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MATHEMATICAL MODELING OF THE REGULAR-MODE ELECTRIC POWER SUPPLY AND ELECTRIC POWER CONSUMPTION PROCESSES OF THE ORGANIZATION

Volodymyr Gotovych[1]; Oleg Nazarevych[1]; Leonid Shcherbak[2]

[1]Ternopil Ivan Puluj National Technical University, Ternopli, Ukraine
[2]Kyiv International University, Kyiv, Ukraine

Summary. *The topicality of providing reliable regular mode of organization functioning is substantiated. It is proposed to consider the problem of providing regular mode of organizations functioning from the position of systems analysis as a complex of two interrelated tasks – control of electricity quality at the input of the electrical grid of the organization and control of the amount of topology load of the organization's electricity consumers.*

As a background of information support for the control of the organization's regular operation mode, a general and constructive model of the process of electricity supply (electrical voltage) at the input of the company's electrical grid a common vector model and a constructive discrete model with change points of the process of electricity consumption of the organization were created. On the basis of the results of mathematical modeling of power supply and electric consumption regular mode processes, the structure of the information system of the control of the organization's standard mode functioning is proposed and the problems it should solve are justified.

Key words: *electric power supply, electric power consumption, electric power quality, regular mode, model of regular mode, change point detection.*

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Setting the problem. Ensuring the reliable operation of institution's electric supply is a problem of high priority and importance. It is urgent both for organizations that belong to manufacturing and services sector of the economy, and for residential-commercial market.

In science and technical works the study of the problem of electric supply quality and analysis of electric consumption are viewed as two separate and independent areas. Meanwhile, these sectors are interrelated and equally important for providing reliable functioning of electric consumption of institutions.

If consider the system of electric power consumption of the organization from the standpoint of the system approach (Fig. 1), the quality of electric power entering the input of organization's electric supply determines the reliability of the functioning of the system in general, in fact, the topology (territorially distributed network) of electricity consumers of the organization.

The input action is the process of electric power supply and the output is the process of electric power consumption.

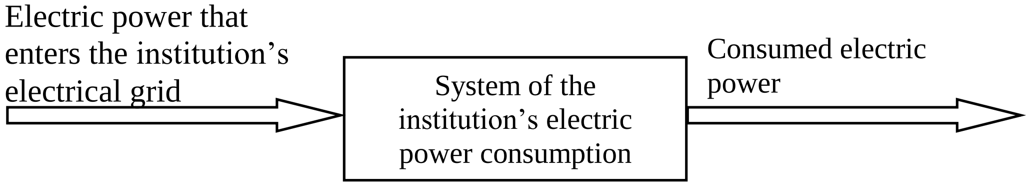

Figure 1. Schematic representation of the institution's electric power consumption system in terms of the system approach

To provide the reliable operation of various electric devices and equipment the notion of standard operation conditions is introduced. In this case, the equipment operates in regular mode, if the parameters of its operation (characteristics of power supply, climatic and meteorological conditions) are within certain limits provided by the standards and the manufacturer. Accordingly, if the parameters go beyond these limits, there is a non-regular mode of operation.

Under conditions of non-regular mode, the probability of improper functioning of equipment and even its failure is increasing, which, when aggregated into the whole organization, can potentially cause non-regular situations of different scale, manufacturing and technological disorder, production of defective products, over-consumption of energy and materials, accidents, material and moral damages etc. The concept of regular and non-regular modes can be generalized to the entire system of electrical consumption of the organization as a set of electrical equipment used by the organization.

In view of this, the task of developing information (models, methods, algorithms, software, databases) and hardware of modern control means of the organization's regular mode work remains relevant. Nowadays, the tasks of ensuring the process of electricity consumption are solved by means of specialized information systems (hardware and software complexes, power management and control systems (PMCS)).

Analysis of previous research. Taking into account the importance of the electrical equipment operation reliability, in present work, the tasks of providing regular mode of operation of the organization are divided into two interrelated tasks:

- Control of electricity quality at the input of the electrical grid of the organization;
- Control of the amount of topology load of the organization's electricity consumers.

