ANALYSIS OF APPROACHES TO THE ELECTRICAL ENERGY MANAGEMENT SYSTEM IN MICROGRIDS

Sobirov Muzaffar Azatovich
Acting associate professor of the Department of
Mathematics and information technology
Renaissance University of Education
Tashkent, Uzbekistan
m.sobirov@renessans-edu.uz
https://orcid.org/0009-0000-4719-9481

Abstract*—Today, based on new principles, the structure that connects the reliable communication between the producer and the consumer, which plays a leading role in the modernization of the entire energy industry in the electric power system, is attached to the power grid.*

Based on various situations, taking into account the operational situation, modern technologies used in electric power networks based on the adaptation of equipment characteristics, production and active relations with consumers allow to create a perfectly functioning system. It includes modern information diagnostic systems using modern information technologies, as well as automation and control of all types of elements. Electricity can be combined in production, transmission and consumption processes.

This article presents an approach to solving the problem of monitoring hybrid intelligent energy systems in today's power supply sources and predicting electrical loads of the electric network based on intelligent systems. Such systems consist of expert systems and artificial neural networks. The main areas of application of the neural network methodology in the field of energy are considered, and it is based on

the development of the automation of energy system design, the functional and informational model of the system.

Keywords— *decentralized, grid, multi-leveled, necessary, generators, commercial, consumers, corporating, convenient communication, specification, solution, consumption.*

Introduction

Today, a single power system is a unique organizational and technical object, the structure and management of which is built on a hierarchical Principle, ensuring a balanced unity of generation, distribution and consumption [1].

The scattered generation implies the following:

- Distribution of generating sources along a general-purpose Network close to electricity consumption nodes;
- For the presence of a large number of consumers generating electricity own needs, orientation of its excess to the general network;
- In order to improve the reliability and quality of electricity supply based on the demands of consumers, it is necessary to use the capabilities of IES AAS and coordinate the generating sources of electricity.

An even more important feature is the ability to allocate a local source for autonomous power supply to the neighboring network in the event of serious failures in the network [2].

This also includes the needs of the power plants themselves, the loss of which significantly prolongs the time to eliminate the accident. The function of separating local sources for power supply for power plants and nearby consumers for their own needs is achieved through special divider automation.

As practice shows, both of these requirements in many cases turn out to be unfulfilled in the design of gas turbine and gas turbine units.

ANALYSIS OF LITERATURE ON THE SUBJECT

A Virtual power plant – is a single unit of control of many small generators located in residential areas, hospitals and offices. The organization of the joint operation of distributed generators requires the fulfillment of special conditions necessary to ensure stable, reliable operation in trouble-free activated, deactivated and operating conditions. Difficulties are exacerbated by the difference in type and power that their energy consumption belongs to non-stationary subjects [3].

Distributed generators - have negligible power and complicate ups dispatch control due to the uncertainty of operating modes. Combining many small generators under one control frees up a system - wide control unit that deals not with each individual generator, but with one sufficiently powerful energy source a virtual power plant. Thus, virtual power plants are more convenient management facilities for the system operator than the small distributed generation sources they replace, as they have reliable, planned and managed correspondence together. As a rule, the structure of such a station includes an energy storage system [4].

Fig.1. Review of Energy Management System Approaches in Microgrids.

The advantages of the technology are the automation of the delivery of the planned power target to the active power management systems at the power plant (GRAM, SAUM).

It has the following advantages:

• reducing the load on the operational staff of the station;

• increasing the speed and reliability of information delivery.

Fig.1. Management in an energy system with distributed production.

In the Energy Exchange mode with the energy system, the dispatch center receives assignments from the system operator and redistributes them between distributed generators, ensuring the maximum efficiency of the entire virtual power plant (Fig.1.)

The use of a distributed generation puts new organizational tasks for the formation of an energy system:

- setting the conditions and discipline of connecting individual generators to the network low power;
- distributed producer asset management strategy;
- network connection standards;
- forming price signals in the feedback loop;

- environmental protection.
- measurement and calculation of consumer tariffs, transport tariffs.

