System analysis and approaches to the developement of the automated electrical energy consumption and supply system of the food industry enterprise

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Abstract

Introduction. The conducted researches of the food industry enterprise (FIE) electrical energy consumption and supply control process with the aim of electrical resources transmission and use efficiency increase by electricity consumption.

Materials and methods. The researches are made on the base of control processes system analysis methods and the modern automated control theory.

Results and discussion. The main stages of the electrical energy supply and consumption control process: the basic control functions – electrical energy (EE) consumption registration, forecasting of EE consumption, calculation of EE consumption norms, conducting of FIE electrical energy supply system (EESS) regimes analysis as well as electrical energy quality indices (EEQI) and FIE EESS reliability analysis, consumers – regulators (CRs) list formation; control functions support conditions – EE consumption information, restrictions and rates, electricity consumption forecasting accuracy requirements;decision-making about configuration change and FIE EESS regimes optimization as well as EEQI normalization;organizational and technical mechanisms of control functions fulfillment – information and computing system, electric power dispatcher, technological process operator, electrical supervisor; automated power sector control system of the FIE data base, which is used for decisions preparation;basic information flows which provide electrical energy consumption control. The functional scheme is represented and the separate FIE EE consumption and supply control units requirements with use of CRs. FIE EE consumption and supply is implemented using decision-making support subsystem what includes interconnection of technological process and EE consumption process.

Conclusion. Developing on the base of the system analysis and interconnection methods provides the high EE consumption and supply efficiency.

Glossary

ACS – automated control system;
CR – consumer-regulator;
DB – database;
DMSS – decision-making support subsystem;
EE – electrical energy;
EECACSS – electrical energy consumption automated control and supply system;
EEQI – electrical energy quality indices;
EESS – electrical energy supply system;
FIE – food industry enterprise;
RPA – relay protection and automatic;
UES – united electrical energy system.

Introduction

The electric energy (EE) consumption reducing problem, the EE supply reliability and normative EEQI ensuring is relevant for the food industry, since it allows to increase the generating capacities use efficiency and to reduce EE consumption during its transmission and the energy intensity of production outputted by enterprises.

For ensuring of rational EE consumption and wastes levels for food industry enterprise (FIE) EE supply systems, it is necessary to forecast its consumption and use consumers – regulators (CRs) as well as to optimize regimes of these systems.

Let us look at the works, devoted to FIE EE consumption and supply control questions. some of them. In the article [1] the technical facilities complex and the software of commercial EE accounting systems of "Energomira" company is represented. It is represented by the software modules set for the commercial EE accounting organization on energy sites. As such objects can be used energy companies, electricity grid areas, substations and other EE consumers.

The technical facilities complex "Energomira" software includes realization of following function:

– automation of dispatcher workplace, which realizes the data processing from the data collection device and from data collection and transmission device, their representation in form of charts and tables;
– report generator for creating various documents forms;
– software data collection and database (DB) forming;
– technical facilities complex administering programs for the EE consumption accounting system devices parameters determining.

As a result of works analysis [1, 2] was ascertained that the software which is presented in these works is developed by various organizations, which during its developing do not interact with each other. This fact causes essential complications by common use of the mentioned software.

In the article [3] is represented a two-level automated EE consumption accounting system "E1 – Energy-accounting". The lower system level contains electronic counters "Euro Alpha" and "Alfa Plus" with digital communication channels, and the upper – modern computers with automatic dispatcher workplaces. The system is based on the "client-server" architecture. It allows to support an arbitrary number of client computers with automatic dispatcher workplaces. However, the mentioned system, solves only the EE accounting problems.

Recently, by developing of new generation automated control and accounting EE systems the modern industrial controllers are extensively used [4]. These systems except the problems solving of commercial EE accounting and capacity consumption ensure also the technical accounting and monitoring of industrial enterprises electrical loads in real time mode, what is the base for FIE EE consumption and supply control tasks solving.