Considerable part of studies in the area of energy deals with high-power energy consumption [1, 2, 13]. At the same time, much less works tell about energy consumption of individual organizations. Here are some of them. For instance, study [14] concerns about the consumption process monitoring in the organization at regular mode and the ways of revealing non-regular mode. As a main diagnostic characteristic of organization's regular mode energy consumption, the total (integral) amount of topology load of the organization's electricity consumers is proposed. The appropriate methods of revealing non-regular mode is also proposed. It consists on working out confidence interval for the amount of integral power consumption and the following control of this amount and revealing the moment it goes beyond the limits of confidence intervals. It is proposed to monitor power consumption at both long and short intervals of observation. There are also articles concentrated on providing the quality of electrical energy, as for example [4, 11]. The background of the study is relevant power quality standards [5, 6].

Aim of study. The study aims to create mathematic models of the processes of organization's power supply and power consumption and to determine their main characteristics in order to provide the control of its regular mode functioning.

Study objectives. Creating mathematic models of power supply and power consumption processes on the basis of experimental measurements data. Suggesting hardware and software system structure of providing the tasks of regular mode of organization's power supply control on their background.

Plot of the research. According to setting the problem, in present work the models of regular mode are presented which aim for solving interrelated task of input power quality control of organization as well as control of total electric power consumption control by means of the organization's consumers topology.

Model of regular mode of institution electric power supply. Here we give the definition of electric power quality according to normalization document.

Definition 1. *Electric power quality is the degree of compatibility between electric power characteristics at a given point of the electric system and a set of normalized electric power quality indices.*

Standards [5, 6 et al.] determine the set of electric power quality indices, methods of their measuring and limits of their numeric values. Basically, all quality indices are brought to distortion of such characteristics of voltage sinusoid as amplitude and frequency. The main effects of electric power quality depravation of: malfunctioning and shortening the life of electrical equipment and chips, overheating and power failure, data loss, lighting flicker, increase in electricity consumption and losses etc.

In the known mathematic formula of voltage

$$U(t) = U_m \cos(2\pi f_0 t + \theta_0),\ t \in T,\ \theta_0 \in [0, 2\pi), \tag{1}$$

where U_m – amplitude; f_0 – frequency; θ_0 – initial phase, voltage distortion characteristics, such as amplitude and frequency, are not represented so, in fact it is an idealized model.

Basing on the theory of stochastic processes, the following mathematic model of power supply (voltage) process at the input of organization is proposed:

$$\begin{gathered} u(\boldsymbol{\omega},t) = U(\omega_1,t)\cos\Psi(\omega_2,t),\ t \in T, \omega_1 \in \Omega_1, \omega_2 \in \Omega_2, \\ \boldsymbol{\omega} = (\omega_1, \omega_2),\ \boldsymbol{\omega} \in \Omega,\ \Omega = (\Omega_1, \Omega_2), \end{gathered} \tag{2}$$

where $u(\boldsymbol{\omega},t)$ – random process of voltage, $U(\omega_1,t)$ – random process of the amplitude voltage values, $\Psi(\omega_2,t)$ – random process of general phase and voltage frequency correspondingly.

Present expression is a general model of random harmonic voltage with the simultaneous amplitude and angular modulation by random and predominantly independent processes $U(\omega_1,t)$ та $\Psi(\omega_2,t)$.

More constitutive is the model as a particular case of the model (2) in the form:

$$\begin{gathered} u(\omega,t) = U_m \left(1 + \sum_{i=1}^{n} \xi_{1i}(\omega_1,t) I(t,\Delta T_i)\right) \cdot \cos\left[2\pi t \left(f_0 + \sum_{j=1}^{m} \xi_{2j}(\omega_2,t) I(t,\Delta T_j)\right)\right], \\ \Delta T_i, \Delta T_j \subseteq T,\ t \in T,\ \omega \in (\omega_1, \omega_2),\ \omega_1 \in \Omega, \end{gathered} \tag{3}$$

where $\left\{\xi_{1i}(\omega_1,t),\ i = \overline{1-n}\right\}$ – sequence of random processes that describe random distortion of the amplitude in the interval of observation time T, the distortion effect for each process takes place in a time interval ΔT_i, determined by indicator function $I(t,\Delta T_i) = \begin{cases} 1,\ t \in \Delta T_i \\ 0,\ t \notin \Delta T_i \end{cases},\ i = \overline{1,n}$; $\left\{\xi_{2j}(\omega_2,t),\ j = \overline{1-m}\right\}$ – sequence of random processes that describe random distortion of the frequency in the interval of observation time T, the distortion effect for each process takes place in a time interval ΔT_j, determined by indicator function $I(t,\Delta T_j) = \begin{cases} 1,\ t \in \Delta T_j \\ 0,\ t \notin \Delta T_j \end{cases},\ j = \overline{1,m}$.

