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THE SECURITY OF ELECTRICITY SUPPLY AS THE DETERMINANT OF SUSTAINABLE DEVELOPMENT[1]

It is defined the term security of energy supply and identified its segments in the article. The role of electricity in sustainable development is analyzed. The article emphasize the importance of a secure electricity supply that is a key prerequisite to well-functioning modern society

Keywords: energy, security of supply, sustainable electricity system.

Introduction. World studies emphasize the need and importance of the secure electricity supply as the precondition of modern life, needs of people and economy. Continuous use of electricity, and thereby its secure supply, must enable the achievement of general-social progress, that is economic growth and development, and meeting the human demand for electricity at any time, without jeopardizing the possibility of its use in the future.

Formulation of the general problem. One of the key determinants of the human development is electricity and its use, being an irreplaceable resource of a modern economy. Thus, the topical issue of this research is to estimate the importance of providing safe and continuous supply of electricity, which is the phenomenon that has a direct impact on social welfare. In this regard, it is necessary to investigate the relevant features and the role of the security of electricity supply as a basic prerequisite to sustainable development.

Selection of outstanding issues. The purpose of this paper is to find answers to a number of questions. The first question relates to the meaning of the term *security of energy supply* and identification of its segments. The topical issue of the paper is the security of *electricity* supply, the role of electricity in sustainable development, i.e. the importance of sustainable electricity system for the development of modern society.

The aim of the article is to emphasize the importance of a secure electricity supply that is a key prerequisite to well-functioning modern society.

Basic materials.

Basic guidelines of the security of energy supply

Given the different interpretations of the term *security of energy supply*, below are sorted out some of the selected definitions. One of the most general definitions proposes the International Energy Agency, which describes the security of energy supply as physically continuous availability of energy at the price that is available, subject to compliance of ecologically acceptable conditions. The problem which imposes is the risk of energy insecurity, i.e. disturbance or interruption in the energy supply and the potential loss of

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welfare due to price change or availability of energy [23].

Based on a similar view, Asia Pacific Energy Research Centre (APERC), which is established by the states members of Asia Pacific Economic Cooperation (APEC), defines the energy security as the ability of economy to guarantee the availability of energy sources in a sustainable and timely manner, with energy price that will not adversely affect the economic performance of economy [3]. Given this situation, APERC defines several factors which can affect the security of energy supply, such as the availability of energy resources from both domestic and external suppliers, i.e. conditions in the domestic and foreign market; the ability of economy to purchase sufficient quantities of energy that will be able to meet the projected energy consumption; level of diversification of energy sources in economy and also the energy diversification of suppliers; the availability of energy sources in the sense of availability of associated energy infrastructure and energy transport infrastructure; geopolitical interest in the acquisition and concentration of energy resources; and more.

Traditionally, security of energy supply has been associated with providing access to oil, or availability of oil and direct pumping of fossil fuels. Lack of oil as global commodity in the world market has caused the short-term fluctuations and long-term increase in price. By that, Security of supply concept (SOS concept) partially "moved away" from a purely physical location of fossil fuels, toward the one which considers the price of energy and consequences, regarding that, on the economy [17]. Thereby the security of energy supply takes an economic dimension.

Interruption in the energy supply is stated as a classic problem of energy security. The interruption in supply may occur anywhere in the supply chain, due to the conversion of energy from one form to another or the transport of energy. The concept of security of energy supply is especially considered in the conditions of contingencies, such as the ability of energy system to deal with extreme events, such as hurricanes, strikes or acts of terrorism. Also, decisions of transit countries or political stability greatly affect the security of energy supply [18].

In this way, the concept of energy security spread over time, and the term has become more complex and comprehensive. Today are emphasized four main segments of security of energy supply, and APERC proposes classification known as the concept "4A" [18]: a) availability, elements associated with geological existence; b) accessibility, geopolitical elements; c) affordability, economic elements; d) acceptability, ecological and social elements. It should be noted that the categories are by no means isolated, but mutually interrelated elements which function addictively.