The works analysis [4–6] shows that the presented in these works automated systems are performing functions of electric capacity and EE consumption control. But these systems do not realize the EE normalization, planning, forecasting and optimal FIE EE consumption and supply control functions of industrial enterprises, which allow to obtain the main economic effect.

Aim of the research consists in the synthesis of FIE EE consumption automated control and supply system (EECACSS) on the base of the systematic analysis of EE transmission, dividing and consumption control process with ensuring of integration and compatibility sequence of separate parts.

Materials and methods

Research materials

In this work the FIE EE consumption and supply control process are studied [7] as well as the automated system developing principles are formulated [4, 8] and the functional scheme of automated control system (ACS) is developed [9].

Research methods

Researches were conducted in the following order:

- there were formulated FIE EE consumption and supply control tasks [6, 10];
- it was made a systematic analysis of the FIE EE consumption and supply control process [9];
- there were formulated FIE EE consumption and supply control criteria [11, 12];
- it was developed the FIE EE consumption and supply control functional scheme [13, 14];
- it was developed the algorithm of compatibility and integration ensuring method when construction of FIE EECACSS [5, 15];

Here is used the method of sequence modeling [10, 16], which is based on the simple, the most abstract description and makes possible to include the objects of various type [17] and get connections of different character and content [18].

Results and discussion

EE consumption and supply control task consist in minimization of technical and economical criteria set on following grounds:

FIE damages from CR active load disconnection (changing to the reduced work mode):

$$F_1 = \sum_{j=1}^{M} \sum_{i=1}^{I_j} y_{ij} k_{ij} \ ; \tag{1}$$

CR disconnection amount (electrical grid commutation):

$$F_{21} = \sum_{j=1}^{M} \sum_{i=1}^{I_j} k_{ij} \ ; \tag{2}$$

capacity (energy) wastes of FIE electrical grid, which appear as a result of reactive energy flows:

$$F_3(X) = \sum_{j=1}^{M} \sum_{i=1}^{I_j} \{[Q^2(t) - \sum_{g_{ij}=1}^{G_{ij}} Q_{g_{ij}}(t) h_{g_{ij}}]\} R_{ij} \Big/ U_{ij}^2(t) ; \tag{3}$$

by restrictions: on FIE active load :

$$\sum_{i=1}^{I_1} P_{extr}^C (t + t^*) - \sum_{j=1}^{J} \sum_{i=1}^{I_j} P_{extr_{ij}}^C (t + t^*) k_{ij} \le P_{rest} \ ; \tag{4}$$

on FIE reactive load:

$$Q_{\min}(t) \le \sum_{i=1}^{I_1} [Q_{extr}^C (t + t^*) - \sum_{g_{j1}=1}^{G_{i1}} Q_{gi_1}(t) h_{g_{i1}}] \le Q_{\max}(t) ; \tag{5}$$

on the EE receiver voltage:

$$U_{ij\min} \le U_{ij}(t) \le U_{ij\max} \tag{6}$$

on EEQI:

$$\delta U_y \le \delta U_y^{(NORM)} ; \tag{7}$$

$$\delta U_t \le \delta U_t^{(NORM)} ; \tag{8}$$

$$k_{U2} \le k_{U2}^{(NORM)} ; \tag{9}$$

$$k_{U0} \le k_{U0}^{(NORM)} ; \ k_U \le k_U^{(NORM)} ; \tag{10}$$

$$k_{U(n)} \le k_{U(n)}^{(NORM)} ; \tag{11}$$

where $\delta U_y, \delta U_t$ is standard deviation and voltage change variation; k_{U2}, k_{U0} – null and inverted sequence coefficients; $k_U, k_{U(n)}$ - harmonicity distortion and n - harmonious waveform voltage part; (with upper index (norm) are marked standard indices values).

EECACSS of FIE is impossible to describe with the help of the present mathematical apparatus. Thus occurs the necessity for their division into separate subsystems, for formalization of which can be used mathematical methods. However even at that still leaves the wide horizon of experience, that can not be described with the necessary completeness on the base of mathematical tools.