Model (3) enables analyzing all possible amplitude and frequency distortions of the voltage taking into account all practical cases. Model (3) completely implements the physical model of both regular and non-regular modes of supplying electric power to the input of the grid of the institution. Another advantage of the model (3) is that it allows to simulate different variants of voltage sinusoid distortion, even low-probability ones, by selecting different random processes in its characteristics $\left\{\xi_{1i}(\omega_1,t),\ i = \overline{1-n}\right\}$ та $\left\{\xi_{2j}(\omega_2,t),\ j = \overline{1-m}\right\}$.

In work [3] certain results of model application are presented (3), in particular, methods of modeling the examples of voltage sinusoid and the structure of databases for their storage. An example of MATLAB simulated signal with amplitudes variation is shown in Fig. 2.

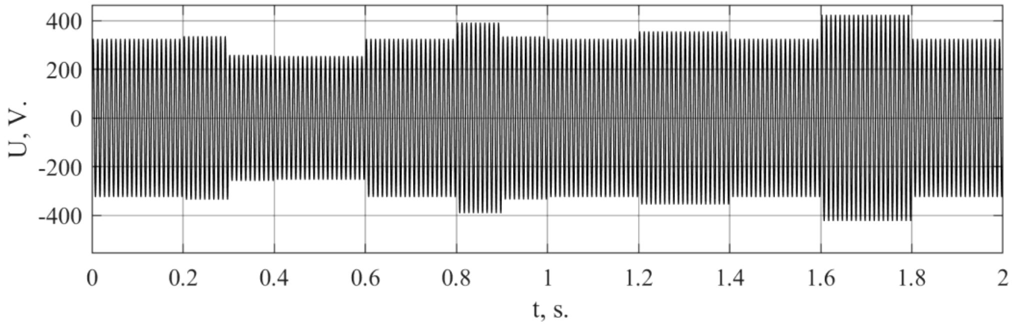

Figure 2. Graph of simulated signal of electric voltage with changes of amplitude

Now we present the results of creating institution's regular mode model of electric power consumption.

Model of the regular mode of electric power consumption process. When creating the model, we will apply an approach that consists in analyzing measurement data using modern decomposition methods and further constructing a vector model based on the results obtained [11]. The object of the study will be the implementation of the process of electricity consumption of the organization on the annual interval of observation (Fig. 3).

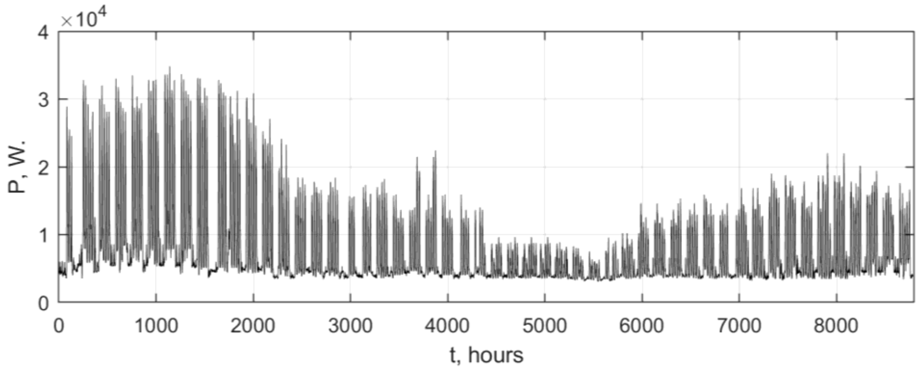

Figure 3. Diagram of implementation of electricity consumption process in one of Ternopil city organizations during one year observation. Sample rate 1 hour

The general vector model of the process of organization's electric power consumption is presented in the form [6]

$$\Xi(\omega,t) = \left(A(t), B(t), \xi(\omega,t)\right),\ \omega \in \Omega,\ t \in \left[0,T\right], \tag{4}$$

where components of the model have clear physical justification, namely: $A(t)$ – the main component, called the trend, which reflects the general nature of the process development due to the main factors of the process formation (topology of consumers, operating modes of the equipment of the organization, climatic and meteorological conditions); $B(t)$ – the sum of harmonic determined components with different but constant fluctuation period for each of them, which represents different periods of human activity (daily, weekly, etc.), that is $B(t) = \sum_{i=1}^{p} b_i(t)$; $\xi(\omega,t)$ – component of stochastic nature, caused by the effect of significant number of random process formation factors (chaotic switching of many devices, usually low power, for example, lighting devices).