Understanding Smart Grids.

Smart grids are the evolution of conventional power grids, integrating digital technology, communication networks, and advanced sensors to optimize the generation, distribution, and consumption of electricity. The driving force behind smart grids is the need for greater flexibility, improved efficiency, and the integration of renewable energy sources. Here's a closer look at their key components and benefits:

Advanced Metering Infrastructure (AMI):

Smart grids deploy smart meters that provide real-time data on energy consumption, enabling consumers to monitor and manage their usage efficiently. This promotes energy conservation and empowers consumers to make informed decisions about their energy consumption.

Distribution Automation:

Automated systems detect and respond to faults in the grid, reducing downtime and minimizing the impact of outages. This feature enhances reliability and decreases the duration of power disruptions.

Renewable Energy Integration:

Smart grids accommodate the intermittent nature of renewable energy sources like solar and wind. They can dynamically adjust power distribution based on the availability of these sources, ensuring efficient use and reducing waste.

Demand Response:

Smart grids facilitate demand response programs, allowing utilities to incentivize consumers to reduce their energy usage during peak demand periods. This helps avoid grid overloads and stabilizes energy prices.

Grid Intelligence: Advanced analytics and machine learning algorithms analyze grid data to predict demand patterns, optimize energy flow, and improve overall grid efficiency.

When asynchronous work occurs, the local control center's intelligent control system switches the territory's energy system to island mode by customizing

ISSN 3060-4567

the virtual power plant, preventing generation sources from escaping. Thus, the AAS of the territory's energy system increases the reliability and survivability of the system in the event of a cascading accident risk. In addition, in the self-treatment mode of the automated energy complex of the territory, it is possible to increase the reliability of the system to the level of "N-k" in the future.

A the local level, management functions can be carried out by various enterprises (including network, energy sales, producer and energy service companies), the activities of which are coordinated by the network governing body of the local executive (on energy supply).

ANALYSIS AND RESULTS

System Modes - is its state at any time or interval of time. The mode of the system is determined by the parameters of the mode - indicators that depend on the change of the mode. Mode parameters include voltages at different points of the mode, currents in its elements, divergence angles of EMF and voltage vectors, active and reactive powers, etc [5].

Microtarms are typically defined as low voltage networks with distributed generation sources, local storage devices, and controlled loads (e.g. heaters and air conditioners). The total installed capacity of this system varies from a few hundred kilowatts to several megawatts. A distinctive feature of microtarches is that, despite operating in the distribution system, they can automatically switch to an isolated state in the event of network failures and restore synchronization with the network after the failure is eliminated.

In the future, it is assumed that the operation of the energy system will be carried out through a close interaction between centralized and distributed decentralized production capacities. Distributed generator management can be combined into a single block of microtarches or "virtual" power plants that are integrated into both the network and the electricity and power market, helping to increase the role of the consumer in the management of the energy system.

Most often, microtarms are called virtual power plants (henceforth referred to in the text as WPP), since they are essentially a combination of demand management programs and distributed energy sources, allowing the dispatcher to model them as sources of production. WPS allows energy companies to manage a large number of consumers with a large volume (capacity), which affects the set of capabilities of their commercial operations. In this context, the use of wind farms provides a closer connection between the wholesale and retail markets by controlling the transmission system and distribution system, and creates a double flow of electricity and money, providing a deeply integrated optimization system with everything necessary for efficient operation. complex smartgrid control.

Demand response programs are similar in many ways to the performance of the traditional generation. For example, in the demand response program, the client, as a special condition, determines that the utility company cannot turn off the air conditioning system more than once a day. Otherwise, frequent delays can lead to consumers abandoning such programs.

In addition, the consumer can program the energy company to activate the dishwasher every two hours. This request, like the previous one, corresponds to the minimum downtime at the production facility, which makes most of the features of the demand response program similar to the operation of a conventional power plant.

