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# APPLICATION OF ENERGY-SAVING DISTRIBUTION TRANSFORMERS IN INDUSTRIAL ENTERPRISES

**Abstract:**The article analyzes energy-efficient distribution transformers for power supply of industrial enterprises.

**Key words:**Power engineering, economic efficiency, industry, economy, transformer, power engineering facilities, Zhongpeng , energy-saving transformer.

Based on the decisions of the President of the Republic of Uzbekistan, the powers of the Ministry of Energy include the introduction of modern energy-efficient and energy-saving technologies in government agencies and organizations, as well as monitoring the efficiency of energy resource consumption.

One of the decisive conditions for reducing costs and increasing the economic efficiency of production at industrial enterprises is the rational use of energy resources. At the same time, the development of the local economy is possible with the formation and subsequent implementation of energy saving programs at enterprises, which requires the creation of an appropriate methodological base. Delay in the implementation of energy saving measures will cause great economic damage to enterprises and will have a negative impact on the overall environmental and socio-economic situation. In addition, a further increase in costs in industry and other sectors of the economy is accompanied by an increase in the deficit of financial resources, which leads to the renewal of the production base of enterprises in accordance with the achievements of scientific and technological progress [1].

At present, the subject of scientific research is the problems of sustainable development of economic systems on the scale of enterprises, regions, individual industries and the national economy as a whole. The relevance of solving the problems of sustainable development is characterized by the acceleration of the process of changes in modern conditions and the growth of uncertainty both within economic systems and in the external environment.

Examples of active energy conservation policies aimed at reducing inefficient losses in transformers include organizations such as the Department of Energy (DOE) and the Environmental Protection Agency (EPA), which systematically interact with energy companies, disseminate information and related mathematical software that is distributed [2].

One of the natural obstacles to the widespread and rapid implementation of energy efficient distribution transformer models is the highly competitive market economy.

In fact, transformers used in power supply are among the most efficient mechanisms. The efficiency of distribution transformers may be slightly lower, but still around 99%. However, despite the high efficiency of the transformer, losses occur at each section of the movement of electricity due to its conversion into voltage. Even in the most modern networks, transformer conversion losses reach 10%, and at high loads such losses are small or, conversely, high [3].

Specialized energy companies account for up to 90% of all electricity produced in Europe. Their total number is approaching 2000. The remaining 10% is produced by non-specialized enterprises as a by-product or for their own needs - some of the energy can be purchased by operators

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of railway transport, metro, tram, chemical industry, oil and gas industry and large metallurgy enterprises. All of them have their own distribution network. Domestic production of electricity for own needs is based on the availability of gaseous fuel and is growing rapidly: there is reason to believe that in the near future it will account for not 10, but 20% of all electricity produced in Europe. The total production capacity in Europe, shown in Table 1, is 535 million kW, with France and Germany accounting for 35%. In the period up to 2022, about 80 million kW are expected to be added to this capacity, and about 20 million kW will be cancelled [4].

Oil transformers of the TMG12 brand are slightly behind ABB transformers in terms of losses, despite the small difference in price.

Transformers of the Chinese brand Zhongpeng are attractive due to their low cost, however, such large losses compared to other transformers raise doubts about the correctness of choosing these energy-efficient transformers [5].

Of all the energy-saving transformers listed above, the most suitable choice is the 630 kVA dry transformers from the Swiss company ABB EcoDry.

Dry transformers convert electrical energy with a frequency of 50 Hz. In this case, the voltage decreases with an increase in the current load of the consumer relative to the power supply line. In operation, such transformers can be installed both inside and outside the enterprise, since their operating mode allows an external ambient temperature from -60 to +40 degrees. The most common types of oil transformers are EcoDryBasic, EcoDry99Plus and EcoDryUltra [6].

The ABB EcoDry series transformers, shown in Figure 1, have the lowest shunt and short-circuit losses of all general-purpose power transformers sold in the CIS and were selected in accordance with the recommendations of the European Electricity Committee (CENELEC).