The first and basic element, enclosed in all the other elements, is the *availability of energy* in economy, household and other subjects. This implies the absolute availability of energy or its physical presence in order to the economy and society could function normally [18]. In the report, APERC states that the concept of availability is limited on oil and other fossil fuels. This relates to the quantity of offer of the primary energy resource in relation to existing reserves, because it is generally accepted thesis that fossil resources are essentially limited. This meaning is considered too narrow because it only encloses geologic resources such as fossil fuels and radioactive material for the source of primary energy resources. Today, mentioned concept should also include other energy sources such as hydroelectric energy, solar energy, wind energy or biomass. The availability of energy sources is also influenced by other factors such as energy infrastructure and energy transport infrastructure [23].

Accessibility of energy is the next element of security of energy supply, significant with regard to the possible geopolitical implications that may arise from the large spatial difference

between the extraction or production of energy resource and its consumption. That geopolitical element makes accessibility difficult to measure, and is therefore almost impossible to accurately investigate it. Within the same framework should be perceived and geographical element, since the current energy reserves are still by a certain extent unused, even unexplored, and are mainly located in isolated areas, such as deep seas or the Arctic areas, by which is pumping of resources difficult and requires great funding. Difficulties in obtaining energy resources may include both political and physical element, resulting in the overlap of the concepts of availability and accessibility.

In considering the aspect of energy security, should be also investigated the *availability of energy*, in the context of acceptable price or justified cost, whether it is assumed the cost of energy infrastructure, the cost of service or the cost of energy source to the ultimate consumer. In other words, the availability of energy encloses its economic element. This concept may lead to energy shortage, which often occurs in developed countries. Economic availability demands that even the poorest segment of population must have a secured energy supply at a price that is acceptable to them. Otherwise, appears the energy shortage [23]. This issue was recognized by the European Union when in 1996 adopted the Directive 96/92/EC in which had introduced the provision *Public service obligations*, under which Member States may impose to energy companies an obligation to provide public services, which could be (but not exclusively) relate to "security, including security of energy supply, regularity, quality and price of supply and environmental protection". By adopting the new Directive 2003/54/EC, it has been significantly expanded the scope of operation of the provision *Public service obligations*, and are stated a new general principles and provisions of providing public service, among which the most important relates to the providing of so-called *Universal service*, which concept is defined as "the right to the electricity supply of specific quality within a determined area at the reasonable, easily and clearly comparable and transparent prices". In addition to that provision where is an obligation that all customers, especially households and small companies, be connected and supplied with electricity, defined are other objectives which are intended to enhance the European energy market, and relate to the principles such as protection of ultimate consumers, where are considered particularly vulnerable (sensitive) consumers, and consumers in remote areas. It is also emphasized the social and economic cohesion, environmental protection, then the supplier in ultimate necessity, under which is considering the supply of those customers who did not choose their supplier in the market or their supplier stopped working. In this way is preventing the failure of electricity supply due to real absence of supplier [24, 19].

Finally, in considering the concept of security of energy supply, need to be included the *acceptability of energy*, i.e environmental approach, that is an element of environmental sustainability such as the rational use of coal, nuclear and non-conventional fuels (biofuel or bituminous sand) [16]. When describing the environmental aspect of the problem, APERC emphasizes that is foreseen a significant increase in energy demand in the APEC member countries, since it is expected that this area will achieve a strong economic growth (forecasts are that the annual growth of GDP will be 4.1% from 2002 to 2030). This trend of increased energy consumption will certainly have negative environmental effects in the form of a drastic increase in greenhouse gas emissions. It is estimated that the emission of carbon dioxide (CO_2) will nearly double, from 15 billion tons in 2002 to about 27 billion tons in 2030, of which approximately 47% of emissions will be caused by the activity of the electric-power sector. Similarly, it is estimated double increase in emissions of sulfur dioxide (SO_2) and nitrogen oxide (NO_x). Faced with the challenges and problems related to energy issues of

