«Сейфуллин оқулары – 18(2): « XXI ғасыр ғылымы – трансформация дәуірі» халықаралық ғылыми - практикалық конференция материалдары = Материалы международной научно-практической конференции «Сейфуллинские чтения – 18(2): «Наука XXI века – эпоха трансформации » - 2022.- Т.III. Ч.I. – P.146-150

RESEARCH AND JUSTIFICATION OF MEASURES TO REDUCE ELECTRICITY LOSSES IN ELECTRIC NETWORKS WITH A VOLTAGE OF 10-35 KV

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Losses of electricity in networks are considered the main indicators of the efficiency and cost-effectiveness of their work. This is a kind of indicator of energy-saving activities of enterprises. A large number of electricity losses in the networks shows that there are certain problems in this area. Solving these problems is of paramount importance, since energy losses in networks affect the percentage of costs in the final cost of products. The price of products could be much lower for ordinary consumers if the losses of electricity in the networks were minimized.

According to international analysts, the loss of electricity at the level of four or five percent is considered acceptable. With such indicators, the activity of the enterprise is not associated with excessive costs. If we consider the situation from the standpoint of the laws of physics, then the maximum loss of electricity in the networks can be about ten percent.

From the point of view of economics, the consumption of electricity for substations own needs is no different from the consumption in network elements for the transmission of the rest of the electricity to consumers.

The underestimation of the volume of usefully supplied electricity is the same economic loss as the two components described above. The same can be said about the theft of electricity. Thus, all four components of losses described above are the same from an economic point of view.

The actual loss can be divided into four components:

- technical losses of electricity, are formed during the transmission of electricity through electric networks, due to physical processes in wires, cables and electrical equipment;
- the amount of electricity spent for the own needs of substations , necessary to ensure the operation of the technological equipment of substations and the life of the maintenance personnel, determined by the readings of the meters installed at the TSN;
- power losses due to measurement errors (instrumental losses);
- commercial losses due to theft of electricity, interference in the connection scheme, exposure to metering devices with a magnet, inconsistency in meter

readings with payment for electricity by household consumers and other reasons in the field of organizing control over energy consumption. Their value is determined as the difference between the actual (reported) losses and the sum of the first three components.

Technical losses of electricity can be represented by the following structural components:

- no-load losses, including losses in electricity in power transformers, compensating devices (CU), voltage transformers, meters and devices for connecting high-frequency communications, as well as losses in the insulation of cable lines;
- load losses in substation equipment. These include losses in lines and power transformers, as well as losses in measuring complexes of electric energy,
- climatic losses, which include two types of losses: corona losses and losses due to leakage currents in the insulators of overhead lines and substations. Both types are weather dependent. [1].

Technical losses in electrical networks of power supply organizations (power systems) must be calculated for three voltage ranges:

- in supply networks with voltages of 35 kV and above;
- in distribution networks of medium voltage 6 - 10 kV;
- in distribution networks of low voltage 0.38 kV.

Distribution networks 0.38 - 6 - 10 kV, operated by the area of electrical networks, are characterized by a significant share of electricity losses. This is due to the peculiarities of the length, construction, functioning, organization of operation of this type of networks: a large number of elements, branching of circuits, insufficient provision of metering devices of the corresponding class, etc.

At present, technical losses in networks of 0.38 - 6 - 10 kV for each distribution network of power systems are calculated monthly and summarized for a year. The obtained values of losses are used to calculate the planned standard for electricity losses for the next year.

Recently, you can increasingly hear the term Smart Grid, many conferences and discussions on the implementation of this system in the electric power industry of different countries are held on this topic. Let's try to figure out what is a Smart Grid?

Despite the fact that the term Smart Grid has been officially used since 2003 after the publication of M. T. Burr "The demand for reliability will drive investments", a single interpretation of the concept has not yet come.

For the first time this term Smart Grid was used by Massoud Amin and Bruce Vollenberg in the publication "To the intelligent network" in 1998. The first applications were associated with the advertising names of special controllers designed to control the operating mode and synchronization of autonomous wind turbines with the electric grid. Then this term began to be used to refer to microprocessor-based electricity meters capable of independently accumulating, processing, evaluating information and transmitting it via communication channels or the Internet. [2].