In order to monitor the regular mode of the organization's functioning, taking into account the topology of electricity consumers, a constructive model is justified. It is formed by the additive mixture of general model components (4), namely

$$Z(\omega,t) = A(t) + B(t) + \xi(\omega,t),\ \omega \in \Omega,\ t \in [0,T]. \quad (5)$$

Taking into account the use of computer facilities in information monitoring systems, we will present the model (5) in a discrete form:

$$Z(\omega,t_j) = A(t_j) + B(t_j) + \xi(\omega,t_j),\ \omega \in \Omega,\ j = \overline{1,n},\ t_j \in [0,T], \quad (6)$$

where sequence $\{(t_j),\ j = \overline{1,n}\}$ is a discrete grating on the time interval of the survey $[0,T]$; n – number of points. Sampling interval $\Delta t = t_j - t_{j-1}$ depends on technical capabilities of certain measuring devices, such as electrical meters.

It is known that monitoring of the process of electricity consumption of the organization is carried out on the current (day, week) and long-term (month, quarter, year) time intervals of observation. The intensity of the process-forming factors (for example, air temperature) varies in time. This is especially noticeable at long intervals of observation. So, the graph on Fig. 3 clearly demonstrates a change in the intensity of electricity consumption during the year.

To identify the moments of time in which there is a change in the nature (statistical properties) of the process under the influence of external factors, methods of the theory of change points detection are used. Mathematically, the combination of several parts of the implementation of a random process with different values of statistical characteristics in one model is described by means of indicator functions. After introducing the indicator function for the model (7), we obtain:

$$Z(\omega,t_j) = \left(A(t_j) + B(t_j) + \xi(\omega,t_j)\right) \cdot I(t_j,\Delta T_k),\ \omega \in \Omega,\ j = \overline{1,n},\ t_j \in [0,T], \quad (7)$$

where the indicator function is defined as:

$$I(t_j,\Delta T_k) = \begin{cases} 1, t_j \in \Delta T_k \\ 0, t_j \notin \Delta T_k \end{cases},\ k = \overline{1,m}. \quad (8)$$

Indicator function breaks the observation interval into subintervals which do not intersect i.e. $[T_0,T_1) + [T_1,T_2) + ... + [T_{m-1},T_m] = \bigcup_{k=1}^{m} \Delta T_k = T$, and $\Delta T_i \cap \Delta T_j = \varnothing$ at $i \neq j$.

Working outing fixed change points $T_1, T_2, ..., T_m$ is a separate problem (the problem of change points detection), one of the possible solutions to which can be found in [10].

In model (7), the indicator function divides the realizations of all components of the model into fragments. This is explained by the fact that the aggregate of factors of the process of organization's electric power consumption formation simultaneously affects all consumers of topology electricity.

In accordance with the model (4), a number of methods are used to identify the components of both the implementation of the process of electricity consumption and the implementation of processes similar in nature. So, in practice the most reasonable is using the «Track-SSA» method. The results of the corresponding studies are presented in publications [7, 8, 9, 12]. Here are some graphs obtained from the study (Fig. 4).