environmental protection, public authorities and other decision makers seek to influence the reduction of pollution by defining more stringent regulations, and by implementing other mechanisms of environment protection, such as for example, the additional tax burdens for "dirty" fuels, and other. Stricter environmental rules and regulations, combined with the increased environmental awareness of increasing number of consumers on issues related to the energy sector and ultimately for sustainable development, influence on reducing the usage of fossil fuels [3]. To that is contributing the fact that fossil resources are limited, scanty, so their usage should be gradually reduced or substituted by alternative energy sources. It is considered, even if demand does not increase, that the remaining oil could be sufficient just for 45 years, gas for 65 years and coal for about 170 years, but coal is also the largest polluter of environment [28, 3]. Limitations in the usage of fossil fuels can be solved by improving energy efficiency, introducing new technologies and technological processes, using less energy in production of larger number of products and services, and using alternative energy sources such as renewable energy sources and biomass. It is the energy efficiency, with climate protection, effectiveness of demand management and fulfillment of other environmental requirements, one of the environment protection objectives of the Directive 2003/54/EC of the European Union [24]. Finally, it is considered that the concept of acceptability in some cases is more important and broader concept than the economic impact of energy security, because it can involve social and political issues such as discussions on the issue of food or fuel (biofuel), displacement of indigenous peoples because of the energy extraction, and other.

For purposes of this research is necessary to narrow the concept of security of energy supply on the security of electricity supply, and determine the impact of the described segments on the sustainable development.

The role of electricity in sustainable development

The next is the review on the issue of security of electricity supply, then are stated the most common causes of disturbance and interruption of electricity supply in the world, and finally, indicated are the fundamental characteristics of sustainable electric-power system.

The security of electricity supply: challenges and assumptions

Historically, security of electricity supply had been secured by functioning of energy vertically integrated companies. By liberalization in the 80s of last century (by energy acts in 1983 and 1989 the United Kingdom was the first European country which introduced competition in electricity supply, opening the market to third parties), followed the separation of vertically integrated electric-power companies, and emerged a number of independent companies which perform various energy activities such as electricity production, transmission and distribution, electricity supply, and other activities. The parallel existence of competitive activities (production, supply, electricity trade) and regulated activities (transmission and distribution of electricity, as natural monopolies) additionally aggravated the concept of security of electricity supply.

With the occurrence of liberalization of the electric-power sector, substantially has changed the framework, as well as the principle of making investment decisions, and has appeared a concern about the possible significant reduction of investment in electric-power infrastructure. With regard to the increase in electricity consumption and the need for replacing the old, worn-out energy facilities, some projections show that Europe in the near future could face a severe shortage of electricity, unless it ensures significant financial resources and new investment in energetics [22].

Last few years, the concept of security of electricity supply has developed into one of the

key issues in an open, liberalized electric-power market. The term *security of electricity supply* appears to be very clear, but it requires the precise formulation. Many simply consider that this term denotes the *absence of interruption of electricity supply* in households ("lights are turn on when I turn on the switch, and remain so until I turn off the switch"). This is essentially correct, although superficial understanding of this concept. The essence of security of electricity supply is undoubtedly related to the ultimate user of electricity, whether are households, companies or institutions, but at the same time involves several elements which all must function properly in order to, for example, "lights really turn on, and remain so". The Association of the electricity industry (Eurelectric) defines the security of electricity supply as the ability of electric-power system to provide electricity to ultimate users with a specific level of continuity (uninterruptedness) and quality, in a sustainable manner, and in accordance with the standards and contractual agreements [22].

The security of electricity supply is a very complex issue, because electricity is a specific product, essentially without any substitute, which cannot be "taken off the shelves" and consider before buying. This represents a challenge for consumers to notice or visualize the uniqueness of this product. Electricity cannot be easily transferred in the market, and its production is almost immediately delivered and used, since the same cannot be stored.