There was proposed the approach to the decomposition of FIE EECACSS, which ensures the independence and completeness of decomposition criteria.

This approach stipulates:

- the control system structure formalization at the theoretical-multiple level;
- as part of the unified conception the subsystems development conception, which ensure its functioning;
- the ensuring of the common functioning of these subsystems.

System analysis of FIE EE supply and consumption control process

The EE consumption and supply control is the most important FIE ACS subsystem, what causes the FIE EE supply efficiency.

At the theoretical-multiple level the control process of organizational-technical objects is presented in the form of representation of separate actions $F_n : \{L \times K \times Z \times P_{inc}\} \to P_{outc}, n = \overline{1,N}$, (12)

where: L means actions of basic control functions forming; K and Z mean actions of possible main conditions combinations forming and fulfillment mechanism of control function accordingly; $P = P_{inc} \cup P_{outc}$ are actions of possible combinations forming of main information flows; P_{inc} and P_{outc} mean sets of incoming and outcoming information flows. By FIE EE supply and consume control are implemented following actions:

Actions of main control functions forming:

L_1 is EE consume, electric grid mode and conditions as well as EEQI meterage and measuring data adequacy validation; L_2 means the model choose as well as production units and enterprise EE wastes (consume) forecasting; L_3 is EE wastes rates estimation as well as EE wastes planning and EE balances forming according; L_4 means EEQI and *FIE EESS* parameters estimation, electric grid configuration analysis; L_5 is CRs list and their optimal composition forming; L_6 means FIE EE wastes control DB forming and its maintenance in actual mode and status. L_7 means production subunits and FIE EE wastes decision-making as well as maximal capacity consumption ; L_8 is decision-making for electric grid configuration, EEQI improvement, FIE EESS mode optimization;

Actions of control functions main fulfillment conditions forming:

K_1 means FIE EE consumption information інформація (normative acts); K_2 is restriction and rates information, which contains in FIE EE supply contract; K_3 are metrological forecasts accuracy requirements; K_4 are EE consumption forecast accuracy requirements;

K_5 means the interaction order with the DB control system; K_6 are EEQI and EE supply reliability requirements. K_7 are FIE EESS parameters requirements.

For actions of control ensuring are used the following main parts and mechanisms, which implement control functions:

Z_1 means is an information and computing complex of electrical supervisor service, who gives information about FIE EESS conditions and work mode; Z_2 is is an electric power dispatcher, who forms restrictions for EE consumption standards fulfillment; FIE EESS functioning mode as well as EEQI and electric grid configuration. Z_3 means the technological process operator, who forms restrictions concerning CRs; Z_4 is the electrical supervisor, who forms restrictions for unified energy system (UES) requirements fulfillment; EE supply reliability Z_5 are EE consumption, EEQI, FIE EESS parts conditions accounting sensors and electrical apparatuses for consumers commutation and FIE EESS configuration change; Z_6 means DB of ACS of FIE EE, that is used for decision-making.

For control functions ensuring are used the following information flows:

P_1 mean forecasted values of environmental temperature and air humidity, received with the help of the weather station; P_2 are current data on production subunits and FIE EE consumption; P_3 mean data on production volumes produced by subunits and FIE; P_4 are current data on connected CRs and damages, caused by their disconnection; P_5 mean FIE EE consumption limit; P_6 are EE consumption current data; P_7 are current data on current environmental temperature; P_8 are forecasted values of subunits and FIE EE consumption; P_9 is FIE EE consumption plan; P_{10} mean EE consumption decision-making; P_{11} are actions of control for EE consumption regulation; P_{12} is CRs optimal composition; P_{13} mean EEQI current data; P_{14} are FIE EESS parameters current data; P_{15} are FIE EESS configuration current data; P_{16} mean actions of control for EEQI control; P_{17} are actions of control for FIE EESS configuration change; P_{18} mean actions of control for FIE EESS modes optimization.