In this regard, WPP represents a new generation of demand management system as a holistic strategic resource for an energy company. As these programs moved from manual (non-automatic) industrial load control systems to direct control of the load of home air conditioning and heating systems, and then “advanced” load management with flexible prices, customer needs grew steadily. energy system to satisfy them in real time. Currently, wind farms help to establish a stronger connection between consumer and commercial transactions.

IES AAS technologies make it possible to implement fundamentally new concepts, in particular, include microgrids.

Smart microtars include local sources of backup power and energy storage, have a high level of flexibility and allow connecting a wider range of generating energy sources, including those that are difficult to integrate for a centralized energy system: wind and sun.

Microtars will be part of the national energy system: they will connect to regional networks, and through them to national power networks. Electricity from microtarves is directed to consumers and again to regional networks, depending on demand and supply conditions.

(Fig.2.) Microgrid System.

Real-time monitoring and regulation ensures the exchange of information and allows all deliveries to be processed instantly at the national level. In doing so, consumers will be able to adjust the electricity supply based on their needs. Energy-consuming devices inside residential buildings and factories are connected to the microtarm through sensors and control systems.

Microtarches connected to an autonomous or national energy grid can be placed close to consumers (small towns, villages, factories) and "generate electricity on the spot", greatly reducing transmission losses through wires and thus increasing efficiency by 35 to 40%. 80% to 26. Intelligent microtarrains allow to effectively meet the growing consumer demand due to the increased supply of electricity from renewable energy sources.

The effectiveness of the introduction of Smart microtarves, according to US scientists, can be four times higher than the efficiency of existing networks due to the benefits obtained in the economy, reliability and efficiency of the use of energy by the consumer. In a microgrid, energy resources cannot be fully “planned”; intellectual systems are integrated with communication infrastructure to provide control on the demand side and, through this, balance between supply and demand. The microgrid principle can be applied much more broadly than geographic Islands (Fig.3.)

(Fig.3) – Microgrids

The following advantages of microgrids are highlighted (however, each project requires careful evaluation of benefits and costs):

- energy efficiency;
- minimizing total energy consumption;
- improving environmental impact;
- improve system reliability and stability;

- benefits for the network complex;
- Cost-effective strategies for replacing electrical infrastructure.

In the European Union, from 2003 to 2006, a major research project called Microgrid was carried out, aimed at studying various aspects of microgrid activity. A continuation of this project from 2006 to 2010 was the More-Microgrids project, which involved 11 states of the European Union.

As part of this project, a microgrid was built on the Greek island of Kithnos. Let's consider this as an example of a microgrid that is already working (Fig. 3). This system is a single-phase microtarm consisting of overhead lines and communication cables running parallel to them. The system connects 12 houses. This network is used to test centralized and decentralized offline management strategies, as well as communication protocols, which are the main problem for such microgrids.

Conclusion

Today, in modern energy supply systems [10], it is necessary to comply with the requirements for increasing the reliability of information developed by information systems in order to ensure decision-making in the production of power [11]. Based on this, the used models and decision-making methods should be applied with data exchange.

Based on the demand of consumers for information resources, it is implemented using programs and methods in the implementation of energy problems with the help of mathematical models. Part of the information can be obtained through communication channels for objective reasons related to its impossibility [12],… [13].

The efficiency of electricity consumption for industrial enterprises is determined by the necessary quantity and timely supply of electricity of the specified quality, the condition for ensuring the technological process with minimal losses and the reliable and stable operation of electricity receivers. The most important part of energy efficiency measures is to reduce energy losses.

Reactive power compensation allows increasing the efficiency of energy use in three main directions: increasing the power of lines and transformers, reducing active energy losses, and normalizing voltage.

REFERENCES

1. Muqeet H.A, Javed H, Akhter MN, Shahzad M, Munir HM, Nadeem MU, Bukhari SSH, Huba M. Sustainable Solutions for Advanced Energy Management System of Campus Microgrids: Model Opportunities and Future Challenges. Sensors (Basel). 2022 Mar 18;22(6):2345. doi: 10.3390/s22062345.