To the maximum extent possible, modern societies depend on electricity, and any shortage or disruption in the operation of the electric-power sector may lead to interruption of electricity supply, and thereby cause major negative consequences. Even the current lack of electricity supply from a few milliseconds can cause damage to industrial processes or information technology devices. In order to achieve adequate security of electricity supply, it is necessary to adequately ensure the smooth functioning of the entire process of production and, ultimately, the usage of electricity. This means, above all, the use of a sufficient amount of an energy resource in order to produce electricity in the estimated range; then so-called "plant margin" which makes the percentage of installed production capacities over the maximum consumption of electricity in a certain period; maintaining of energy quality by investments in transmission and distribution infrastructure; harmonization of supply and demand for electricity in the real time since the same can hardly be saved; possibility of more flexible usage of the electric-power system in response to irregularities in demand, for example, large industrial consumers accept the occasional smaller voltage of electricity or short-term disruptions in supply in exchange for lower electricity prices; the ability that large industrial consumers purchase electricity directly from the production generators, thereby relieving electricity network infrastructure; and other [21].

In order to further ensure the reliable and safe electricity supply and impact the stability and resistance of the electric-power system on contingencies, in the system should be included the *variety* and *flexibility*. Diversity can be increased by using a wider range of energy resources, using new production technologies and geographic dispersion of production plants and primary energy sources [21]. The flexibility of the electric-power system is in turn related to the ability of quickly adjustment of the whole system at a low price, whereat is firstly thought on the adjustment of energy resource, that is fuel. In fact, flexibility has two important features. First, it improves the security of the fuel offer in the case of interruption of supply, and secondly, it allows competition in the choice of fuel, by which affects on reducing costs. Emphasized is the possibility of using more than one energy resource in electricity production or stockpiling of fuel (especially coal) in order to avoid interruptions in supply. The possibility of switching to another energy resource is especially important since the continuity of fuel supply is one of the primary conditions for safe and reliable electric services. In any case, as

electricity markets deregulate more, the choice of a more acceptable energy resource will gain more importance [26].

Disturbances and interruptions in the electricity supply

During the last fifty years, a developed world has built a very strong dependence on electricity, although it should be added that more than one and a half billion people still have no access to electricity, the basic precondition for economic and social development. In any case, it can be argued that the electricity has become a "necessary good". The increasing of number of interruptions of electricity supply, especially in developed countries such as USA, Canada, Europe, re-opened the question of security of supply, which is related to two main factors, sufficient and available production capacities, and appropriate and secure transmission and distribution networks.

Interruption of electricity supply currently affects daily activities, through public lighting, electric heating, all electric appliances, televisions, computers, and can lead to disturbance of public transport system, hospitals and health institutions, etc. After few hours begins to affect the frozen food, telecommunication systems, even on the water distribution. Interruption of electricity supply can be caused by a variety of factors which, acting on a part of the electric-power system, as a rule lead to the failure of entire system. Difficulties in the work of electric-power system and impossibility of a reliable and secure electricity supply can have various causes, among which the most significant are as follows [6]:

– first cause of an unstable power system relates to the weather conditions. With natural disasters such as storms, snow or floods which in large scope damage the parts of the power system, a direct impact on the supply and demand of electricity have the weather conditions and their exploitation. Dry periods reduce the potential of hydro power plants and capacity of cooling; wind is an important factor in countries such as Spain, Germany or Denmark, where wind farms are developed, and the sudden termination of wind may immediately suspend the production of electricity of several GW; unusually high or low temperatures directly depend on the use of air conditioners and power consumption; long periods of cold or heat can also cause an imbalance between production and consumption of electricity, etc. One such case occurred in France in December 1999, when the powerful storm struck northern and southern part of the country, during which occurred large damages in the power system: submerged electric power stations; destroyed network infrastructure in the form of tangled or broken electrical wires, collapsed pillars; ¼ of the total number of very high-voltage lines had been broken or were not working satisfactorily; and other damages. This resulted in interruption of electricity supply for approximately 3,4 million households, which were left without electricity for several weeks [27]. That extraordinary weather event demonstrated large gaps and all vulnerability of modern power grid, as well as damages that may be caused by the cessation of electricity supply;