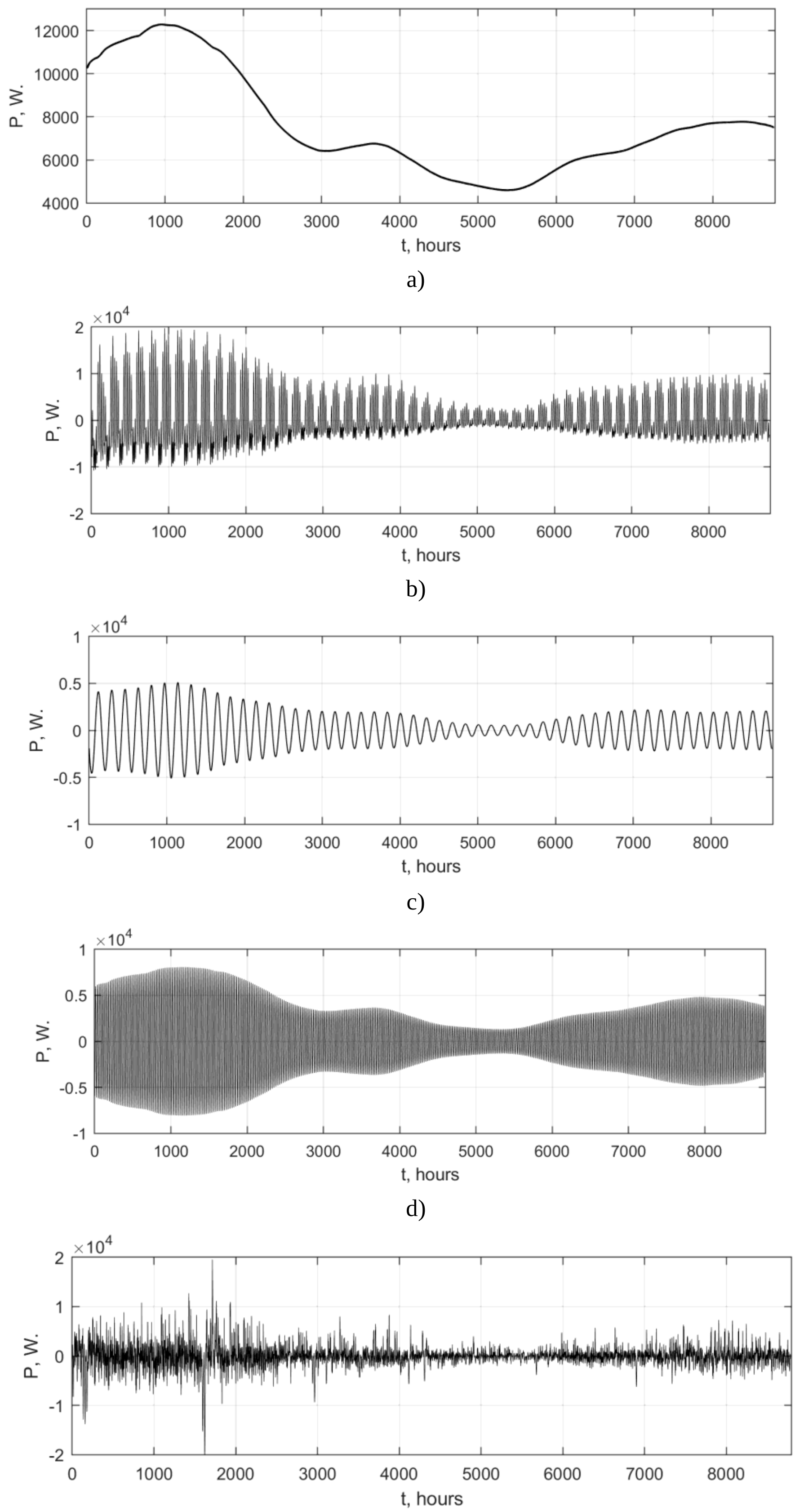

Figure 4. Graphs of implementation of organization’s electric power consumption process components: a) – trend $A(t)$; b) – sum of oscillating components $B(t)$; c) – component with one week period of oscillation; d) – component with one day period of oscillation; e) – stochastic component $\xi(\omega,t)$

Basing on the literature analysis [1, 4, 11, 13, 14] and the analysis of the known PMCS samples we are going to propose the structure of the information system (IS) of providing the regular mode of organization's functioning.

IS support for the regular organization operation mode. It is supposed to use the proposed models as the basis for information support of IS with functions of electric power quality control at the input of the power grid of the organization and control the amount of total electricity consumption by the topology of the consumers in the organization in order to ensure the regular mode of its work. The IS has to contain both hardware (primary measuring convertors including electricity meters, data transmission channels, computers for processing and storage of data) and information (models, algorithms, software, databases) support. In Fig. 5, the structural scheme of the proposed IS is represented.

