Study on energy consumption regulation of devices in industry enterprises

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Abstract. As a result of the implementation of certain standards for the energy consumption of electricity consumers used in industrial enterprises, the work on prevention of excess energy waste in the enterprise is gaining urgent importance. Grouping devices with the same performance into groups, monitoring energy consumption and early detection of deviations from established limit parameters, has a positive effect on energy and resource saving in the enterprise.

1. Introduction

The development of the global economy and social structure depends on energy and the entire infrastructure that surrounds it. At the most fundamental level, individuals want access to power for house lighting and heating as well as clean, safe water for drinking and cooking. The introduction of the amount of electrical energy corresponding to the product unit of the devices in the enterprise is necessary to recognize the contribution of all enterprises to the cost of the developed product [1]. Up to the middle of the 20th century, the second industrial revolution was responsible for the development of the current marketplaces for the sale of energy and transportation. The energy industry is the most traditional restraint on the national economy in the third industrial revolution era [2].

Increased energy efficiency is a significant step in the fight against climate change and a key element in helping individual businesses stay and grow competitive. Energy services make it simple to achieve significant improvements in energy efficiency. The most notable example may come from the building industry, where several buildings in a given area may have identical energy service measures, which subtly implies cheaper procurement transaction costs for energy service contracts. Energy services have received far less attention from the industrial sectors, and especially from industrial enterprises [3, 4].

A number of achievements are achieved as a result of monitoring the changes in energy consumption of devices used in industrial enterprises separately or in groups based on their performance characteristics [5-8]. These include the prevention of major damage caused by some small damage to the equipment used in the enterprise, the reason for the increase in energy consumption from the limit value, and the increase of the service life of the electric machine. Standards should be based on the energy characteristics of technological equipment and take into account acceptable operating modes [9, 10]. Standardization of consumption of fuel, electricity and thermal energy is to determine planned measures of their consumption in production [11-13]. Individual standards of electricity and thermal energy, fuel consumption are developed for each enterprise in accordance with specific technologies of product production.

2. Methods

In production enterprises, a number of methods are used to determine the amount of energy per unit of product.

Analysis methods are divided into physical and financial-economic.

Physical analysis works with physical (natural) quantities and aims to determine the characteristics of energy use. A physical examination usually includes:

- the composition of analyzed energy use objects is determined. Individual consumers, systems, technological lines, buildings, departments and the enterprise as a whole can serve as objects;

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- the distribution of all energy consumed by objects, energy sources and energy carriers according to individual types is determined, for which information on energy consumption is brought to a single measurement system;
- factors affecting energy consumption are determined for each object, for example, product production is a factor for technological equipment, external temperature for heating systems, useful energy for energy transmission and conversion systems, etc.;
- the relative energy consumption for certain types of energy resources and objects is calculated, which is the ratio of energy consumption to the influencing factor;
- the relative consumption values are compared with the main Fig.s, after which a conclusion is made about the efficiency of energy use for each object. Key Fig.s may be based on industry standards, previous performance of a particular enterprise or relevant foreign and domestic enterprises, physical modeling of processes or expert assessments;
- direct energy losses are determined due to slippage of energy carriers, insulation failure, equipment malfunction, failure, failure to load, and other identified disturbances;
- in the end, the most vulnerable objects in terms of energy efficiency are determined.

The financial and economic analysis is carried out in parallel with the physical analysis and aims at economic justification of the conclusions obtained on the basis of the physical analysis. At this stage, the distribution of costs for energy resources is calculated for all energy consumption objects and types of energy resources. Direct losses are assessed in monetary terms. Financial and economic criteria are very important in the analysis of energy-saving recommendations and projects.

Development of energy saving recommendations . The purpose of this stage: to determine which of the ideas are feasible as real projects; comparing alternative ideas and choosing the best; develop a single list of projects. Energy-saving measures are developed by applying the usual energy-saving methods to the objects that use the energy resources most wastefully or inefficiently, identified at the analysis stage.

