# Applying different time enterprises rates for electricity consumption industrial and its impact on the energy system

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**Abstract.** This article calculates the consumption of electricity consumption in the "peak", "half-peak" and night periods due to the application of a time-varying tariff system in an industrial enterprise and the impact on the regime of the energy system, in the article we are discussing about. If a consumer electricity at night, he will be able to pay for each kW·h of electricity consumed at a price 1.5 times lower than during the day. This, in turn, will lead to the long-term operation of networks and transformers, reducing the load period and smoothing the load schedules of the power system.

## 1 Introduction

In any economic system, a certain rates - tariffs - is used to maintain financial settlements between the energy supplier and energy consumers, to pay for electricity consumed. This system of tariffs applied to consumers should be chosen in such a way that it contributes to a certain extent to the elimination of the state of the energy system in the morning and evening "peak" periods.

The following basic requirements should be taken into account when setting electricity tariffs:

• Tariffs represent all the accumulated funds associated with the development, transmission, distribution and planned deductions of electricity and the development of a particular energy system;

• ensure that tariffs reduce costs associated with the production and use of electricity;

• Tariffs are differentiated by regions of the country by season, days of the week, hours of days;

• Tariffs provide incentives to reduce congestion during peak hours and increase congestion during evening hours;

• Tariffs are clearly defined by purpose;

• Tariffs should be as simple as possible to account for and account for energy, and so on [1-3].

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The prices of electricity consumed by consumers are divided into one or more types, i.e., these price allocations are made using different types of tariff systems in different countries. The most common type of tariff system is a single-rate tariff system. Such a tariff system calculates only the fixed price for 1 kWh of consumed electricity.

The prices set for such tariffs and the periods of electricity consumption do not ensure a smooth operation of the load period of the power system. In addition, the single-rate tariff system affects the energy system in the morning and evening "tight" periods of the load period.

Costs and emergencies in the power system should not harm the continuous supply of electricity to consumers.

Currently, enterprises with a relatively stable schedule of electricity loads and a three-shift mode of operation can use time-stratified tariffs to pay for electricity with high efficiency. Time-stratified tariff coefficients for electricity by time periods are currently used in enterprises with a capacity of more than 750 kVA. Currently, the country does not use a system of time-classified tariffs for holidays and weekends [4-6].

The main part of the daily full load schedule in the energy system is the electricity consumption of individual consumers. In addition, the power plants 'own needs and losses in the power grid also play an important role in electricity consumption. The graphs generated daily by the power system are determined by the characteristics of the graphs change based on the load periods of different consumers and their total load shares. The main characteristics of the daily load graphs are the highest and lowest loads, thus resulting in the sum of the average daily load graphs.

If the share of the consumer's energy system in the morning and evening peak periods in the load schedule is high, this can have negative consequences for the system's performance. The density and uniformity of the load schedule in the power system have a strong impact on the normal operation of the system as well as the economy. The higher the unevenness of the load schedule, the higher the cost of the power system, which in turn has an impact on the selling price of electricity. Covering the unevenness of the load schedule is related to these power reserves and fuel consumption costs. Electricity generating devices must be constantly ready to withstand the loading period, or it will be necessary to use the opportunity to change the mode of operation of the power system as a result of the application of a time-varying tariff system. The costs associated with this are reimbursed by the consumer in the form of a separate tariff payment (for connected power).

## 2 Research methods

The methodological provisions are based on the results of theoretical and practical research, in a broad generalization of practical experience in assessing the total energy intensity of products, scientific works of TIIAME and the Scientific and Technical Center of JSC "Uzbekenergo". Practical research was carried out using standard and special developed techniques, the reliability of the results was evaluated by verifying the research results.

## 3 Results and discussion

The purpose of applying the differentiated tariffs in the electricity system for "peak", "half-peak" and night time is to significantly reduce electricity bills. In turn, one of the current problems is the uninterrupted supply of electricity to consumers without quality losses and interruptions. In turn, it is necessary to take into account the "tight" periods in the energy system [7-10].

Electricity consumers (industrial, agricultural or transport, domestic and other consumers) belonging to any tariff group should be involved in the study using the

proposed targeting mechanism, which requires the proposed capacity to coordinate the electricity load schedule in the energy system. It can also be consumers who use the time-stratified tariff system for electricity consumption or consumers who do not currently use these tariffs.