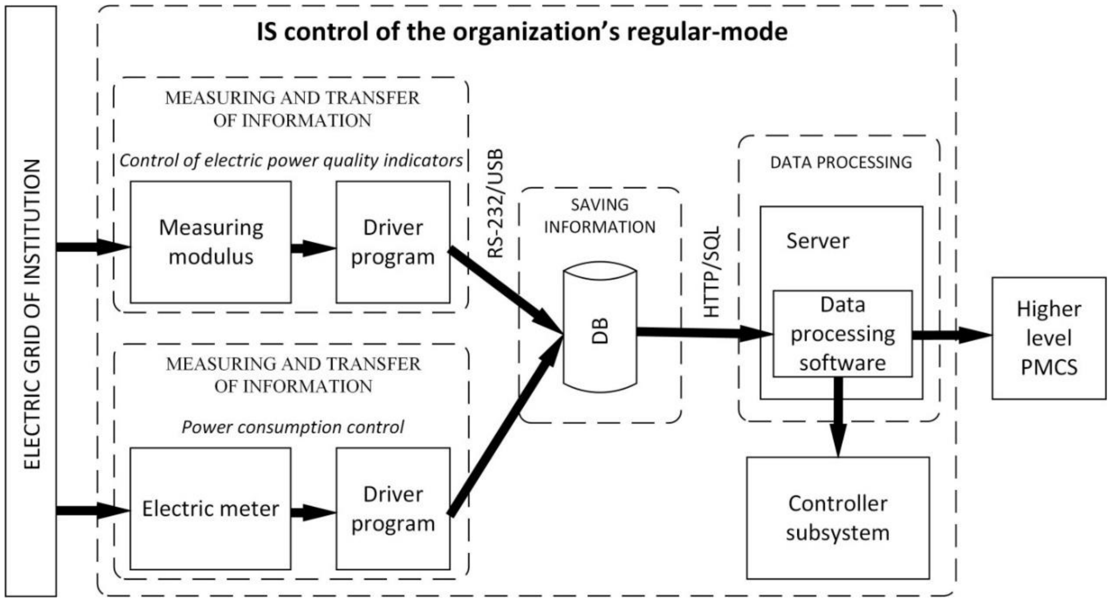

Figure 5. The structural diagram of the IS control of the of the organization's regular-mode electric power consumption

The increase of the corresponding dispatching service operation efficiency of the organization owing to the introduction of the proposed IS it is expected. First and foremost, the IS must function in the interests of the organization. If necessary, it can be used as a part of PMCS of a higher level (city, district).

The proposed models are supposed to be used as the basis for data processing algorithms on a computer-server. Data should be transmitted using common communication protocols HTTP, USB, RS-232, etc. As a database, we suggest using a modern relational database, such as MySQL.

Conclusions. In present work it is proposed to consider the problem of providing regular mode of organization's functioning as a complex of two interrelated tasks – control of electricity quality at the input of the electrical grid of the organization and control of the amount of topology load of the organization's electricity consumers.

To solve these tasks it is suggested:

- The general vector model and constructive discrete model with change points of the process of the organization's electric power consumption layout;

- General and constructive models of electric voltage at the input of the electrical grid of the organization.

On the basis of the obtained mathematical modeling results, the structure of the IS is proposed to provide the regular mode of operation of the organization and the problems for it to solve are justified.

The validated models of power supply and power consumption processes make it possible to create the necessary algorithm-software for the effective use of the organization's operating mode control system.