System analysis results of FIE EE consumption control process are presented in form of representations for separate actions:

– EE consumption registration, electric grid conditions and EEQI estimation as well as measuring information reliability check:

$$F_1 : \{L_1, (P_1, P_2), K_3, (Z_1, Z_2, Z_5)\} \to (P_6, P_7); \quad (13)$$

– model choose and EE consumption forecasting conducting:

$$F_2 : \{L_2, (P_3, P_6, P_7), (K_1, K_4), Z_1\} \to P_8; \quad (14)$$

– separate subunits and FIE balances normalization, planning and forming:

$$F_3 : \{L_3, (P_3, P_8), K_1, (Z_1, Z_2)\} \to P_9; \quad (15)$$

– FIE EESS and EEQI modes analysis conducting as well as FIE EESS reliability analysis conducting:

$$F_4 : \{L_4, (P_3, P_4, P_5), (K_6, K_7), (Z_1, Z_2, Z_4, Z_5)\} \to P_3, P_4, P_5; \quad (16)$$

– CRs list and their optimal composition forming:

$$F_5 : \{L_5, (P_2, P_3, P_5, P_8), (K_1, K_2), (Z_1, Z_2, Z_3, Z_4)\} \to P_4, P_2; \quad (17)$$

– EE consumption decision-making:

$$F_6 : \{L_7, (P_5, P_6, P_9, P_{12}), (K_1, K_2), (Z_1, Z_2, Z_3, Z_4)\} \to P_{10}, P_{11}; \quad (18)$$

– FIE EESS configuration change and modes optimization decision-making as well as EEQI normalization decision-making:

$$F_7 : \{L_8, (P_{13}, P_{14}, P_{15}), (K_6, K_7), (Z_1, Z_2, Z_4, Z_5, Z_6)\} \to P_{16}, P_{17}, P_{18}; \quad (19)$$

– FIE EE consumption control DB forming and updating:

$$F_8 : \{L_6, (P_3, P_4, P_5, P_6, P_7, P_8, P_9, P_{10}, P_{12},), K_5, (Z_1, Z_3, Z_6)\} \to P_3, P_4, P_5, P_6, P_8, P_9. \quad (20)$$

The decomposition of the EE supply and saving control system, which has ensured its representation wholeness and represents informational interaction, conditions and mechanisms was conducted.

Approaches to the development of the FIE EECACSS

The aim of the FIE EE supply and consumption control is effective (reliable and economical) FIE EE supply and consumption.

The control criterion under existent relations with the EE supply organization could be given in following form

$$J = \lambda_W W + \lambda_W^{'} \Delta W + \lambda_R P_S + \lambda_R^{'} \Delta P_S + \lambda_Q Q + k_W \lambda_W W + \\ + Y_R\left(\Delta P, t_{rest}\right) + Y_{\mathrm{TR}}\left(y_{pc}, 3\right) \to \min . \quad (21)$$

where: λ_W and W are EE rate and its consumption volume by FIE (including conumption in electric grid) accordingly; $\lambda_W^{'}$ and ΔW are consumed over the contract EE rate and its wastes correspondingly; λ_R are P_S contracted (stated, subscribed) capacity rate, that takes part in maximal UES load, and this capacity value correspondingly; $\lambda_R^{'}$ and ΔP_S are active capacity rate, that was consumed over than was stated and its value accordingly; λ_Q and Q are UES peak hours maximal load reactive capacity rates and maximal value of this capacity correspondingly; $k_W = k_W^{''''}$ (or $k_W = k_W^{'''''}$) means the charge coefficient for consumed (or generated) reactive EE over the contract (confirmed by rates regulation authority) accordingly; Y_R are FIE consumption of UES peak hours maximal load active capacity regulation; Y_{TR} mean damages from unreliable work of electrical equipment y_{pc} and its tardy out of service for repair.

Electrical energy consumption automated control and supply system of food industry enterprise

On the base of main control tasks and using control criterion the functional scheme of FIE EECACSS is developed (Figure 1).