Aligning the load schedule of the power system, in turn, leads to a change in the mode of operation of the system, in which power transmission companies and electricity consumers are directly involved. The following are some of the principles of interdependence between power transmission organizations and electricity consumers:

- conclusion of an appropriate agreement (agreement between electricity supply organizations and electricity consumers);
- government agencies (links between wholesale electricity suppliers and electricity transmission companies);
- installation of modern devices for commercial accounting of electricity consumption (Automated system of accounting and control of electricity consumption (EHNAT) Procurement and installation of appropriate meters can be carried out by consumers themselves or at the expense of electricity transmission organizations);
- all tariff group consumers must provide daily schedules of their electricity loads before participating in the regulation of power system loads (average real graphs of electricity consumption of power transmission companies, industrial, household, utility, transport and other consumers) [11-14].

The population and residential areas, industrial enterprises, factories and plants will be able to pay for electricity at reduced prices as a result of the application of time-stratified tariffs during non-peak hours of the day and eliminate "tight" cycles of the energy system contributes a certain amount to its development.

Time-stratified tariff is a type of periodic payment for electricity consumed and operates on its own system of tariff rates for the following periods of the day (Table 1).

**Table 1.** Time-stratified tariff.

| tariff-1 | **tariff-2** | **tariff-3** | **tariff-4** |
|---|---|---|---|
| Morning is a busy time | Semi-busy time | The evening is busy | Night period |
| 06:00 to 09:00 | 09:00 to 17:00 | 17:00 to 22:00 | 22:00 to 24:00<br>00:00 to 06:00 |

In the three-rate tariff system, classified by time, the amount of payment in the "tight" period is 150%. The amount to be paid during the day is 100%. The amount of the nightly payment is 50%.

Taking into account the above tariff periods, the calculation of time-varying tariff periods for electricity for the three periods (zones) of the day is expressed on the basis of the following equation:

$$EP_{average} = P^p E^p + P^{hp} E^{hp} + P^n E^n; \quad (1)$$

in this: $P_{average}$ – a fixed or average fixed tariff price for consumers;
E – total electricity consumption of consumers;
$P^t$, $P^{st}$, $P^n$ – "peak", "half-peak" and night prices of daily electricity consumption;
$E^t$, $E^{st}$, $E^n$ – "peak", "half-peak" and night periods electricity consumption.

In the electricity market, tariff policies are applied in different ways to regulate, as a result of which high prices can lead to the destruction of the monopoly, prices will be the same, suppliers will not cover the costs of the power plant. Foreign energy markets do not provide a clear development of investment, investment processes in market models are long overdue due to clear initial reforms in the process of electricity generation.

In order to cover the costs of electricity generation, the form of tariffs, taking into account electricity, will greatly help in solving the problem of formation. And to increase the cost of electricity, power plants are one of the most optimal management methods for generating loads. By saving electricity, it is possible to motivate consumers and increase the supply of quality and reliable electricity. Subsequent requirements are very high and will be one of the key factors in regulating the balancing of tariff policy.

The consumer is ready to change electricity tariffs at any time, only when it is an economic benefit for suppliers and consumers in this area. Nevertheless, the transition to time-stratified tariffs requires serious legal production. Defining and approving the norms of power consumption cycles in manufacturing enterprises is socially justified.

The population and residential areas, industrial enterprises, manufacturing enterprises, factories and a number of electricity consuming organizations will be able to pay for electricity at reduced prices as a result of the application of time-varying tariffs during non-peak hours of the day.

Values of minimum and maximum capacities are often used in determining the parameters of power systems. In some calculations, the power values between them are very important. Detailed information on power changes can be obtained using electrical load graphs. There are 3 different types of power consumption period load schedules: daily, seasonal and annual. These power consumption load schedules consist of morning and evening peaks (“peak”) as well as day and night minimum periods (Fig. 1).

In the power system, the demand for electricity by consumers is higher on weekends and in the morning and evening than on weekdays. Therefore, it is advisable to sell the system of time-stratified tariffs to consumers on a periodic basis, depending on the number of working days and days off. As a result of the application of a system of time-varying tariffs, payments for electricity consumed can be increased by “n” times during the “busy” periods, and vice versa at night [5, 15].