**Figure 1 – Energy saving transformer ABB EcoDry Swiss type ABB**

They also have a reduced sound power level. Thus, this series of transformers is energy efficient and low-noise.

The energy-saving transformer ABB EcoDry is a product of the Swiss company ABB and is an extremely efficient dry transformer. These are environmentally friendly and energy-efficient transformers that are the optimal solution for the specified operational loads. These transformers can be used to step down or step up voltage. They are mainly used in power plants, industrial facilities or renewable energy facilities. The core of the transformers is made of amorphous metal or low-loss electrical steel.

The operating principle of the energy-saving ABB EcoDry transformer is based on the phenomenon of electromagnetic induction. The transformer consists of a steel magnetic core and two windings (primary and secondary) located on it. The ABB EcoDry windings are made of insulated wire and are not electrically connected. Electricity is supplied to one of the coils from an alternating current source. This winding is called the primary. Consumers are connected to the other winding of the ABB EcoDry transformer, which is called the secondary.

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The main parts of the ABB EcoDry energy-saving transformer design are: - magnetic system (magnetic circuit); - packages; - cooling system.

Service life T = taken as 25 years.

The value of annual energy losses for transformers is calculated using the following formula: $W_{yil} = T \cdot N \cdot t \cdot ( R_x + k_{yu2} \cdot R_k )$ (1)

where T is the electricity tariff (12%) (T=295 sum); N is the number of days in a year (365 days); t is the number of hours in a day (24 hours); $P_x$ is the net operating power; $R_k$ is the short-circuit power; $k_{ю2}$ is the transformer loading factor.

Total cost of TMG11 transformers for the specified service life, sum: $Ц_{ум} = C_{tr} + W_{year} \cdot T$ , (2)

where is $C_{tr}$ - the price of the transformer; oh my god - cost of electricity losses per year; T – service life of transformers (about 25 years).

To save energy, the energy-saving transformer we are studying:

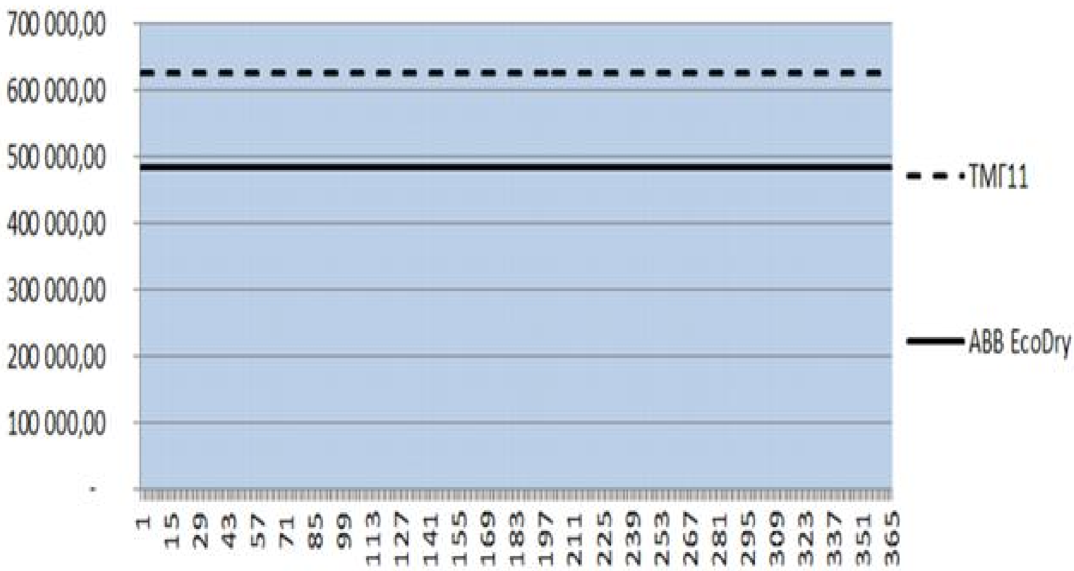
$$Ts_{org.tr} = Ц_{ум\ ТМГ\ 11} - Ц_{ум\ energy\text{-}saving\ tr}, \quad (3)$$

where $Ц_{um\ ТМГ\ 11}$ is the total cost of the initially installed power transformer; $Ц_{um\ energy\text{-}saving\ tr}$ is the total cost of the energy-saving transformer.