On the base of the conducted system analysis let us formulate requirements for FIE EE consumption and supply separate automated control functional subsystems (blocks).

Functional block of EE supply and consumption monitoring: in this block the automatic data transmission form EE accounting devices and information reliability control are implemented. Data registering time interval is determined, starting from parameters accounting accuracy, that describe EE supply and consumption process.

The FIE EE supply and consumption efficiency control to a considerable degree depends on the initial information quality, that is metering from measuring devices with the aim of subsequent processing.

At the initial stage this information reliability control is implemented via EESS modes and FIE EE consume parameters prior data analysis, such as permissible limits and character of their temporal change, consistency etc. The additional control based on the use of different dependence between EE supply and consume parameters.

Functional block of EE consumption: the FIE and its subunits EE consume forecast (daily, monthly and annual) is conducted. For the forecasting are used both statistical model and artificial neuronal network, what allows to take into account factors variety, which have an influence on EE consumption norms and limits by FIE energy facilities.

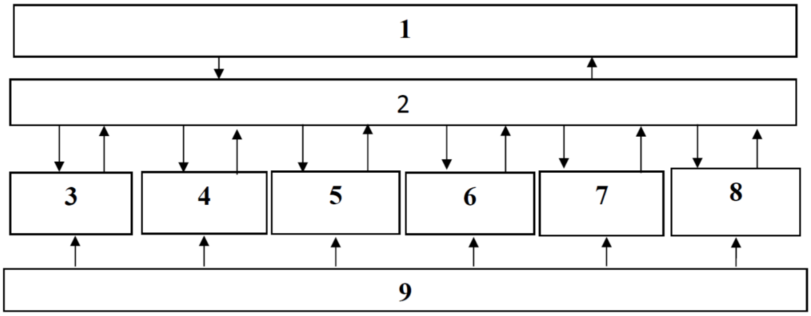

Figure 1. Functional scheme of FIE EE consumption and supply control:
1 – DB of FIE power sector ACS;
2 – DB of FIE EE supply and consume; 3 is monitoring block of EE consumption: here is implemented the automatic data transmission from EE accounting devices and information reliability control;
4 – forecasting block of EE consumption: here is implemented the FIE EE forecast (daily, monthly and annual);
5 – analysis and optimization block of EE consumption: here is efficient comparison and annual, quarterly and monthly EE balances optimization for FIE and its subunits;
6 – control block of EE consumption specific rates and efficient EE supply implementation, that ensures the decision-making process of EE supply control;
7 – optimization block of EE supply modes on the base of measured voltage values, active and reactive capacity;
8 – control block of EEQI based on the measuring devices values and normative EEQI ensuring methods choose;
9 – organizational-technical FIE EE supply and consumption control methods.

Functional block of EE consumption analysis and optimization: on the base of the FIE EE consumption collection and processing information automation the effective comparison and optimization of annual, quarterly and monthly EE balances for FIE and separate production subunits (shops) is conducted, as well as their accuracy and reliability due to exception with erroneous data of erroneous devices recordings is ensured.

On the base of EE balances:

- the EE consumption analysis is conducted;
- EE saving tendencies are defined;
- EE consumption reduction possibilities are determined;
- EE consumption improvement measures are planned;
- EE consumption optimal scheduling strategy is chosen.

The electrical balance presents the base for EE consumption normalization improvement, which essence brings to its implementation during the scheduling of economically and scientifically justified EE consumption rates.

Functional block of EE consumption specific rates and efficient EE supply implementation control ensures the act of control forming process and need to be conducted by an expert or a group of experts on the base of the professional-logical analysis with the use of decision-making support subsystems (DMSS) for EE industry.

The DMSS use ensures:

- more accurate and effective decision-makings for FIE and its production subunits EE control;
- improves the decision-makings quality in incompleteness and uncertainty condition of outcoming information;
- reduces time and labor intensity of decision-makings.