Today, consumers of electricity in Uzbekistan use different tariff systems. For example, while the population uses a simple system of tariffs for electricity consumption (295 soums per 1 kW·h in 2020), consumers of industrial enterprises above (mostly) above 750 kVA use a system of time-varying tariffs.

The system of differentiated tariffs for such time has been in force since January 1, 2018 for consumers of (mainly) industrial enterprises in the country above 750 kVA. However, the use of time-varying tariffs during the day should create opportunities for regular monitoring of statistics on the number of consumers, as well as the volume of their electricity consumption and the impact of changing schedules of electrical loads of the single energy system. As a result, it is possible to analyze the results of the use of time-classified tariffs in the country.

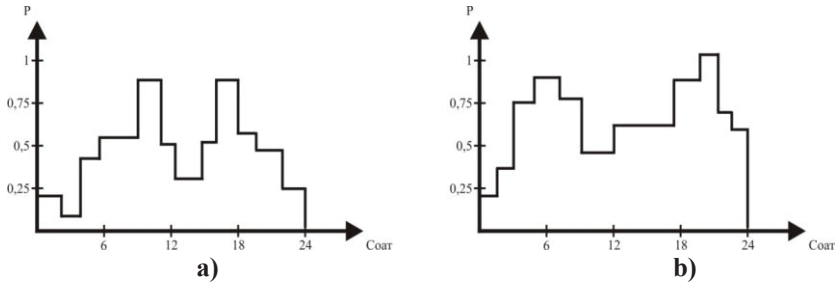


**Fig. 1.** In the winter (a) and summer (b) seasons of the substation changes in electrical load schedules.

To analyze the results of the use of time-stratified tariffs requires consideration of the following cases, namely:

- the dynamics of changes in the number and composition of electricity consumers using time-varying tariffs;
- the dynamics of changes in the demand for electricity of these consumers;
- the impact of the use of time-varying tariffs on changes in electricity consumption regimes.

In the process of applying time-varying tariffs, electricity consumers will be able to make payments for tariff periods. These periods provide an opportunity to save consumers' financial resources.

Due to the impossibility of collecting the generated electricity, in order to use it wisely, it is possible to create opportunities to align the load schedules of the energy system during the day by applying the tariff system in the prescribed manner during its transmission to consumers.

Loads in the power system Despite the period of loads consumed by different consumers, the distribution of daily (annual) load load schedules has not been resolved [16, 17].

At present, the energy system of the republic has automated means of accounting for electricity consumed between enterprises and consumers of electricity. The data obtained from electricity metering equipment are calculated on the basis of time in kWh · hours in three different periods based on the time of the time-varying tariff system, ie these periods consist of dense period, semi-dense period and night periods [5, 18, 19].

The current system of differentiated tariffs and the use of modern new equipment, rational use of electricity and reduction of waste, will help to regulate the relationship between consumers and electricity generating enterprises. One of the main goals of time-varying tariffs is to bring the energy system to a smooth operation by reducing the loading periods in the morning and evening peaks by increasing electricity consumption during the day and night [20, 21].

It is possible to smooth the load schedules by using electricity consumption of industrial enterprises and residential areas at non-peak times of the day, ie at night. This increases the reliability of existing equipment in the power system and ensures their long-term operation.

Electricity tariffs in the retail market are formed on the principle of taking into account the interests of both parties, ie energy supply and consumer organizations (investment to ensure production costs, sales revenue and timely replacement of equipment and overhaul).

## 4 Conclusion

If a consumer electricity at night, he will be able to pay for each kW·h of electricity consumed at a price 1.5 times lower than during the day. This, in turn, will lead to the long-

term operation of networks and transformers, reducing the load period and smoothing the load schedules of the power system.

If the consumer transfers electricity consumption (tariff-4) at night, this enterprise will be one of the enterprises that contribute to the smooth operation of the energy system. Also, the cost of the product produced by this enterprise differs from the cost of the product by other enterprises.

In addition, there is no increase in the load on the transformer during the production process at this enterprise. As a result, the condition and service life of the transformer is also much higher.

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