 \times 0{,}5 \times 1 = 42 \text{ (hours)}.$$

So, an electrician need is 42 hours a year to check one 14-floors apartment.

Electrician labor costs, we calculate as follows:

$$CE = Ce \times T; \tag{4}$$

CE - electrician labor costs, UAH;

Ce - work electrician costs per hour, UAH/hours;

T - time spent on checking the electricity for one 14-floors house per year, hours.

Wages per hour electrician is 93.26 UAH.

$$CE = 93{,}26 \times 42 = 3916{,}92 \text{ (UAH)}$$

Consequently, labor costs account for electrician are 3916.92 UAH per year for one 14-floors apartment.

b) Using the previous formula we can calculate the time to spend controllers for the year to check one 14-floors apartment.

$$T = t \times k \times r; \tag{5}$$

T - time costs of collecting information from the meter from 14-floors apartments per year, hours;

t - time costs of collecting information from the meter to one apartment, hours;

k - number of apartments in the building, pieces;

r - number of inspection in each flat for the year, times.

In the previous section we have already reported that the new 14-floors apartments consist with two entrances are 84 apartments. In average, checking one apartment controller is 0.2 hours (0.1 hours for direct examination and 0.1 hours for recording information). The controller is required to inspect all apartments every month.

Therefore,

$T = 84 \times 0{,}2 \times 12 = 201{,}6$ (hours)

That is, to check one building controller must 201.6 hours per year.

Now we will calculate the cost of the controller for a year for one 14-floors apartments:

$$CK = Ck \times T; \quad (6)$$

CK - controller costs per year for a house, UAH;

Ck - consumption of the controller in one hour, UAH/hour;

T - cost time to check the electricity for one house per year, hours.

Costs of the controller in one hour account for 81.97 UAH.

$$CK = 81{,}97 \times 201{,}6 = 16525{,}15\ (UAH)$$

Consequently, the cost of the controller for the year to make a house is 16,525.15 UAH.

C) Transportation costs using car brands UAZ 3909 is 26.73 UAH, and fuel costs are 17 UAH/hour. Time of transportation is 0.18 hours in two directions. And 0.5 hours are for waiting electrician from one flat. In situations where electrical installer checks for all customers (once a year), the total time will be:

$$Tt = wt \times k + tt \times k; \quad (7)$$

Tt - vehicle time, hours;

wt - time, when the car is waiting for electrician, hours;

k - number of apartments in the building, pieces;

tt - time, when the vehicle is in motion, hours.

$$Tt = 0{,}5 \times 84 + 0{,}18 \times 84 = 57{,}12\ (hours)$$

Then we can determine what shipping costs we are using at apartments for one year:

$$Tc = Tt \times Ct + k \times tt \times oc; \quad (8)$$

Tc - travel expenses for a apartments, UAH.

Tt - vehicle time, hours;

Ct - value transport use, UAH;

k -number of apartments in the building, pieces;

tt - time, when the vehicle is in motion, hours;

oc - fuel expenses, UAH/hour.

$$Tc = 57{,}12 \times 26{,}73 + 84 \times 0{,}18 \times 17 = 1783{,}86\ (UAH)$$

Thus, transportation costs are 1783.86 UAH per year for one building.

For information about this action, we find the sum of all three subparagraphs:

$$LC = CE + CK + Tc; \quad (9)$$

LC - labor costs for collecting information from the meters and the verification of their operation, UAH;

CE - electrician labor costs, UAH;

CK - controller costs per year for a house, UAH;

Tc - travel expenses for a house, UAH.

$$LCbefore = 3916{,}92 + 16525{,}15 + 1783{,}86 = 22225{,}93\ (UAH)$$

That is, the labor costs for collecting information from the meters and test their operation is 22,225.93 USD.

