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МОДЕЛЮВАННЯ ФАЗОВИХ ПРОЦЕСІВ У СОРБЦІЙНИХ ТЕРМОТРАНСФОРМАТОРАХ

Б.Х. Драганов, В.В. Козирський

Наведено математичну модель гідродинаміки гетерогенних середовищ в ейлерових змінних в умовах циліндричної симетрії. Виконано аналіз досліджень течії багатокомпонентної суміші, один із компонентів якої конденсується. Розглянуто дифузійні процеси в сорбційних термотрансформаторах.

Ключові слова: математичне моделювання, гетерогенне середовище, дискретне середовише, термодинамічна рівновага, хімічний потенціал Гіббса, стала Больцмана, макроскопічна дифузія, пористе середовище, ентропія

MODELLING OF PROCESSES IN THE SORPTION PHASE THERMOTRANSFORMERS

B. Draganov, V. Kozyrskiy

The mathematical model of fluid dynamics in heterogeneous environments Euler variables in a cylindrical symmetry. The analysis studies the flow of a multicomponent mixture, one component of which is condensed. We consider the diffusion processes in the sorption thermotransformers.

Keywords: mathematical modeling, heterogeneous environment, a discrete medium, thermodynamic equilibrium, the chemical potential of Gibbs, Boltzmann constant, macroscopic diffusion, porous medium, entropy

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SMART GRID AS AN INNOVATION BASE OF DEVELOPMENT OF ELECTRICAL ENERGY

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The work is devoted to the strategy of future energy development, implementation of Smart Grid technologies in heavy growth of distributed generation.

Keywords: Smart Grid, distributed generation, energy development, GRID technologies

The new ideology of construction and operation of electrical networks and systems of power requires significant investment and should be implemented consistently on several parallel and coordinated areas that include:

• development of new alternative and traditional technologies of generation and energy storage;

• development of a new promising concept of the structure of distribution networks, methods of optimization of their parameters;

• improving management operating power grids considering broader integration into these sources of dispersion generation;

• creation and implementation of new communication technologies for sharing information between the electricity distribution companies and consumers;

• development of innovative hardware and software protection and automation of power grids;

• improving the regulatory and tariff policy in the direction of trades - the sale of energy and other services in real time;

• energy market reforms with a view to further liberalization.

Implementation of the above stages of transformation of the energy sector requires the formulation and solution of a large group of technical, economic, organizational issues and problems, most of which are still in the world almost never seen [1, 3].

In the near future, thousands or millions of users become owners of their own generators, thus becoming both producers and consumers of electricity. In addition of productive capacity of local systems of power leads to the need for costly upgrades to transmission lines and transformers, and indicates the potential value of small, dispersed generators. Producing a certain amount of energy within the local network, small generators can reduce the load by power systems equipment. All these generators are connected to each other through a fully interactive intelligent electricity network. However, in electricity generation in the network bandwidth problem persists, requiring revision of concepts of distribution structure of electrical networks. This revolution will require careful monitoring and communication technologies to ensure perfect operation of electrical networks, establishing new models for energy distribution and the development of advanced energy technologies in accumulating, power electronics devices, etc.

So the end result should be to create an interactive electricity network, dedicated to providing diverse set of energy services. The sources of distributed generation, which integrate into a network of centralized power supply, be able to work separately or in parallel with the system. Mode of operation must be determined by operational requirements for energy. This flexible architecture of power networks will enable consumers which have its own sources of generation and energy storage and optimized control regimes of power consumption are active participants in the process of energy supply.

Intellectual networks will provide an opportunity to realize the automatic detection of lesions, their prediction and localization. Principles of structure and functioning of such systems should build on GRID technologies, together with the switchgear will be made only by means of measuring systems with data transmission in the so-called think tank management regimes. This will permit networks be completely self-governable and self-restorable in future. Cost effectiveness of their management will be achieved through the possibility of complex effects on the parameters of the regime. For example, the voltage control than using traditional means can be realized by changing the generation of active or reactive power, the influence of the means of energy storage, power consumption control schedule.