In order to save electricity throughout its service life, we study the energy-saving transformer of the year:

$$\Sigma P_{org.tr} = T \cdot (W_{year\ TMG\ 11} - W_{year\ energy\ efficient\ tr}) / T, \quad (4)$$

here T - service life of the transformer (25 years); $W_{year\ TMG\ 11}$ – cost of electricity losses per year of the initially installed power transformer; $W_{year\ energy\ efficient\ TR}$ - annual cost of electricity losses of an energy-efficient transformer; T – electricity tariff (12%).



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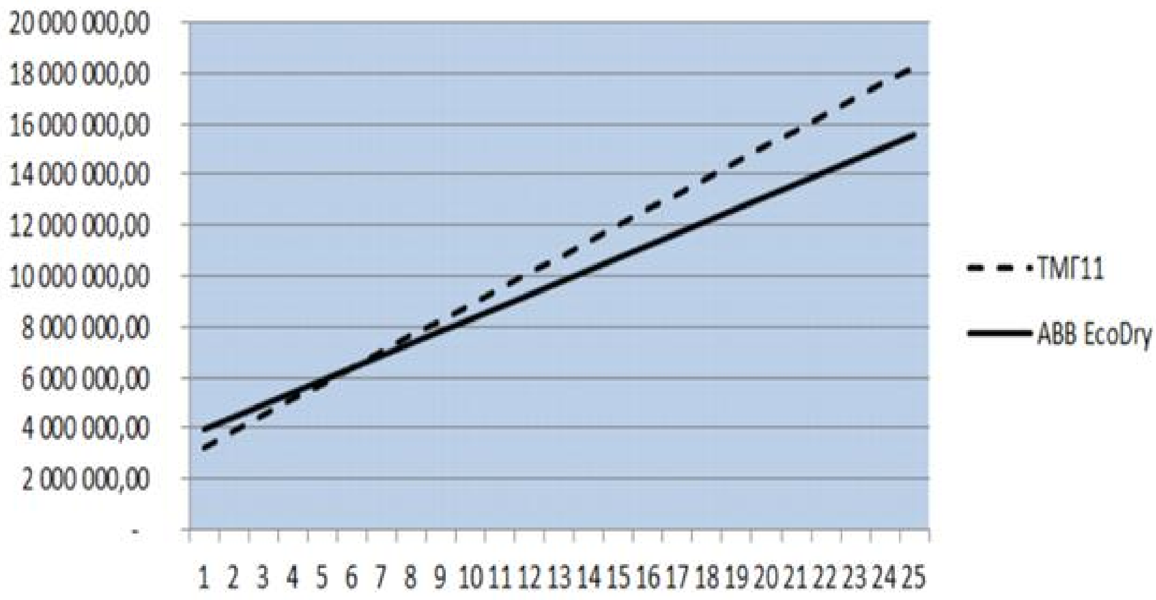


Figure 1 – Comparative characteristics of the cost of electricity losses per year of two types of conventional (TMG11) and energy-saving (ABB EcoDry) transformers

Figure 3. Comparative characteristics of the total cost of two types of traditional (TMG11) and energy-saving (ABB EcoDry) transformers over the entire service life (25 years).

A comparative table of the obtained parameters of all two types of energy-saving transformers, considered on the basis of the energy efficiency calculation presented above, has been compiled.

As can be seen from the table, despite the fact that the energy-saving transformers EcoDry from the Swiss company ABB are the most expensive, they are lower in terms of cost losses and significantly higher in terms of profit than others.

The use of energy-saving transformers in an industrial enterprise allows for energy savings, which additionally allows for the installation and connection of various machines and devices . This will further increase the productivity of manufactured products.

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