The total aggregate cost you is given by:

$$TC = CC + LC; \quad (10)$$

TC - set of the total costs and losses, UAH;

CC - commercial loss per year for the whole house, UAH;

LC - labor costs for collecting information from the meters and the verification of their operation, UAH.

$$TCbefore = 111888 + 22225{,}93 = 134113{,}93 \text{ (UAH)}$$

II. The cost of implementing the system PLC (system for multi-accounting communication via power lines).

Essential equipment that you need to buy for this system:

Table 2 - Equipment Systems PLC

Name of thing	Quantity, items	Price per unit, (UAH)	Cost, (UAH)
PLC base station with GPRS / GSM modem	1	30 000	31 000
Electricity counters	84	900	75 600
PLC modems	84/32≈3	700	2 100
Software with a license	1	35 000	32 000
Total			140 700

Thus, the one-time costs for implementation of the system amounted to 140,700 UAH, and it is for the following electrical equipment's:

1. Server software PUMA (client-server) license can provide one hundred percent certain data collection with distributed objects with subsequent storage of these data in a highly protected database.

2. PLC modem KI-PLC/485-CAN-01 used to work in a complex system of supervisory monitoring and control.

3. Counter Mercury 203.2T LBO.

Labor for the introduction of meters and the whole system:

a) First you need to calculate labor costs electrician to install the PLC system for one 14-floors apartments. To do this, we need to know the cost of time:

$$T = t \times k + T(PLCm) \times Qm + T(PLCps) \times Qps + T(PLCbs) \times Qbs; \quad (11)$$

T - time costs for the installation of electricity for a 14-floors apartments, hours;

t - time costs of installation of the meter for one flat, hours;

k - number of apartments in the same 14-floors building, pieces;

T (PLCm) - a waste of time to install another modem, hours;

T (PLCps) - a waste of time to install other software, hours;

T (PLCbs) - a waste of time to install one base station, hours;

Qm - number of modems, pieces;

Qps - number of softwares, pieces;

Qbs-number of base stations and stuff, items.

We know from previous research and practices of other companies that they want to establish 1modemu 0.5 hours of electricity for 1-0.25 hours for a single software - 1.1 hours for a base station - 1.4 hours. The number of devices we can see in Table 2.

$$T = 0{,}25 \times 84 + 0{,}5 \times 3 + 1{,}1 \times 1 + 1{,}4 \times 1 = 25 \text{ (hours)}$$

Electrician labor costs, we calculate as follows:

$$CE = Ce \times T; \quad (12)$$

CE - electrician labor costs, UAH;

Ce - work electrician costs per hour, UAH/hours;

T - time costs for the installation of electricity for one 14-floors apartments, hours.

Wages per hour electrician is 93.26 UAH.

$$CE = 93{,}26 \times 25 = 2331{,}5 \text{ (UAH)}$$

Consequently, labor costs account for electrician 2331.5 UAH for one 14-floors apartments.

b) Transportation costs using car brands UAZ 3909 we can find using costs per hour 26.73 UAH, and fuel costs 17 UAH/hour. Time of transportation is 0.18 hours in two directions. In situations where electrical installer installs the new system, the total time will be:

$$Tt = T + tt \times k; \quad (13)$$

Tt - vehicle time, hours;

T - time costs for the installation of electricity for 14-floors apartments, hours;

k - number of apartments in the building, pieces;

tt - time, when the vehicle is in motion, hours.

$$Tt = 25 + 0{,}18 \times 84 = 40{,}12 \text{ (hours)} .$$

Then we can determine what shipping costs we use for one house:

$$Tc = Tt \times Ct + k \times tt \times oc; \quad (14)$$

Tc - travel expenses for a house, UAH.

Tt - vehicle time, hours;

Ct - value transport use, UAH;

k - number of apartments in the building, pieces;

tt - time, when the vehicle is in motion, hours;

oc - Fuel costs, UAH/hour.

$$Tc = 40{,}12 \times 26{,}73 + 84 \times 0{,}18 \times 17 = 1329{,}45 \text{ (UAH)}$$

Thus, transportation costs are 1329,45 UAH for one house.