– the next cause of difficulties in the work of electric-power system relates to technology. Technological failures can be the reason for exclusion of generating capacities in a shorter or longer time. This especially relates to nuclear power plants, and together with human error occurs almost daily [12]. The most considerable interruption of electricity supply in relation to the size of population occurred in Indonesia, on the islands Java and Bali, 2005. It is assumed that by the interruption of electricity was affected 120 million people (half of the total population), and the five-hour interruption resulted in a loss of 20,000 MW [14]. The reason for such a large termination of power supply was the lack of necessary energy infrastructure, inadequate maintenance of the entire electric-power system, primarily in the transmission and distribution network, i.e. overloading the network lines, and poor management of state-owned

electricity company [25];

– accidents, sabotages or terrorist attacks can also severely damage electric-power systems and cause economic stagnation and even depression. There are numerous programs of protection, preservation and prevention of power plants, especially in the U.S. after the 2001 terror attacks. Assessed are the economic impacts of potential terrorist attacks on the electric-power system. One such study was conducted in the U.S., using the example of New Jersey. It was assumed that the attack was carried out in the summer of 2005 year, in the period of highest energy consumption. As research results were described two possibilities. First, assuming that economic activity returns to the initial state, before the attack, then the economy can recover within a year. However, if terrorist attacks cause absolute loss of economic activity due to the closure and relocation of companies in more prosperous areas, then the economy would not fully recover over the next five years [11]. Another study that was conducted enclosed 451 disturbances in the production, transmission and distribution of electricity, which had been occurred in North America since 1984 to 1999. The results showed that only 3% of disorders were associated with sabotage or vandalism which is closely related to terrorism [9];

– inability of secure supply of electricity can be related with an insufficient offer of primary fuels such as coal, fuel oil or natural gas. Thus in the 1972 in England and Wales, many households and companies were without electricity for up to nine hours a day due to the miners' strike. Besides the strike, the miners had occupied power plants and blocked a delivery of all fuel sources in order to put pressure on the government. The lack of electricity thus forced many plants and companies to close, it is assumed that 1,2 million workers lost their jobs, and the government had to impose the work week of three days [13]. Another such incident occurred in January 2006, and exactly three years later, when Russia halted supply of natural gas to most of Europe due to dispute with Ukraine. Some analysts (e.g. Marshall Goldman, the expert of economic and political relations in Russia) evaluate these problems as signs of Russian manipulation of natural gas as a political weapon [5];

– potential cause of an unstable and endangered electric-power system is also in the current processes of liberalization and deregulation of the electricity which are taking place across Europe. Creating a single European electric-power market should allow better connection of national energy systems and reduce any form of disturbance or interruption in the electricity supply. But in reality, mentioned is often not the case because of various reasons such as lack of financial resources, environmental opposition and not-running the required projects, and more. An increasing number of interruptions of electricity supply can be explained by shortcomings in the organization, regulation and functioning of the electric-power industry;

– paradoxically is, too, that the increased interconnection of energy networks can lead to interruption of electricity supply when there is a lack of coordination between operators of a transmission system. Communication and coordination between the operators on the one hand, and the regulatory body or agency on the other hand, is the key aspect of security of electricity supply after the appearance and establishment of regional energy markets. Interruption of electricity supply that occurred in Italy 2003 emerged because of the disruption in communication and coordination of activities between ETRANS (Swiss transmission operator) and GRTN (Italian network operator) for the period of only ten minutes. The mentioned resulted in twelve-hour interruption of electricity supply throughout Italy and three-hour break in the part of Switzerland, near Geneva [4].

In order to solve problems in the operation of electric-power system and to ensure a secure

electricity supply, it is necessary to improve cooperation between all activities of the electric-power system, especially the production and transmission of electricity and the independent regulatory body. It is necessary to ensure and conduct the activities of measurements of the electricity supply, especially at critical points, in order to be able to act preventively on the possible disruptions or delays in a system. It is necessary to take into account the fact that certain causes of interruptions of electricity supply may occur at the same time, which further complicates the already problematic situation.

The combination of low electricity reserve margins (as the indicator of reliability of the electric-power generating system), scarce hydro potentials and poor availability of wind, unexpected losses of energy resources and extreme weather conditions, can lead to a very high electricity price and even to interruption of supply, unless the system operators are timely informed of mentioned movements and unless they developed the appropriate plans to balance the disturbed system. The cost of "unsupplied kWh" is very high, and in every moment is seeking to ensure the stable electric-power supply system and secure electricity supply.