Fig. 1. Stages of production of one type of product in the enterprise

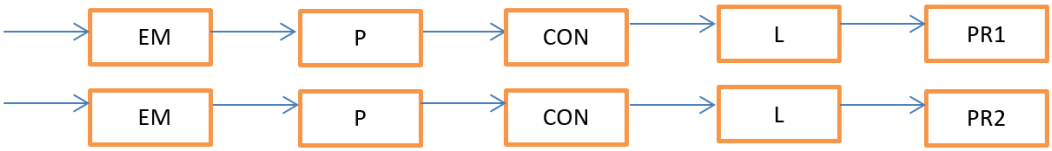

Fig. 2. Lines with production of several types of products in the enterprise

The designation of the above images represents the following: EM-processing unit; R-transmission unit; SON-conveyor; L-processing machines; PR- product. As a result of the analysis of technological schemes of production enterprises, it was shown that enterprises can be divided into three types according to the rules of operation:

1. enterprises with one technological flow, they receive one type of product (Fig. 1);
2. enterprises with several technological streams, each of which produces several types of products. (Fig. 2);

Taking into account the above production stages, it will be possible to evaluate the performance of the devices involved in the production of the product using the types of energy consumed.

3. Results and Discussion

When obtaining the results of the energy consumption analysis of the researched enterprises, a number of requirements were implemented: to analyze the chain of technological processes, to determine the composition of energy consumers and energy consumption, in order to analyze the energy consumption of industrial enterprises ; analysis of the methods of regulation of electricity consumption in industrial enterprises and their improvement taking into account the actual work regimes of energy consumers; development of hardware and software complex for analysis of energy consumption of industrial enterprises ; it is necessary to develop the concept of saving electricity, methods of choosing energy-saving technologies and equipment.

Table 1. The balance of energy consumption of the enterprises

Enterprises/Factories	Installed power	Consumption power	The ratio of electricity consumption	Electricity consumption
	kW	kW	%	кВт · с
Technologies, devices				
Welding shop	1055.9	386.7	32	1177630.2
Czech PPU	1148.5	377.7	31	1151745.2
Collection department	161	140	11	426346.6
Sewing shop	240.2	94	8	286261.3
Total:		998.4	82	3041983.3
Auxiliary devices				
Finished product placement shop	84.9	35	3	106586.6
Compressing and repair shop	227.4	100.4	8	305751.4
Total:		135.4	11	412338
Additional devices				
A BK	24.76	22.7	2	69129.1
Kitchen №1	63.8	39.6	3	120595.1
Kitchen №2	45.24	25.3	2	77046.7
Street lights	2.1	2.1	0.2	6395.2
Total:		89.7		273166.1
Overall:	3527.5	1224		3727487.4

Table 2. The annual energy consumption of the main technological and auxiliary equipment section of industrial enterprise equipment and additional equipment

Name of consumers	Annual electricity consumption,kw*hour/year
Technology devices	
Pressing shop	2608313,2
Welding shop	4072879.6
Repairment shop	106128
Total:	*6787320.8*
Auxiliary devices	
Compressor compartment	538469.2
The boiler house	1565.8
Pump station	333172,3
Laboratory devices	8699.1
Total:	*881906.4*
Additional devices	
A BK	274367
Kitchen	143881.6
Street lights	7829.2
Total:	*426077.8*
Overall:	*8095305*

Also, in some enterprises, simplified expressions are used to determine the monthly and annual consumption of electricity:

$$W_{m.c} = \sum_{i=1}^{n} P_{p.i} \cdot k_{i.u} \cdot \mathrm{T}_{i.m.w.h}, \quad (1)$$

Here $W_{m.c}$ - monthly consumption of active electricity in the workshop, $kW \cdot hour$; n- the number of electrical consumers of one type in the shop, units;$P_{p.i}$ - installed power of i-type electric consumers, kW;$k_{i.u}$ - coefficient of use of i-type electricity consumers ; $\mathrm{T}_{i.m.w.h}$- hours of operation per month of i types of electricity consumers, hours.