For information about this action, we find the sum of the three data:

$$PLCc = CE + Tc + Ctech; \quad (15)$$

PLCc - one-time expenditures for installation of PLC, UAH;

CE - electrician labor costs, UAH;

Tc - travel expenses for a house, UAH;

Ctech - total cost of all the devices to the PLC, UAH.

$$PLCc = 2331{,}5 + 1329{,}45 + 140700 = 144360{,}95 \text{ (UAH)}$$

III. Costs after implementation of a PLC:

Since the company only plans to implement this system, then the item will be based on the results of other companies that already use this system. That is, it will not be the actual cost and planned.

1. Installed Commercial losses PLC reduced to the level of 3-8%.

For a more adequate assessment of this case, we take the average, which is 5%.

That is, if you had commercial losses totaled 300 kW (11%), but now these losses will fall to 136.36 kW per month for a flat or 50858 UAH for the whole house per year.

We can calculate the difference that much money in the future we will be able to save:

$$\Delta CC = CC - CCafter; \quad (16)$$

ΔCC - difference between commercial losses before and after the introduction of PLC, UAH;

CC - commercial losses to establish PLC, UAH;

CCafter - commercial loss after installing PLC, UAH.

$$\Delta CC = 111\,888 - 50\,858 = 61\,030\ (UAH)$$

So, company will be able to save only 61030 UAH of commercial losses.

2. Expenses GSM communication (ie, gathering information from the base station) for the year will be:

a) First you need to calculate electrician labor costs per year (in UAH). To do this, we need to know the cost of time:

$$T = r \times (t + te \times k + tm \times l); \quad (17)$$

T - time spent on checking the base station for 14-floors apartments for a year, hours;

T - time costs for a check up of the base station and software for one month, hours;

r - number of inspection per year, times;

te - cost time to check the meters work, hours;

k - number of apartments in the building, pieces;

tm - cost time to check the modem working, hours;

l - required number of modems for apartments, items.

Suppose to check one base station electrician needed 0.5 hours to check other electricity required 0.2 hours and to test one modem required 0.3 hours.

Based on this information:

$$T = 1 \times (0{,}5 + 0{,}2 \times 84 + 0{,}3 \times 3) = 18{,}2\ (hours)$$

That is, an electrician required 18.2 hours a year just to check apartments.

Electrician labor costs we calculate as follows:

$$CE = Ce \times T; \quad (18)$$

CE - electrician labor costs, UAH;

Ce -work electrician costs per hour, UAH/hours;

T - time spent on checking the electricity for one flat from 14-floors apartments, hours.

Wages per hour electrician is 93.26 UAH.

$$CE = 93{,}26 \times 18{,}2 = 1697{,}33 \text{ (UAH)}$$

Consequently, labor costs account for electrician 1687.33 USD per year for a 14-floors apartments.

b) Using the previous formula we can calculate the time to spend controllers for the year to check 14-floors apartments.

$$T = t \times r; \quad (19)$$

T - time costs of collecting information from the meter per year, hours;

t - time costs of collecting information from one base system readout, hours;

r - number of inspection in each flat for the year, times.

On average, checking one apartment controller uses 0.6 hours. The controller is required to inspect all apartments every month.

So,

$$T = 0{,}6 \times 12 = 7{,}2 \text{ (hours)}.$$

So, to check a house inspector need 7.2 hours per year.

Now we will calculate the cost of the controller for a year for 14-floors apartments:

$$CK = Ck \times T; \quad (20)$$

CK - controller costs per year for a house, UAH;

Ck - consumption of the controller in one hour, UAH/UAH;

T - cost time to check the electricity for one house per year, hours.

Costs of the controller in one hour account for 81.97 UAH.

$$CK = 81{,}97 \times 7{,}2 = 590{,}18 \text{ (UAH)}$$

Consequently, the cost of the controller for the year for a house up 590.18 UAH.