Characteristics of the sustainable electricity system

Looking generally, sustainability considers the quality of life through the economic component, social component and component of environmental protection, providing a healthier, more productive and meaningful life for all members of society, both for present and future ones [15]. The concept of sustainable development was originally used by the Organization of United Nations in 1972 for the nature conservation. Year 1987, the World Commission on Environment and Development defines the concept of sustainable development in the report entitled "Our common future". In this study states that sustainable development aims to meet the needs of present time, without compromising the ability of future generations to meet their own needs. Emphasized is the urgent implementation of appropriate measures and actions in four key steps of sustainability related to the rapid growth of world population, problems of production and supply of food, development of clean energy and production technologies, and conservation of natural resources [10]. Sustainable development is a dynamic category of social, environmental, economic (and technological) parameters which allow the state and society the progress toward a better and more quality life [20]. In such development, it is important to achieve the balance of system between prominent components.

Electric-power system, or electricity as a product of that system, plays a key role in sustainable development. The same drives and contributes significantly to the economic and social progress, but also affects the environment.

From *the economic perspective*, the electric-power system generates economic value through technical and commercial processes enclosed by the production and distribution of electricity, and using electricity by ultimate users. Electric-power system distributes that value on the level of society in the form of salaries for employees, profits or dividends to owners, and taxes to state. As a relatively large sector in the economy of state, electric-power industry employs a significant number of jobs, both directly in its core business, and indirectly through the demand of goods and services from other companies and business units. It should be pointed out the necessity of electricity as one of the basic inputs in the production of almost all industrial branches and activities.

From *the social perspective*, the electric-power system enables the provision of service that is different than any other, and it is essential in the core activities of society. The electricity supply is an important factor in maintaining national and global stability and peace. Since the electricity is difficult to store for later usage, safe and reliable electricity supply is a

prerequisite for economic development, social security and general welfare. In many developing countries, where is inability of usage or low utilization of electricity, limited are numerous activities like social services such as health or education. In such countries, it is necessary to ensure the extension of electrification, by which would be significantly contributed to alleviating poverty on the social level.

As the last, from *the ecological perspective,* the electric-power system has different implications depending on which production facilities and technologies are about. For example, the production of electricity using fossil fuels results in harmful emissions to the atmosphere, the usage of nuclear energy raises questions concerning the handling and storage of radioactive waste, hydro power plants have significant effects on the environment such as the impact on river systems, wetlands, biodiversity, etc. It is important to emphasize that, apart from electricity production, transmission and distribution of electricity also have a significant impact on the environment, social environment and physical condition of people [7]. For the usage of electric energy in sustainable development can be easily argued that it should include the maximum contribution to economic and social development, and minimal environmental impact.

Recently, electricity has been increasingly associated with sustainable development, which leads to the inclusion of the electric-power system in the concept of sustainable development, i.e. the formation of concept of "sustainability of electricity system". In the most general sense, sustainable electric-power system is usually defined in the context of energy efficiency, reliability and environmental impact. The basic prerequisite for achieving this concept, according to Bonser, is the production of sufficient quantities of energy for everyone's needs at an affordable price, and the usage of clean, safe and reliable electricity [2]. Acres defines the sustainable electricity system by combining the energy hierarchy with a set of economic, social and environmental principles [1]. He states that the energy hierarchy starts by reducing of energy usage, it continues by energy-efficiency measures (improving of energy processes), the implementation of renewable-energy sources and, finally, the combination of most effective non-renewable and conventional energy sources with the best available technologies. Within this hierarchy Acres proposes several principles: the energy system should have zero net emissions of greenhouse gases, i.e. it should not contribute to climate changes; it should not have the significant impact on environment; it should be improved the security of electricity supply, particularly because power interruptions have negative social implications; it should be reduced the cost of energy procurement and improved the availability of energy (it is necessary to take into account the large industrial needs on the one side and small power consumption of households with relatively low incomes on the other side); should be used renewable energy sources as much as possible [1].