The analysis of the situation and problems of World Energy

Today, transmission methods based on the principles of "unilateral" communication, developed many decades ago. The real is that the modern grid will no longer be centralized and will be required to provide the ability of integration a large number of small generators that work, primarily based on renewable energy. Some world tendencies such as lack of energy resources, increasing competition for resources and global warming prove necessity to increase the efficient use of energy. According to the forecasts of the International Energy Agency, by 2030 the needs of mankind in the electric power will rise to 30,116 billion kilowatt·hour, that more than twofold exceeds modern demand.

Due to growing consumption of electric power, energy grids were at the interface exceeded the estimated load, so Energy Company throughout the world face the same dilemma:

- steady growth requirements as power supply;
- conservative tariff policy of regulatory authorities makes it impossible to modernize and upgrade infrastructure.

Most networks of power the world built in the 50's and 70's of last century, so Data currently a lot of equipment that is essential for networking, approaching the end of the period of operation. However, the current state does not allow full-scale modernization exercise, so Network Company forced to work with equipment that has exhausted resource. This tendency poses a threat to reliability and safety of energy systems.

Growth capacity of peak load requires the full resources mobilization of network possibility. Today in the energy markets of almost all countries of the world are increasing volumes of electricity consumption, consequently, increase peak load, which makes to increase electrical power. Thus, the energy company's global waiting for permanent growth energy consumption, respectively, increase capacity of transport and distribution networks. With this in mind, economic incentives includes, when electricity sector is available for integration of small generation to power.

In the manufacture of electric power by generators large number of low power, from the economic point of view, its more reasonably to place the generator closer to the consumer to reduce losses in electric networks. Due to this many small sources of electric power generation embedded in the network, which originally created under big centralized power station. This tendency can significantly change the model of traditional distribution of electric power. Distributive network is designed to automatically regulate the voltage within tolerances, and the presence of large number of small generators significantly changes the ideology of supervisory control, particularly in the part of the regulation voltage, of relay protection and emergency automatics. Classical networks doesn't create to work with the complex modes of management of energy flows, which appear with the transition to distributed generation, such as unexpected reverse flow affiliated to aside generators in closed or "conditionally" closed distribution networks.

Development decentralize Power Systems

One of the main directions of possible development decentralizes generation one must consider the organization of predicted structural association with many local sources. This trend can realize the benefits of known electric power systems with parallel working of small generation sources to the corresponding system of independent sources: increasing electricity reliability and reduce the necessary set of power.

Moreover, this approach allows to create enough mighty source generation with unique properties, which are capable of to act as an organized unit of generation, making it possible to supervisory control of large power system. This trend promotes elimination of almost all dissolution of divergence between large and small sources of generation of electric energy, creating a level condition of competition between them. Realization of related methods and technical devices combining local sources of energy among themselves and with external networks relies on the so-called intelligent network. They are necessary for the exercise of the functions of optimal control and monitor the performance of all elements inside consumer network, including keeping mutual settlements between owners of some sources and functions of management by all generators of the association from the regional energy system.

Thus, energy infrastructure networks must become more "reasonable" for the energy distribution obtained from various sources. Networks should be able to manage the transfer of energy and its consumption, and, do it in real time with maximum efficiency and through the use of new measurement technologies.

Create "smart networks", better known under the original name of Smart Grid, should solve all these problems.

What is Smart Grid?

Smart Grid is a term that describes the transmission system, distribution and consumption of modern integrated digital and information technologies to improve the quality of power supply and optimization of power consumption in real time. Determination of the merits of intelligent networks can be understood with the goal create of intelligent networks and technologies that they implement. The goals of the Smart Grid in general pursue the following key tasks:

• improve the reliability of electricity supply and unfailing of the system (must to say that the beginning of the concept of Smart Grid in the USA put a number of major system failures in the country);

• energy efficiency;

• preservation of the environment.