1. Transportation costs using car brands UAZ 3909 we can find using opening hours which is 26.73 UAH, and fuel costs are 17 UAH/hour. Time of transportation is 0.18 hours in two directions. And as electrician job is 18.2 hours, the test will be in 3 days (about 6 hours). The total time will be:

$$Tt = d \times tt + wt; \quad (21)$$

Tt - vehicle time, hours;

d - the number of days in which electrical installer will work, days;

wt - time, when the car is waiting for electrician, hours;

tt - time, when the vehicle is in motion, hours.

$$Tt = 3 \times 0{,}18 + 18{,}2 = 18{,}74 \text{ (hours)}$$

Then we can determine what shipping costs we use at home for one year:

$$Tc = Tt \times Ct + d \times tt \times oc; \quad (22)$$

Tc - travel expenses for a house, UAH;

Tt - vehicle time, hours;

Ct - value transport use, UAH;

D - the number of days in which electrical installer will work, days;

tt - time, when the vehicle is in motion, hours;

oc - fuel expenses, UAH/hour.

$$Tc = 18{,}74 \times 26{,}73 + 0{,}18 \times 17 \times 3 = 510{,}1 \text{ (UAH)}.$$

Thus, transportation costs are 510.1 UAH per year for a single house.

For information about this action, we find the sum of all three subparagraphs:

$$LC = CE + CK + Tc; \quad (23)$$

LC - labor costs for collecting information from the meters and the verification of their operation, UAH;

CE - electrician labor costs, UAH;

CK - controller costs per year for a house, UAH.

Tc - travel expenses for a house, UAH.

$$LCafter = 1687,33 + 590,18 + 510,1 = 2787,61(UAH)$$

So, the labor costs for collecting information from the meters and test their operation is 2787.61 UAH.

We can find the difference between the cost of labor to collect information from the meters and check their operation before and after the PLC:

$$\Delta LC = LCbefore - LCafter; \quad (24)$$

ΔLC - the difference between the cost of labor before and after the installation of the PLC, UAH.

$$\Delta LC = 22225,93 - 2787,61 = 19438,32\ (UAH)$$

Also we can find how many times the cost decreased after the introduction of:

$$LC = \frac{LCbefore}{LCafter}; \quad (25)$$

LC - cost ratio before and after installation, times.

$$LC = \frac{22225,93}{2787,61} = 7,9$$

So, after installation of PLC labor costs decreased by 21,392.71 UAH, or 7.97 times.

The total set of costs and losses is given by:

$$TC = CC + LC; \quad (26)$$

TC - set of the total costs and losses, UAH;

CC - commercial loss per year for the whole house, UAH;

LC - labor costs for collecting information from the meters and the verification of their operation, UAH.

$$TCafter = 50858 + 2787,61 = 53645,61\ (UAH)$$

We can also compare this figure with those for the establishment of PLC:

$$\Delta TC = TCbefore - TCafter; \quad (27)$$

ΔTC - the difference between the aggregate costs and losses of the enterprise before and after implementation, UAH.

$$\Delta TC = 134113,93 - 53645,61 = 80468,32\ (UAH)$$

Again, we can find the ratio between the total costs and losses before and after the introduction of:

$$TCr = \frac{TCbefore}{TCafter}; \quad (28)$$

TCr - ratio between the total costs and losses before and after the implementation of a PLC, times.

$$TCr = \frac{134113,93}{53645,61} = 2,5$$

So, the company can save on costs and losses 80,468.32 UAH annually if the system will set the PLC compared to the conventional system.

Therefore, the company must first find 144360.95 UAH to install the system and buy all the necessary equipment for it. That is, the first year the amount of disposable costs and annual costs and losses will be:

$$\mathrm{Sum} = \mathrm{TC} + \mathrm{PLCc}; \tag{29}$$

Sum - Sum of all one-time costs and annual costs and losses, UAH.

$$\mathrm{Sum} = 144360,95 + 53645,61 = 198006,56\ (\mathrm{UAH})$$

In this case, the economic effect of the proposed innovations:

$$\Delta\ \mathrm{Savings} = \mathrm{TCbefore} - \mathrm{TCafter}; \tag{30}$$

ΔSavings - economic impact of the installed system, UAH.

$$\Delta\mathrm{Savings} = 134113,93 - 54645,61 = 79468,32\ (\mathrm{UAH})$$

We can also find the payback period:

$$\mathrm{PP} = \frac{\mathrm{PLCc}}{\Delta\mathrm{Savings}}; \tag{31}$$

PP - payback period, years.

$$\mathrm{PP} = \frac{144360,95}{79468,32} = 1,82\ (\mathrm{years})$$

So, payback period to introduce new technologies is one year and 10 months.