The amount of two-year production of the researched enterprise and indicators of annual production in million soums are given. Table 3 shows the indicators of the enterprise

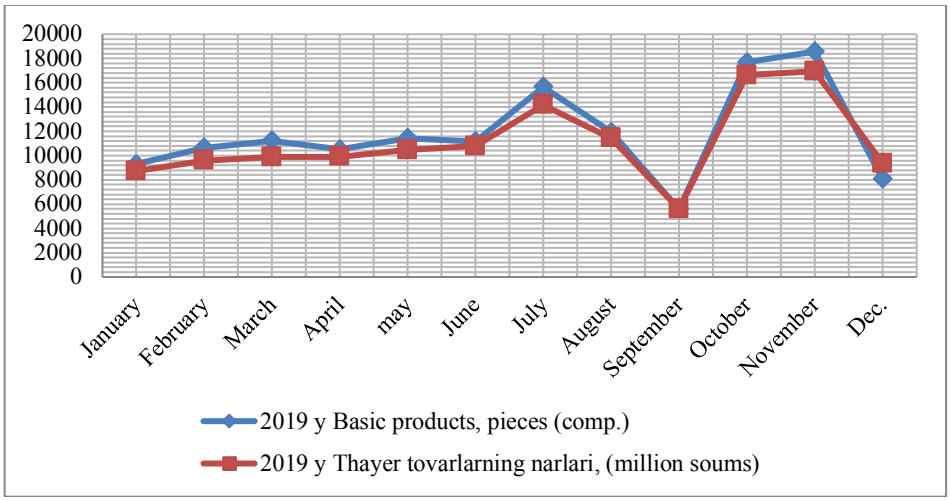

Fig. 3. "Uz-Tong Heung Company" joint venture electricity consumption change

Table 3. Two-year production index of "Uz-Wong Company" JV

	2019		2020	
	Basic products, pieces (comp.)	Thayer goods pomegranates, (million soums)	Basic products, pieces (comp.)	Thayer goods pomegranates, (million soums)
January	9287	8731	12956	12913
February	10652	9586	15824	14680
March	11219	9884	14964	14822
April	10523	9910	10139	9682
May	11426	10454	9309	8414
June	11168	10773	12757	12563
July	15654	14183	12821	12713
August	11936	11435	11897	10830
September	5590	5608	12369	12775
October	17692	16619	8566	8116
November	18568	16941	9622	10236
December	8067	9353	8170	8142
	141782	133477	139394	*135886*

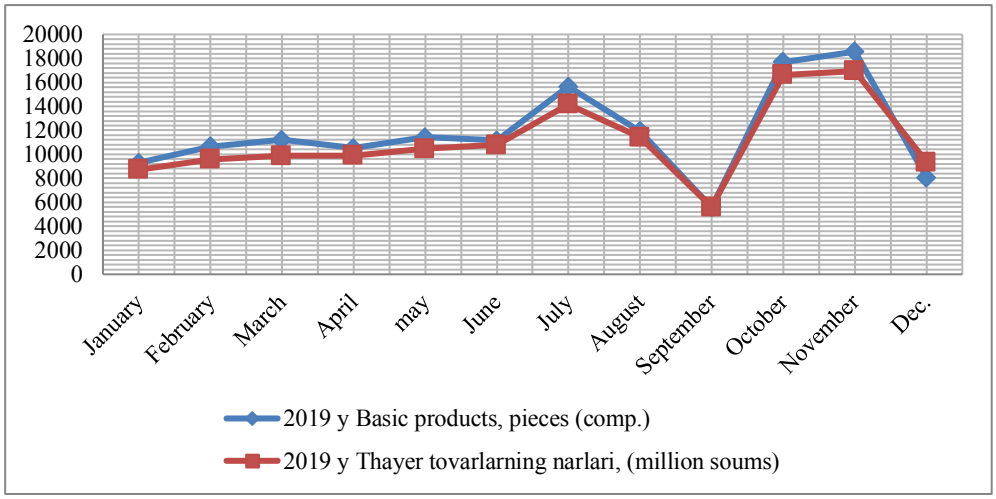

Fig. 4. Changes in the quantity and prices of products in the first year of the enterprise are presented