Based on this goal, as well as referring to reviews and analysis of the concept of Smart Grid in the world, are the following key segments, which greatly affect the development of technologies Smart Grid:

• accounting of energy;

• automation of distribution networks;

• management and monitoring of electrical equipment;

• automation of electric transmission lines and substations and control node overflows;

• electric network and the customer;

• development of distributed generation based on alternative and renewable energy.

For these segments are the following technologies that are understood today, the term Smart Grid for different segments:

• automation of accounting and information systems users;

• communication infrastructure of power objective;

• system of monitoring and management of electrical equipment;

• automation systems to improve surely and supply reliability;

• systems that provide integration of low power energy sources and reservoirs;

• data management system;

• management of operative network service.

Combined into a single platform, these technologies enable a new approach to the construction of electrical networks, moving from a rigid structure "generation - network - consumer" to a more flexible, in which each node of the network can be an active element. Besides that, intelligent network automatically conducts node reconfiguration of joint when conditions changing.

Intelligent Smart Grid provides infrastructure services, forming the market of integrated distributed energy resources and management programs.

The main components of the Smart Grid are:

• intelligent measuring system;

• automated distribution of electric power, control and management of power supply

• automation of substations and distribution networks;

• asset management company.

Architecture Smart Grid

One of the key factors of implementing Smart Grid is the energy of the external network, combined with energy storage and use of own resources (both traditional and renewable) consumers who can control the schedule of consumption, depending on their needs and prices. The optimization problem requires the development and refinement of algorithms operating local power supply system as a subsystem of the external network. Clearly, such a system should work in automatic mode to control power consumption in real time.

Combining the architecture of Smart Grid functions graduated consumption of electrical energy in specified time intervals with software to control and manage the optimum balance of energy from diverse sources of local power grid, consumers can minimize their cost of power consumption. As the price of electricity increases during periods of high demand and decreases in intepeak and night hours, some consumers who would use such approaches can at times reduce the cost of electricity. Principles of Smart Grid architecture based on technology design generation mode, power consumption and optimal functioning of the local energy system as a subsystem of the external network.

It is important to note that in the near future structure of electricity consumers will change by increasing the fleet of electric vehicles. This will give opportunity to accumulate significant amounts of electricity to the car battery.