2. I. Siddikov, K. Khujamatov, E. Reypnazarov and D. Khasanov, "CRN and 5G based IoT: Applications, Challenges and Opportunities," 2021 International Conference on Information Science and Communications Technologies (ICISCT), Tashkent, Uzbekistan, 2021, pp. 1-5, doi: 10.1109/ICISCT52966.2021.9670105.

3. I. Akhtar, A. Altamimi, Z. A. Khan, B. Alojaiman, M. Alghassab and S. Kirmani, "Reliability Analysis and Economic Prospect of Wind Energy Sources Incorporated Microgrid System for Smart Buildings Environment," in IEEE Access, vol. 11, pp. 62013-62027, 2023, doi: 10.1109/ACCESS.2023.3287832.

4. M. A. Sobirov, I. S. Kurbanova, S. I. Hamrayeva and Z. O. Sabirova, "Analysis of Mathematical Modeling Model in Power Supply Systems," 2023 IEEE XVI International Scientific and Technical Conference Actual Problems of Electronic Instrument Engineering (APEIE), Novosibirsk, Russian Federation, 2023, pp. 1570-1573, doi: 10.1109/APEIE59731.2023.10347687.

5. M. A. Sobirov, I. S. Kurbanova and Z. O. Sabirova, "Multi-Level Approach in Organizing the Energy Supply System in Telecommunication Networks," 2023 IEEE XVI International Scientific and Technical Conference Actual Problems of Electronic Instrument Engineering (APEIE), Novosibirsk, Russian Federation, 2023, pp. 1830-1834, doi: 10.1109/APEIE59731.2023.10347846.

6. I. Kuchkarov et al. “Inverse optimal control with continuous updating for a steering behavior model with reference trajectory,” International Conference on Mathematical Optimization Theory and Operations Research. – Cham : Springer International Publishing, 2021, pp. 387-402.

7. I. Muda, M. Sultana, S.A. Quadri, S.A. Qureshi, T. Munawar, & H. M. Awan, “Historical Evolution of Islamic Thoughts and Its Dimensions,” Research, vol.8(2), pp.238-252, 2023.

8. Sattarov, K., & Safarov, A. (2022). Choice of a mathematical model of a current converter based on a galvanomagnetic effect. International Journal of Advanced Logistics, Transport and Engineering, 3(3), 7–11. https://doi.org/10.52167/2790-5829-2022-3-3-7-11

9. J. Djumanov, R. Yakhshibaev, S. Khushvaktov and N. Sayfullaeva, "Mathematical model and software package for calculating the balance of information flow," 2021 International Conference on Information Science and Communications Technologies (ICISCT), Tashkent, Uzbekistan, 2021, pp. 1-6, doi: 10.1109/ICISCT52966.2021.9670277.

10. S. Uguz, S. Redjepov and U. Sahin, "Two states uniform 2D linear cellular automata and some replicating patterns," 2020 International Conference on Information Science and Communications Technologies (ICISCT), Tashkent, Uzbekistan, 2020, pp. 1-6, doi: 10.1109/ICISCT50599.2020.9351515.

11. I.Sh.kurbanova SOCIOLINGUISTIC APPROACH TO THE PROBLEM OF TERMINOLOGY. (2024). Ta'limning Zamonaviy Transformatsiyasi, 6(2), 68-73. http://pedagoglar.org/index.php/03/article/view/1419

12. Abasxanova X.Yu. Osobennosti vnedreniya innovatsionnix texnologiy v selskoye xozyaystvo Uzbekistana [Features of introduction of innovative technologies in agriculture of Uzbekistan]. Mejdunarodniy nauchniy jurnal «Universum: texnicheskiye nauki». 2021, Vipusk: 12(93), chast 7, – S. 24-27 (https://7universum.com/ru/tech(https://scholar.google.com/) [In English].

13. O. Khudayberganov, R. Gaybullaev and S. Redjepov, "2D Adiabatic CA Rules over ℤp," 2022 International Conference on Information Science and Communications Technologies (ICISCT), Tashkent, Uzbekistan, 2022, pp. 1-4, doi: 10.1109/ICISCT55600.2022.10146848.