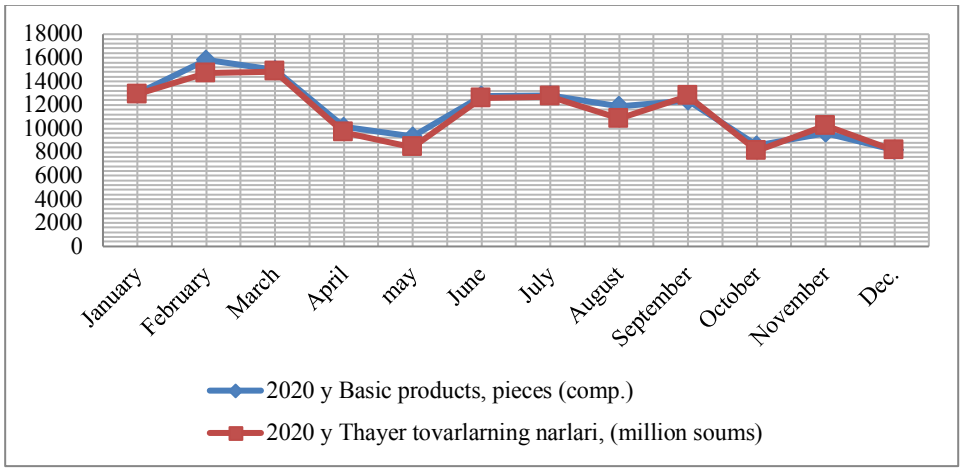

Fig. 5. Changes in the quantity and prices of the company's products in the second year are presented