Literature indicates to significant differences between the conventional and sustainable electric-power system. *Conventional electric-power system* is characterized as a centralized hierarchical system that, basically, is based on supply or delivery of electricity, as a system with large conventional power plants (most of them take time to start working) connected to the passive transmission and distribution networks, where consumers experience electricity only when they turn on the lights or device. Concern about energy security is observed only by the aspect of additional conventional generating plants, where minimal negative environmental externalities are acceptable. The overall market of the conventional electric-power system is in most cases of monopoly structure in state ownership, where the possibility of choice for consumers is very small or almost none, and there is no concern about the risk or interruption of electricity supply due to the constant state support to the energy sector. On the

other side, *sustainable electricity system* is characterized by condition in which the citizens are aware of the problem and relation between energy and environment, and therefore use energy efficiently. Within this system, environment and factors that affect the environment represent a major role and are an important initiator of entire activity, while the energy security relates to the diversification of production technologies. Sustainable electric-power system includes the production of large-scale electricity from renewable sources, but also environmentally acceptable micro production for small companies or individuals; then implies a smaller energy dependence based on imported oil; reducing the energy demand due to change in consumers' behavior and energy-efficiency measures; compliance of production capacities with the transmission and distribution network due to the good coordination of economic subjects and regulatory bodies. It is considered that the market structure of sustainable power system is liberalized, privatized and competitive, that provides consumers the possibility of choice of energy operator, while the risks (e.g. for the market supply of energy) should be borne the companies for themselves, with the monitoring and control of energy regulatory agencies [8].

Sustainable electric-power system must ensure the sustainability in each and the balance between all three components of its development, where is additionally emphasized the reliability of system, continuous availability of electricity of satisfactory quality for all consumers in the market, energy efficiency and economic efficiency, environmental impacts, and other.

Conclusions and directions of feather researches. The security of electricity supply is a recent term, and appears with the liberalization and restructuring of the electric-power industry. In recent years, security of electricity supply is becoming one of the most important issues in an open and partially competitive electric-power market. Security of electricity supply is a necessary precondition in the sustainable functioning of economy and human activity, and lifestyle of a modern human.

The availability and usage of energy, particularly electricity, is considered a key segment in the global discussion of sustainable development. Therefore, security of electricity supply is an extremely important determinant of sustainable development. Electric-power system must ensure the reliable and continuous electricity supply to all, and meet the total needs of everyone, at any time and at a reasonable price. It is considered that the same is the basic premise of improving social conditions and living standard of population.

The current demands for electricity must not prevent the satisfaction of needs in the future. Electric-power system must find a way, how from scarce energy resources ensure stable and continuous supply. Possible solutions are the development of new energy technologies, improving energy efficiency and effectiveness, and the introduction and improvement of renewable-energy sources. Using renewable-energy sources like energy of wind, Sun or tides, besides leaving the possibility of usage of fossil fuels in the future, significantly contributes to the environmental aspect of sustainability. In this sense, the problem of electricity production in the long-term and its stable supply gains further significance, as an extremely important area for further researches.

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Н. Денона Боговіч, Л. Церовіч, Д. Марадін

Безпека поставок електроенергії як вирішальний фактор сталого розвитку

У статті визначаються термін «енергетична безпека» та його сегменти. Аналізується роль безпеки поставок електроенергії в стійкому розвитку. Також підкреслюється важливість безпечного енергопостачання як ключового фактора стабільно функціонуючого сучасного суспільства.

Ключові слова: енергетика, безпека поставок, сталість системи електроенергії.

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Безопасности поставок электроэнергии как решающий фактор устойчивого развития

В статье определяются термин «энергетическая безопасность» и его сегменты. Анализируется роль безопасности поставок электроэнергии в устойчивом развитии. Также подчеркивается важность безопасного энергоснабжения как ключевого фактора хорошо функционирующего современного общества.

Ключевые слова: энергетика, безопасность поставок, устойчивость система электричества.

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