References

1. Baranov H.L., Marchenko B.H., Pryimak N.V. Postroenie modeli i analiz stoxasticheski periodicheskix nagruzok e'nergosistem. Izvestiya AN SSSR. E'nergetika i transport, 1991, Vol. 37, No. 2, pp. 12 – 21 [In Russian].
2. Voloshko A.V., Kotsar O.V. Kontrol, oblik i keruvannia enerhospozhyvanniam u riznykh haluziakh. ElektroTema, 2004, No. 18 (50), pp. 7 – 8 [In Ukrainian].
3. Voloshko A.V., Gotovych V.A., Nazarevych O.B. Osnovy stvorennia bazy realizatsii syhnaliv dlia doslidzhennia kharakterystyk yakosti elektroenerhii. Modeliuvannia ta informatsiini tekhnolohii. Zbirnyk naukovykh prats In-t problem modeliuvannia v enerhetytsi im. H.Ye. Pukhova, 2016, No. 77, pp. 33 – 40 [In Ukrainian].
4. Voloshko A.V. Teoriia ta praktyka otsiniuvannia yakosti elektrychnoi enerhii v intehrovanykh systemakh elektropostachannia: avtoref. dys. … dokt. tekh. nauk. Kyiv, 2014, 40 p. [In Ukrainian].
5. GOST 32144-2013. "E'lektricheskaya e'nergiya. Sovmestimost' texnicheskix sredstv e'lektromagnitnaya. Normy kachestva e'lektricheskoj e'nergii v sistemax e'lektrosnabzheniya obshhego naznacheniya" [In Russian].
6. GOST 13109-97. "E'lektricheskaya e'nergiya. Sovmestimost' texnicheskix sredstv e'lektromagnitnaya. Normy kachestva e'lektricheskoj e'nergii v sistemax e'lektrosnabzheniya obshhego naznacheniya" [In Russian].
7. Gotovych V.A., Nazarevych O.B. Zastosuvannia metodu "Husenytsia-SSA" dlia analizu richnoho chasovoho riadu elektronavantazhennia orhanizatsii. Visnyk NTUU "KPI". Informatyka, upravlinnia ta obchysliuvalna tekhnika: Zb. nauk. pr. K. "Vek+", 2015, No. 63, pp. 123 – 129 [In Ukrainian].
8. Gotovych V.A. Statystychnyi analiz protsesu elektrospozhyvannia orhanizatsii na tryvalykh intervalakh sposterezhennia. Modeliuvannia ta informatsiini tekhnolohii. Zbirnyk naukovykh prats In-t problem modeliuvannia v enerhetytsi im. H.Ye. Pukhova, 2018, No. 82, pp. 27 – 33 [In Ukrainian].
9. Nazarevych O.B. Vydilennia richnoho trendu yak adytyvnoi skladovoi chasovoho riadu hazospozhyvannia. Visnyk TNTU (Matematychne modeliuvannia. Matematyka. Fizyka), 2011, Vol. 16, No. 4, pp. 201 – 209 [In Ukrainian].
10. Nazarevych O.B. Informatsiina tekhnolohiia monitorynhu hazospozhyvannia mista: avtoref. dys. … kand. tekh. nauk. Ternopil, 2015, 21 p. [In Ukrainian].
11. Prakhovnyk A.V., Denysenko M.A., Voloshko A.V. and others. Shchodo vymiriuvannia pokaznykiv yakosti elektrychnoi enerhii. Enerhetyka ta elektryfikatsiia, 2012, No. 3, pp. 16 – 21 [In Ukrainian].
12. Sinichenko S.V., Shcherbak L.M. Stvorennia modeli obiekta doslidzhen po eksperymentalnym danym vymiriuvan. Zbirnyk tez do XI mizhnarodnoi naukovo-praktychnoi konferentsii "Intehrovani intelektualni roboto tekhnichni kompleksy". Kyiv, NAU, 2018, pp. 150 – 152 [In Ukrainian].
13. Stohnii B.S., Kyrylenko O.V., Prakhovnyk A.V., Denysiuk S.P. Intelektualni elektrychni merezhi: svitovyi dosvid i perspektyvy Ukrainy. Pr. In-tu elektrodynamiky NAN Ukrainy: Zb. nauk. pr. Spets. vypusk. Vol. 1. Kyiv, IED NANU, 2011, pp. 5 – 20 [In Ukrainian].
14. Shcherbak T.L. Informatsiina tekhnolohiia diahnostyky dynamiky protsesiv elektrospozhyvannia orhanizatsii u shtatnomu i neshtatnomu rezhymakh. Avtoref. dys. na zdobuttia nauk. stupenia kand. tekh. nauk. Kyiv, 2010, 20 p. [In Ukrainian].

Список використаної літератури

1. Баранов, Г.Л. Построение модели и анализ стохастически периодических нагрузок энергосистем [Текст] / Г.Л. Баранов, Б.Г. Марченко, Н.В. Приймак // Известия АН СССР. Энергетика и транспорт. – 1991. – Т. 37, № 2. – С. 12 – 21.
2. Волошко, А.В. Контроль, облік і керування енергоспоживанням у різних галузях [Текст] / А.В. Волошко, О.В. Коцарь // ЕлектроТема. – 2004. – № 18 (50). – С. 7 – 8.
3. Волошко, А.В. Основи створення бази реалізацій сигналів для дослідження характеристик якості електроенергії [Текст] / А.В. Волошко, В.А. Готович, О.Б. Назаревич // Моделювання та інформаційні технології: Зб. наук. праць. Ін-т проблем моделювання в енергетиці ім. Г.Є. Пухова. – 2016. – Вип. 77. – С. 33 – 40.
4. Волошко, А.В. Теорія та практика оцінювання якості електричної енергії в інтегрованих системах електропостачання: автореф. дис. … докт. тех. наук. – Київ, 2014. – 40 с.
5. ГОСТ 32144-2013. Электрическая энергия. Совместимость технических средств электромагнитная. Нормы качества электрической энергии в системах электроснабжения общего назначения.
6. ГОСТ 13109-97. Электрическая энергия. Совместимость технических средств электромагнитная. Нормы качества электрической энергии в системах электроснабжения общего назначения.