Daily is given the summary list of FIE production subunits EE consumption indices, such as current and scheduled absolute and specific EE consumption, specified limits use coefficients and rate indices. As the need arises, the summary list can be given on staff request by electrical supervisor service at any time. Especially it is necessary during FIE EE supply failures and UES capacity deficiency.

According to this information the electrical supervisor service on the base of DMSS use makes a justified decision on FIE and its subunits EE consumption parameters. DMSS consist of the operating-supervisory control system, that ensures the prompt and efficient decision-making, including alarm conditions in FIE EE supply system and by UES capacity deficiency.

The managerial decision-makings is also supported by visualization tools, that realize graphical models. On the base of EE consumption normalization principles [8] EE consumption control decision are made.

Functional block of EE supply modes optimization on the base of measured in EESS branch points capacity values, active and reactive capacity with the use of mathematical models ensures forming of efficient capacity and EE consumption levels in FIE distribution electric grids.

In functional block of EEQI control with the help of measuring devices set at various EESS hierarchy levels are defined EEQI and with the help of mathematical models are defined technical facilities control methods for normative EEQI ensuring.

For functioning ensuring of functional blocks are developed corresponding control algorithms.

FIE EECACSS integration is implemented via: unification of various functions (EE accounting, capacity regulation, EE resources supply and consumption modes control, EEQI control) in hardware and software tools with the use of data exchange unified protocols and communication channels; effect estimation, received as a result of common and coordinated ACS functioning as well as wastes for their compatibility and interaction ensuring.

As a basis of a method is taken following principles of:

- **systemacy** – the integrated ACS creates the open dynamic system and corresponds to wholeness, statefulness and purposefulness requirements;
- **hierarchy**. ACS hierarchy levels are defined by control processes division levels. The determination of efficient modes organization of the same hierarchy level parts and various levels parts intercommunication and interaction;
- **technological information unity**. The technological facilities monitoring results serve as the base both for technical-economical tasks solving for technological control of the production cycle as a whole and for technological control (regulation processes parametric optimization, EE balances and technical-economical equipment work indices accountings etc.);
- **integrated ACS efficiency increase**. The increase in comparison with overall effectiveness of free-running ACS.

For principle maintenance it is necessary to ensure the compatibility of integrated ACS hardware, software and informational ensuring. The essence of the method of EE ACS compatibility and integration ensuring is in subsequent implementation of following stages.

At the first stage the functional integration is conducted and following characteristics are ensured:

- **system functioning local aims unity ensuring** via FIE EECACSS functioning aim determination is EE transmission effectiveness, division and consumption improvement due to electric grid and EE consumers work modes optimization, EEQI normalization, reliability ensuring of EE supply in emergency mode with the help of relay protection and automation (RPA) and measuring reliability;
- **generic functional structure synthesis of the whole system, its decomposition into components** via control system hierarchical structure development for FIE EE supply and consumption automation including its structure and topology, power sources amount, shop transforming substations amount, transforming substations automation degree, information transmission channel-forming apparatuses use. Separation in the structure of following subsystems: EE accounting and consumption control subsystem, EE supply control subsystem, EEQI control subsystem, RPA subsystem;
- **setting for each component the effectiveness criterion as well as functioning model, data processing procedure, also functional and informational connections between components** with the help of efficiency criterion determination: for EE consumption accounting and control subsystem it is measuring reliability, EE consumers optimal composition and work modes; for EE supply control subsystem it is optimal configuration and optimal working configuration levels of distribution and shop grids; EEQI control subsystem it is optimal amount of EEQI improvement facilities; for RPA subsystem it is EE supply ensuring in emergency modes. The communication channels and communication grid choose. Functions and criteria effectiveness concordance of all components.

At the second stage the informational integration is conducted and following characteristics are ensured:

unified approach development to the information collection, transmission, saving and use of the EE consumption, supply and EEQI control object at all hierarchical levels of FIE EECACSS, what is ensured via system development of effective central DB organization and, which unify functioning of following subsystems: EE accounting and consumption control subsystem, EE supply control subsystem, EEQI control subsystem, RPA subsystem. The ensuring of interdependent information circulation between system components.