The first major project in this area can be considered the Italian project Telegestore, which united 27,000,000 homes using smart meters connected via a digital network using the power line itself. The essence of this project was that devices such as household air conditioners, refrigerators and heaters could adjust their duty cycle to avoid starting during peak network load.

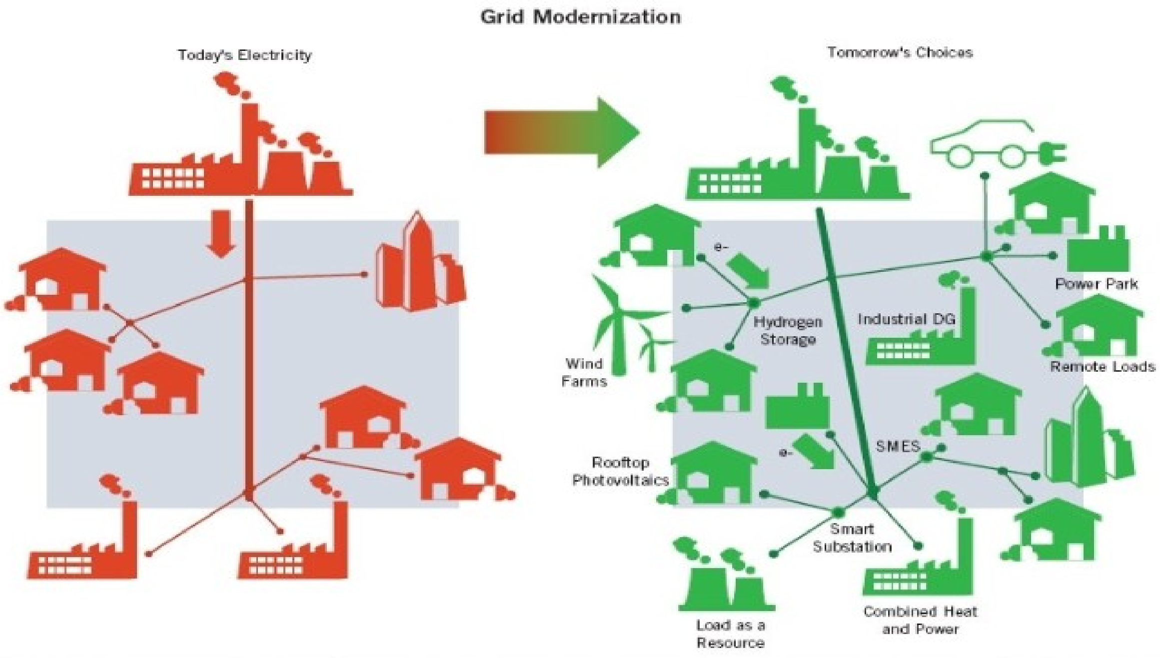
But the impetus for the development of smart grids was the large-scale use of renewable energy sources, which are characterized by the variability of electricity generation both in time and power. All this caused additional difficulties in regulating power and "overflows" in the electrical network. The low potential for increasing the efficiency of the existing technological base of the energy sector, which has practically exhausted the possibilities of increasing the productivity of equipment, also contributed.

As a result, a new concept of electric networks was needed, which would be able to ensure social development, a breakthrough increase in consumer properties and energy efficiency, taking into account all factors of the development of the electric power industry in the future. Smart Grid has become such a concept. [3].

Smart Grid technology is characterized by several innovative properties, such as:

- An active bidirectional scheme of interaction in real-time information exchange between all elements and participants of the network, from power generators to terminal devices of electric consumers.
- Coverage of the entire technological chain of the electric power system from power producers (both central and autonomous) and electric distribution networks to end consumers.
- Ensuring an almost continuous controlled balance between the supply and demand of electric energy. To do this, the network elements must constantly exchange information among themselves about the parameters of electric energy, consumption and generation modes, the amount of energy consumed and planned consumption, commercial information.
- Smart Grid is able to effectively protect itself and self-repair from major failures, natural disasters, external threats.
- From the point of view of the overall economy, Smart Grid contributes to the emergence of new markets, players and services.

Thanks to modern technologies, Smart Grid can be used both on the scale of buildings, enterprises, and for ordinary household electrical devices, such as a refrigerator or washing machine. Accordingly, all devices included in the Smart Grid must be equipped with technical means that carry out information interaction. [4].