7. Готович, В.А. Застосування методу «Гусениця-SSA» для аналізу річного часового ряду електронавантаження організації [Текст] / В.А. Готович, О.Б. Назаревич // Вісник НТУУ «КПІ». Інформатика, управління та обчислювальна техніка: Зб. наук. пр. – К. : «Век+». – 2015. – № 63. – С. 123 – 129.
8. Готович, В.А. Статистичний аналіз процесу електроспоживання організації на тривалих інтервалах спостереження [Текст] / В.А. Готович // Моделювання та інформаційні технології: Зб. наук. праць. Ін-т проблем моделювання в енергетиці ім. Г.Є. Пухова. – 2018. – Вип. 82. – С. 27 – 33.
9. Назаревич, О.Б. Виділення річного тренду як адитивної складової часового ряду газоспоживання [Текст] / О.Б. Назаревич // Вісник ТНТУ (Математичне моделювання. Математика. Фізика). – 2011. – Т. 16, № 4. – С. 201 – 209.
10. Назаревич, О.Б. Інформаційна технологія моніторингу газоспоживання міста: автореф. дис. … канд. тех. наук. – Тернопіль, 2015. – 21 с.
11. Праховник, А.В. Щодо вимірювання показників якості електричної енергії [Текст] / А.В. Праховник, М.А. Денисенко, А.В. Волошко [та ін.] // Енергетика та електрифікація. − 2012. – № 3. − С. 16 – 21.
12. Сініченко, С.В. Створення моделі об'єкта досліджень за експериментальних даних вимірювань [Текст] / С.В. Сініченко, Л.М. Щербак // Збірник тез до XI Міжнародної науково-практичної конференції «Інтегровані інтелектуальні робототехнічні комплекси» (22 – 23 травня 2018 р.). – Київ : НАУ. − С. 150 – 152.
13. Інтелектуальні електричні мережі: світовий досвід і перспективи України [Текст] / Б.С. Стогній, О.В. Кириленко, А.В. Праховник, С.П. Денисюк // Пр. Ін-ту електродинаміки НАН України: Зб. наук. пр. – Спец. випуск. – Ч. 1. – Київ : ІЕД НАНУ, 2011. − С. 5 – 20.
14. Щербак, Т.Л. Інформаційна технологія діагностики динаміки процесів електроспоживання організацій у штатному і нештатному режимах: автореф. дис. … канд. тех. наук. – Київ, 2010. – 20 с.

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МАТЕМАТИЧНЕ МОДЕЛЮВАННЯ ПРОЦЕСІВ ШТАТНОГО РЕЖИМУ ЕЛЕКТРОПОСТАЧАННЯ Й ЕЛЕКТРОСПОЖИВАННЯ ОРГАНІЗАЦІЇ

Володимир Готович[1]; Олег Назаревич[1]; Леонід Щербак[2]

[1]Тернопільський національний технічний університет імені Івана Пулюя, Тернопіль, Україна

[2]Київський міжнародний університет, Київ, Україна

***Резюме**. Обґрунтовано актуальність надійного забезпечення штатного режиму функціонування організації. Запропоновано розглядати завдання забезпечення штатного режиму функціонування організації з позицій системного аналізу як сукупність двох взаємопов'язаних задач: задачу контролю якості характеристик електроенергії на вході електромережі організації й задачу контролю величини навантаження топології споживачів електроенергії організації. В якості основи інформаційного забезпечення контролю штатного режиму функціонування організації на основі застосування теорії випадкових процесів створено загальну та конструктивну моделі процесу електропостачання (електричної напруги) на вході електромережі організації й загальну векторну модель та конструктивну дискретну модель з розладнанням процесу електроспоживання організації. При цьому конструктивна модель процесу електропостачання містить послідовності випадкових процесів, які описують випадкові спотворення амплітуди й загальної фази напруги, а конструктивна дискретна модель процесу електроспоживання представляє процес як суму компонент, кожна з яких має чітке фізичне обґрунтування. Представлено результати досліджень, отримані із застосуванням створених конструктивних моделей, а саме: змодельовану в MATLAB реалізацію процесу електропостачання із перепадами амплітуди та компоненти процесу електроспоживання однієї із організацій Тернополя на річному інтервалі спостереження, отримані із застосуванням методу «Гусениця – SSA». На основі результатів математичного моделювання процесів штатного режиму електропостачання й електроспоживання запропоновано структуру інформаційної системи контролю штатного режиму функціонування організації та обґрунтовано завдання, які вона повинна вирішувати.*

***Ключові слова:** електропостачання, електроспоживання, якість електроенергії, штатний режим, модель штатного режиму, розладнання.*

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