At the third stage the software integration is conducted and following characteristics are ensured:

software tools common functioning ensuring, that are used for tasks solving of EE resources monitoring and control as well as EE supply in standard and emergency modes, what is ensured via program development for automated work place:

a – EE supply automation program module in standard modes;
b – EEQI monitoring module;
c – EE consumption monitoring module;
d – EE supply automation module in emergency modes;
e – EE supply system configuration change module.

At the fourth stage the technical integration is conducted and following characteristics are ensured:

computing techniques tools, sensors, basic automation and local computing grids tools unify, that allows to conduct the automated implementation of all integration kinds under conditions of devided information processing, which is ensured via: communication channels, informational grids of all subsystems and local EE supply automation systems unify; unified exchange protocols use; software development, that are based on the identification and adaptation of EE consumption, supply and EEQI control systems simulated models to their originals with the subsequent determination of optimal regulators settings parameters.

At the fifth stage the experimental method effectiveness estimation according to common criteria is conducted and following characteristics are ensured:

effect determination, that is gained as a result of ACSs common and coordinated functioning, what is reached via determination at the economical effectiveness integration development stage by dint of rate per one FIE shop transforming substation unit. According to main FIE EE transmission, distribution and consume parameters of integration comparison results for the same period last year: EE consumption and wastes determination, capacity wastes, consumed EE costs and fines.

Organizational-technical ensuring of FIE EE consumption and supply control

For FIE EECACSS development let us implement modern information technology. The analysis of ACSs development has shown, that FIE EE consumption control is advisable to implement on the base of common operational system and not on the base of real-time operating system, because FIE EECACSS includes the big amount of «background» tasks, that are not combined hard with the decision-making time: EE balance accounting tasks, FIE EE consumption normalization and scheduling tasks and other tasks. Function, which are combined with information collection and its primary processing, as a rule, are implemented by programmed logical controllers. They are programmatically compatible with the MS Windows platform and are situated on the control centers. Information received from them is inserted into PC.

For FIE EECACSS development is used informational data model, which is developed according to object directed principle, that means that all EE consumption and supply objects, which are control objects, are described by sever objects in the model.

Control objects description in the model is implemented in three stages:

- type development, which determines the object description structure;
- hierarchy element development, correspondingly the object type; the hierarchy element determines the object place of this type in the control objects common structure;
- the object copy of this type is developed, what determines the description elements meaning of the certain object. For the same object type can be create optional hierarchy elements amount and copies.

As the base for data model development is used CIM (Common Information Model), the common informational model, IEC standard 61968, 61970).

Advantages of CIM-model use:

- objects description unification;
- software integration of various producers within the bounds of FIE;
- CIM-scheme portability between the applications.

Let us examine the data model at the level of applied and calculated tasks. At the level of applied and calculated tasks are presented aggregated, processed according to special algorithms data and information. During this information analyzing, it can driven a conclusion about EE supply system work reliability and efficiency. This level has to unify following programs:

- EE resources programs;
- FIE EE supply and consumption modes optimal control programs;
- FIE EEQI control programs.

Thus the offered approach to FIE EECACSS development, which consist of multilevel control system organization taking into account the EE supply hierarchal system structure, local and centralized control systems and energy efficient intellectual control algorithms use and ensures the reach of high efficiency functioning of EE supply system and EE consumption modes.

Conclusion

The FIE EE consumption and supply system analysis on the base of the control process decomposition allows to determine the main control process stages; control functions conditions ensuring; basic informational flows, that ensure EE consumption and supply control as well as organizational-technical control function implementation mechanisms. The FIE EECACSS synthesis is conducted with the use of the compatibility and integration method, what allows to ensure functional, informational, program hardware technical integration, experimental method effectiveness estimation according to common criteria. For the FIE EECACSS development is used the informational data model, which is developed according to the object directed principle with the use of informational CIM-model.

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