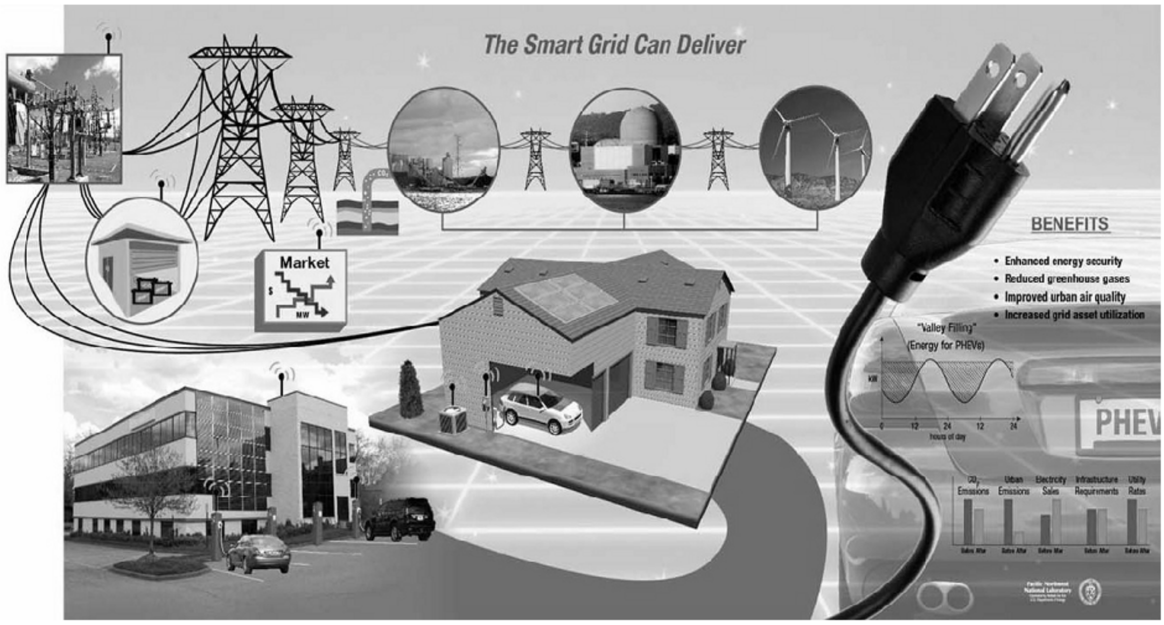

Fig.1. Smart Grid Diagram (Source: Department of Energy of U.S.)

Areas of the concept of Smart Grid

Generation of electricity. Problem of climate change on Earth and predicted shortage of fossil fuels contributes to the development of alternative sources of electricity. It is expected that in future the number of such sources will grow steadily, that generating capacity will be more distributed than concentrated, as now. A characteristic feature of these sources is their relatively low power and instability of parameters of power generation.

Obviously, to stabilize the parameters of such sources and their automatic synchronization with the network requires a "smart" controller. Development of a fundamentally new and improve technical and economic efficiency of existing power generation systems, automatic control of them, communication systems, which provide information exchange such sources with other elements of power is one of the directions of the concept of Smart Grid.

Transmission and distribution. Another focus of the concept of Smart Grid is to improve existing and develop new systems, transmission and distribution. Today, a highly desirable from the standpoint of economy, stability of power systems, and their reliability is to consider the concepts of network structure and systems management by them at the perspective of not less than 50 years, the most efficient ways to adapt existing systems to the prevailing in the new development concept.

The main problem of power, from the point of view of ecology and behavior of the energy is lost electricity. Inefficient use of energy rescores due to losses deteriorating environmental conditions. Moreover, the magnitude of losses directly related to electricity tariffs. Measures to reduce losses include the introduction of new technical solutions in the system of transmission and distribution of electric power, particularly transfer network in the closed mode. The most effective of them belong to the concept of Smart Grid.

Consumption of electric power. Smart Grid technology works through a system of "smart" meters installed in factories and living quarters. They inform about energy consumption, which allows adjusting the use of electrical equipment in time and optimally managing electricity consumption. The principle of optimal consumption of electrical energy is associated primarily with differential rates and the possibility of generation of it from renewable sources or using the drive. However, the beliefs people move to the optimal energy consumption may come into conflict with their comfort. This means that the principles of optimal energy consumption should be implemented automatically. Algorithms management of appliances takes over the "clever" counter - "Smart Meter". «Smart Meter» should be the element that connects intelligent networks. Its will be task exactly for it to direct consumption of electric power. This is especially important given the increase in the share of renewable electricity in the total volume of it consumption and the stochastic nature of its provision. It is the responsibility of Smart Grid for household electricity consumption.

Connecting systems and data communications between electricity facilities. Today, communication and information transfer between different objects using different communication channels. Recently, more and more network technology Ethernet / Internet begin to apply. Primarily, its because cheap, a wide prevalence and widespread availability of such networks with well-developed technology that in future creates the conditions to exchange huge amounts of information from various components of power, that strew by large area. Promising for applications in Smart Grid is the technology of modern wireless communications such as cellular networks, WiMAX, Wi-Fi ets, fiber-optic channels and broadband technology by wire high-voltage power lines.

Accounting systems of power. Microprocessor energy meters appeared on the market for a long time and are one of the basic elements in the concept of Smart Grid. Multi-microprocessor meters, that capable of performing calculations, communicate with other similar meters, collect information and transmit it to network data collection practically applied in power long ago. Modern electricity meters, tools of communication, and data management that allows the transmission of measurement results and to intelligent management in real time regime, become standard elements of architecture Smart Grid.