Finally, we can calculate the effectiveness of the new technology in PJSC "Sumyoblenergo":

$$\mathrm{Effectiveness} = \left(\frac{\Delta\mathrm{Savings}}{\mathrm{PLCc}}\right) * 100\%; \tag{32}$$

Effectiveness - is general effectiveness from improving new technology in a PJSC “Sumyoblenergo”,%

$$\mathrm{Effectiveness} = \left(\frac{79468,32}{144360,95}\right) * 100\% = 55,05\%$$

We can say that with these calculations, we confirmed that the introduction of new technologies PLC (ASMES) for new 14-floors apartments in Sumy businesses save money and reduce energy losses. This proves 55,05% effectiveness and economic impact of positive numbers.

Regarding ASEMS in baccalaureate work is to calculate the economic efficiency and the effect of the PLC for the new 14-floors buildings in the Sumy city . This will be provided as new services PJSC "Sumyoblenergo".

Results showed that the effectiveness of the new system for a 14-floors building is 55.05%. This is due to the high cost of equipment, but payback period is only a year and 10 months. As the economic effect of the introduction of PLC is 79468,32 UAH. So, costs and the loss of one 14-floors building will be reduced by 79468,32 UAH each year.

We can say that the introduction of the new system to the list of services of

PJSC "Sumyoblenergo", namely the PLC system for a 14-floors buildings in the city of Sumy is effective and, most importantly, significantly reduce electricity losses during delivery.

LIST OF REFERENCES

1. Ayvazyan, S. A. etc. Applied statistics. Study of dependences: Reference book / S. A. Ayvazyan, I. S. Yenyukov, L. D. Meshalkin: Under edition of S.A. Ayvazyan. - M. : Finances and statistics. 1985. – 487 p.
2. Barney, J. 'Firm resources and sustained competitive advantage'. Journal of Management, 17: 1, 1991-120 p.
3. Boxall, P. and Purcell, J. Strategy and Human Resource Management, Basingstoke and New York : Palgrave Macmillan, 2003.
4. Decision about organization ASMES [web reaources] http://www.elgama.eu/templates/files/tiny_mce/Broshures/AMI_solutions_ru_v2.pdf.
5. Doorewaard, H. and Meihuizen, H. 'Strategic performance options in professional service organisations'. Human Resource Management Journal, 10: 2,2000-39-57 p.
6. Energy. Knowledge and experience-the way to modern energy. Plachkov S. G., Plachkov I. V., Dunaevskaya N. I., Podhurenko V. S., Shilyaev B. A., Landau J. O. 2012-2013 [web resources]http :/ / energetika.in.ua/ua/books/book-2/intro
7. European Technology Platform Smart Grids – Strategic Deployment Document for Europe's Electricity Networks of the Future, 2010. – 69 p.
8. European Smart Grids Technology Platform Smart Grids - Vision and Strategy for Europe's Electricity Networks of the Future, 2006. – 22 p.
9. Estimating the Costs and Benefits of the Smart Grid / EPRI Technical report No.1022519, 2011. – 162 p.
10. MacDuffie, J. P. 'Human resource bundles and manufacturing performance: organizational logic and flexible production systems in the world auto industry'. Industrial and Labor Relations Review, 48: 2, 1995. - 221p.
11. Miller, D. 'Generic strategies; classification, combination and context'. Advances in Strategic Management, 8,1992. - 408 p.
12. Mueller, F. 'Human resources as strategic assets; an evolutionary resource-based theory'. Journal of Management Studies, 33: 6,1996-785p.
13. The effectiveness of implementing ASMES [web-resources] http://www.teleuchet.ru/effect.html
14. The Smart Grid: An Introduction, the U.S. Department of Energy, 2008. – 48 p.
15. Offisial site of PJSC "SUmyoblenergo" [web-resources] https://www.soe.com.ua/

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