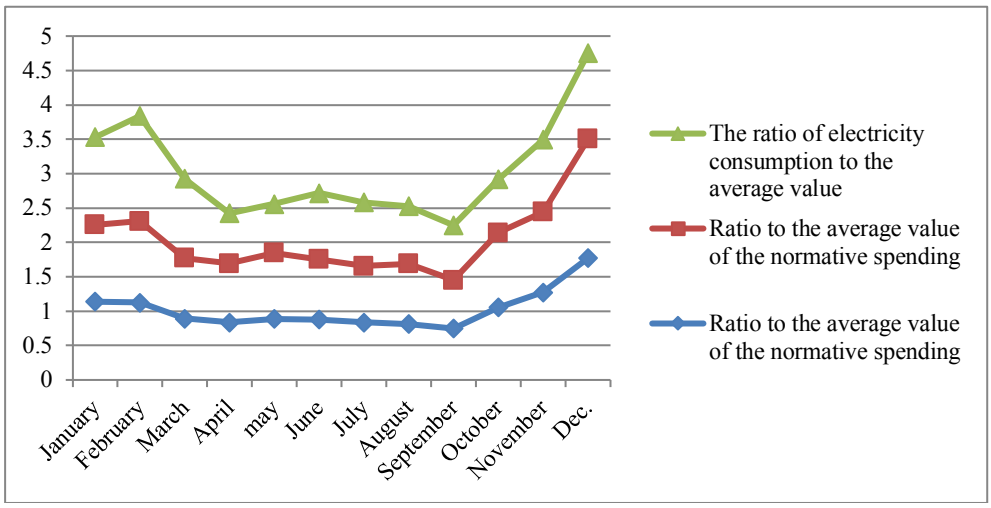

Fig. 6. Changes in production compared to annual average values

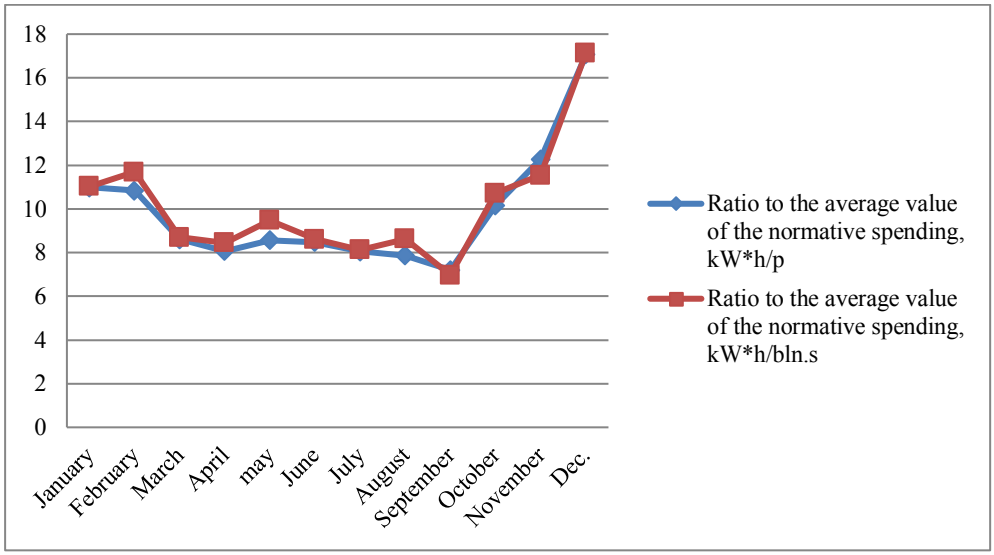

Fig. 7. Change of energy consumption of units of monthly results in ratio of annual average values in product production

Table 4 shows the changes in the company's indicators of electricity consumption per unit of product.

Table 4. An indication of the standard consumption of the product and the average value is given

	Ratio to the average value of the normative spending	Ratio to the average value of the normative spending	The ratio of electricity consumption to the average value	Ratio to the average value of the normative spending, kW*h/p	Ratio to the average value of the normative spending, kW*h/bln.s	The ratio of electricity consumption to the average value, kW*h
January	1.141225337	1.116396761	1.272723888	10.99	11.03	142423
February	1.125649013	1.183198381	1.533107595	10.84	11.69	171561
March	0.894080997	0.880566802	1.151781027	8.61	8.7	128889
April	0.838006231	0.855263158	0.731349541	8.07	8.45	81841
May	0.888888889	0.958502024	0.712065169	8.56	9.47	79683
June	0.880581516	0.87145749	0.966434797	8.48	8.61	108148
July	0.836967809	0.821862348	0.92299581	8.06	8,12	103287
August	0.816199377	0.873481781	0.835170596	7.86	8.63	93459
September	0.747663551	0.705465587	0.796056742	7.2	6.97	89082
October	1.055036345	1.085020243	0.777451523	10,16	10.72	87000
November	1.274143302	1.168016194	1.055216186	12.27	11.54	118083
December	1.771547248	1.732793522	1.245647128	17.06	17.12	139393
Total:				**9.63**	**9.88**	***1342849***

As a result of monitoring energy consumption based on the types of electric energy-consuming devices of the enterprise and planning current maintenance works using the results, the following achievements are achieved:

- to reduce the service life of working devices;
- electric energy provides an opportunity to control the increase in wastage;
- allows to ensure the integrity of the production process.

As a result of controlling the production process at the enterprise according to the normative indicators, the consumption of electricity can be saved by 4-12%. The main factor affecting this result is that the electric motor does not start because the load of the electric motor does not reach the limit values of the protection devices installed on it. As a result of this, the amount of electrical energy consumed in relation to the efficiency of electric motors is increased.

4. Conclusions

The methods of regulating electricity consumption in industrial enterprises help to improve taking into account the actual work modes of energy consumers. At the same time, it will be possible to determine the consumption of energy consumed in relation to the product produced in the enterprise in a short period of time. Industrial enterprises provide the concept of saving electricity, the opportunity to choose the right energy-saving technologies.

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