Introduction of Smart Grids technology requires a higher level of functional possibility of the measuring system and its transformation and intelligent measurement system for:

- Encouraging consumers to improve the technology of Smart Grid based on monitoring of generation, distribution and consumption of electricity, including the results of management regimes using measuring systems;
- The possibility of forming a flexible tariff policy, molding the uniformity of the daily workload in the united power system;
- Possibility of quick and accurate diagnosis through the timely provision of information during the liquidation of emergency outages of equipment and control systems, localization errors;
- Increase the reliability, speed of operation and functionality means of operational equipment and software applications by implementing various communication infrastructure of distribution and supply of electric energy;
- Ensuring the refined and timely data for asset management and energy enterprises operating costs.

Further development of intelligent electricity metering will create preconditions for the introduction of dynamic rates, that why these achievements fully comply with the concept of Smart Grid.

Relay protection. By the new concept of Smart Grid relaying must be combined with the functions of information-measuring system. Microprocessor relaying measure currents, voltages in vector form, record and accumulate information about the emergency and operation modes. This information can be directly used in future control-information-measuring systems Smart Grid. As for the relaying algorithms, they undergo significant changes due to changes in the principles of construction of electricity networks, that there are emergence a large number of managed components in this network that affect the modes of the network, such as instantaneous reactive power compensators, fast current limiting-devices and t. e. This is only the first steps in the reorganization of relaying. Already seriously discusses adaptive relay protection, protection of warning functions, multidimensional relay protection, protection of fuzzy logic, protection from artificial intelligence, security based on neural networks, etc.

Combined into a single platform, Smart Grid technology will allow a new approach to the construction of electrical networks, moving from a rigid structure "generation - network - consumer" to a more flexible, in which each node of the network can be an active element. This intelligent network automatically be able to change the configuration by changing conditions.

Trends in Smart Grid in the world

Governments, members of the European Union plan to reduce electricity consumption by 9% by 2017 due to energy efficiency by implementing Smart Grid technologies. Thus, the using of "intellectual" network will reduce energy consumption. Today appears a unique opportunity to transform an outdated system of all electricity in the world. By deploying high-precision and high-speed information resources Smart Grid, energy companies can manage the entire supply chain as a single system. Thus consumers will be able to accurately plan and manage their energy consumption and regulatory framework can create intelligent energy infrastructure. Such energy networks improvement promoted by governments as a way of solving problems of energy security, global warming, and power grid reliability.

In 2010, according Zpryme Research & Consulting, among countries that have invested in technology development of Smart Grid, China and the USA are leading. The draft shows Top 10 countries by size of investments in technology Smart Grid.

About the development of SMART GRID in Ukraine

Electricity production in Ukraine in 2010 increased by 8.7%. Production of electric power by power plants that are part of IPS of Ukraine, , in 2010 reached 187 billion 910.1 million kW-h, according to available data. According to official data, loss of energy networks in Ukraine up to 2010 amounted to 12.92% with standard 12.65. Alternative energy sources produced about 5.4 million kW-h of electricity in 2010.