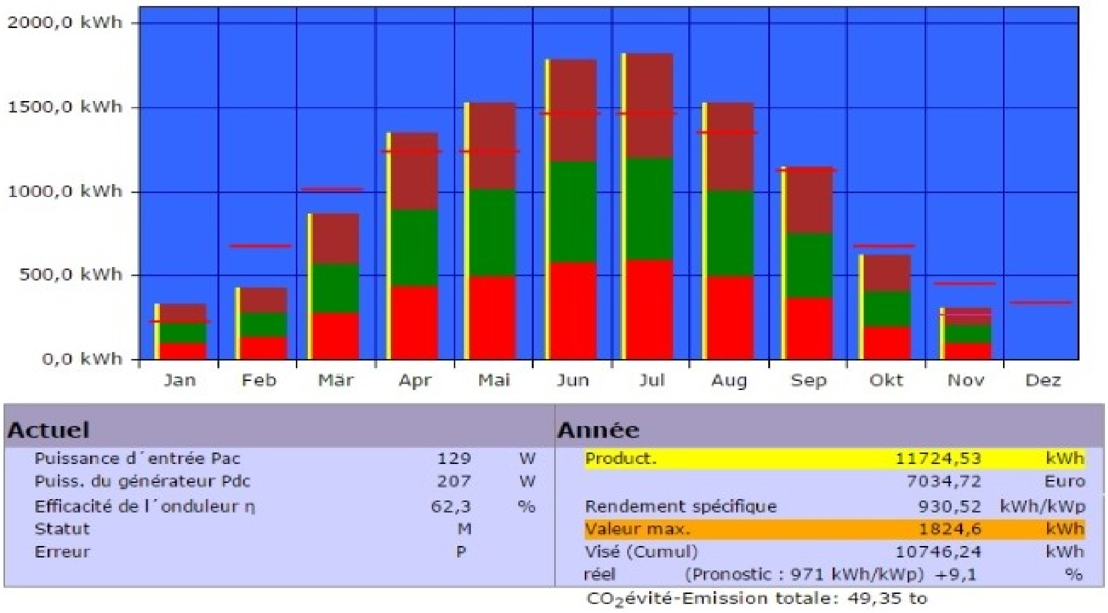
Picture 1 - Comparison of a traditional network and an active adaptive network

Reliability, both informational and physical, plays a very important role in Smart Grid systems. According to the concept, Smart Grid should withstand physical and informational negative impacts without total outages or high costs of restoration work, the fastest possible recovery (self-healing). Many experts express their concerns about the information security of the system. If you try to explain in simple words, then everything that is transmitted over the Internet can be hacked and used for various purposes.

Estimates show that the transition to an innovative development option based on intelligent energy will be accompanied by a significant decrease in the commissioning of new power plants and associated grid facilities for power generation. As a result, the reduction of capital investments is the most significant systemic economic effect.

The second largest effect is the reduction of fuel costs of power plants. An additional effect can be achieved taking into account the economic cost of greenhouse gas emissions.

The manufacturer's website contains information on monitoring systems for photovoltaic installations, which turned out to be extremely common. According to the developer, there are more than 200 thousand solar power plants and almost 1 million inverters connected to the web server of this company in the world. If desired, you can find many systems of private users and pages with data on the consumption and generation of electricity from various systems.



Picture 2 - Manufacturer's website

Of course, this information may be of interest except for the supervisory authorities, but not for the attacker. But some did not stop there and they managed to hack the controller's "firmware". Since this system is mainly being tested, it is possible that the manufacturer will improve the information protection of its product in the near future. [5].

At the moment, the development of "smart networks" is very initial level, most likely, the possibilities and aspects of the introduction of this technology are still being discussed. World experience in the implementation of pilot projects and numerous studies show that the use of intelligent networks in promising and economically justified. At the moment, Smart Grid systems are a natural stage in the development of the electric power industry, taking into account world technical achievements. And by no means should ignore it, moving forward together with the leading powers. It is worth adding to this the fact that for our country there will not be a question of developing basic concepts, because a huge experience has already been accumulated that can be adopted and used already established and working technologies.

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