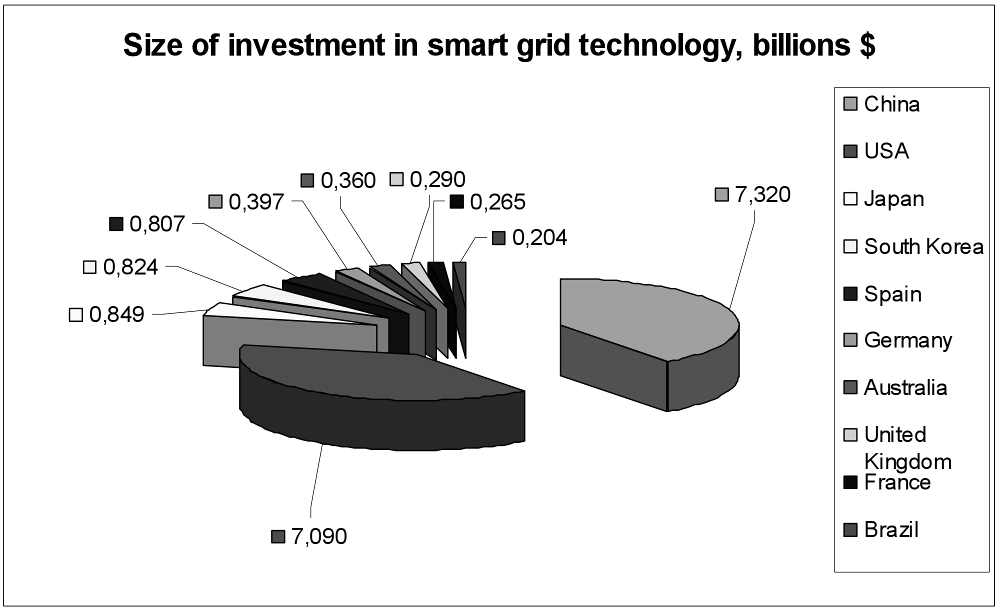

Fig.2. Investment in Smart Grid Technology

Ukraine's energy sector needs reform. According to Western experts, Ukraine is a key state in Eastern Europe with innovative projects in the energy sector. For a long time alternative energy production was in its infancy. Only in 2010 were notable improvements in terms of wind energy and solar panel production in Ukraine. However, due to their high cost for the average Ukrainian, they remain inaccessible. Introduction of automated accounting and information systems for managing energy facilities acquired of significant rates. They have spread predictive control technology of modern buildings. Experts say that the distance between the Ukrainians and the Europeans will quickly decrease due to integration of Ukraine into Europe.

Although the implementation of Smart Grid in Ukraine in the first place necessary innovative approaches and new technologies in general is not just technology. Implementation of the Smart Grid will require a complete rethinking of public policy and modern business models, the real transformation of business processes and consumer behavior.

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SMART GRID ЯК ІННОВАЦІЙНА БАЗА РОЗВИТКУ ЕЛЕКТРОЕНЕРГЕТИКИ

В.В. Козирський, В.В. Каплун

Розглянуто питання щодо стратегії майбутнього розвитку енергетики, впровадження технологій Smart Grid у зв'язку зі зростанням розподіленої генерації.

Ключові слова: Smart Grid, розподілена генерація, розвиток енергетики, GRID-технології

SMART GRID КАК ИННОВАЦИОННАЯ БАЗА РАЗВИТИЯ ЭЛЕКТРОЭНЕРГЕТИКИ

В.В. Козырский, В.В. Каплун

Рассмотрены вопросы, касающиеся будущего развития энергетики, внедрению технологий Smart Grid в связи с ростом распределенной генерации.

Ключевые слова: Smart Grid, распределенная генерация, развитие энергетики, GRID-технологии

УДК 621.314.54

АНАЛІЗ ПУЛЬСАЦІЙ СТРУМУ ВИСОКОВОЛЬТНОГО КАСКАДНОГО ГЕНЕРАТОРА ПОСТІЙНОЇ НАПРУГИ

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Проведено дослідження робочих режимів високовольтного каскадного генератора з нелінійним навантаженням за допомогою аналітичного методу. Для каскадного високовольтного джерела постійного струму здійснено аналітичне дослідження розподілення його напруги у часі та визначено її нелінійну пульсацію. Проведено дослідження залежності амплітуди пульсацій струму та напруги установки.

Ключові слова: каскадне джерело високої напруги, аналітичний метод, амплітуда пульсацій струму, нелінійне навантаження

Каскадні генератори – одні з найрозповсюдженіших джерел високої і надвисокої постійної напруги. Здебільшого вони використовуються для електроживлення різної електрофізичної апаратури, а особливо для високовольтних прискорювачів різних типів. Каскадний генератор складається, зазвичай, з 4–10 каскадів. Спеціальні схеми включення з використанням випрямлячів і конденсаторів забезпечують збільшення напруги в кожному каскаді (порівняно з попереднім) на величину подвоєної амплітудної напруги високовольтного трансформатора, підключеного до першого каскаду.
