Impact of Consumption Management to Consumers Electricity Security Indicator

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Abstract

Power supply system's activity and its relations with other sectors encircle in itself technical, economic, legal, and organizational and other areas. In order to evaluate the current status of the power supply system activity in the above mentioned directions appropriate criteria system – "electricity security indicators" – are being used.

1. Introduction

Along with sustainable and reliable provision of power resources in demanded volumes "electricity security" in its wider meaning also implies, availability of these resources to ideally to each and every consumer, and in reality to the absolute majority of consumers without experiencing any problem. In this aspect one of the main features of the concept of "power security" is to provide the absolute majority of consumers with power at admissible tariffs.

In this article the methods of increase of the level of electricity security indicator (minimization of tariffs) through the management of electricity consumption are being investigated.

As it is known, the main purpose of the power system's activity is to provide continuous and qualitative power in full volume to population and state economy , concurrently to fulfill entirely with minimum expenses all obligations determined by the international agreements. Electricity tariffs determined only under these conditions can play the role of "electricity security" indicator [1].

The main essence of the electricity security indicator, which defines consumers' admissible electricity price, is as following:

Rational level of electricity tariffs (including quantity and sphere of applicability) must be determined in such a way that application of these tariffs would be permissible to the financial means of the absolute majority of consumers, at the same time it should allow to keep the indicator of utilization of equipment of power plants at the optimal level and be enough to cover the expenses of production, transmission and distribution of electricity.

2. Calculation

$$K^{qb} \to \max; \qquad K^{qb} = \frac{P_{\min}}{P_{\max}} \to \max;$$

$$0{,}75 \le k^{qb} \le 0{,}8;$$

$$K^{d} \to \max; \qquad K^{d} = \frac{P_{mid}}{P_{\max}} \to \max;$$

$$0{,}8 \le k^{d} \le 0{,}9$$

$$D_t \ge X_t \to \min; \quad \tau^t = \frac{X^c}{W^{ts}} \to \min. \qquad (1)$$

Admissible level of electricity security indicator is ensured under the condition of $\tau^t \to min$.

P_{min} and P_{max} – minimum and maximum demand of daily load curve; K^{qb} and K^{d} - the coefficient of inequality and fullness of the daily load graphic; D - revenues from electricity sale; X - cost of production, transmission and distribution of electricity; τ^t - *wholesale tariff for electricity*

For the considered circumstance electricity security indicator means correspondence between the electricity tariff (being minimal) and financial means of the majority of consumers and this indicator can be called as "rationality of tariff". In some cases the level of electricity tariffs determined by the calculations is not rational (meaning they are high). At the end there is a need to take proper decisive measures. In this case it is necessary to reduce costs for the same volume of production, transmission and distribution or compensation of some (X) expense components through other sources.

Calculation of electricity security indicator i.e. solution of the admissible tariff case for both parties producer and consumer thru the electricity consumption management can be realized in the following sequence.

For the purpose of determining the impact of the changes in the dynamics of consumption and production (considering the

changes in the cost of fuel) on the electricity tariffs, production and consumption volumes are fluctuating in certain limits and time brackets (for this case conditionally between ± 25%). Based on fluctuation of the indicators, the level of the conditionally variable cost of electricity production – X^{cv} changes accordingly, but conditionally constant expenses (X^{cc}) and the level of profit (M) remain almost stable. On this occasion in order to fit total required expenses (X^t) with the revenues from energy sales(D), lower level of production accompanies by the higher level of tariffs and higher level of production accompanies by the lower level of tariffs [2] [3].

By the great number of calculation results and the analyze of power system technical and economic indices conditional interdependencies (figures 1, 2, 3 and 4) shows that changes of electricity demand is in linear dependence with changes in costs of production, transmission and distribution of electricity. 1% change in the electricity consumption (considering the changes in the cost of fuel) results in approximately 0.5% change in total expenses. The existence of this dependency means that in order to fit required expenses (without any additional measures) wholesale tariffs must be increased or decreased approximately by 0.5%

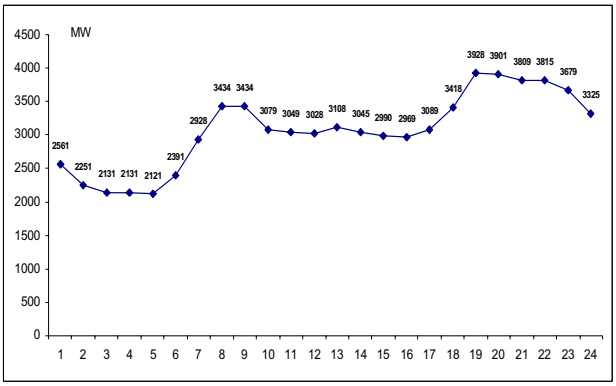

Fig. 1. Daily load schedule of the power system in autumn-winter months: $K^d = 0,77$, $K^{qb} = 0,58$

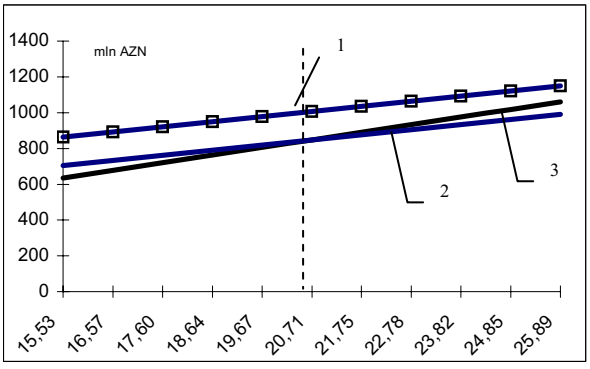

Fig 2. Impact of consumption changes on the level of expenses and revenues from electricity sale:
1- The level of required expenses; 2- regulated level of required expenses; 3- the volume of revenues from the electricity sale through the whole sale tariffs determined on the basis of regulated expenses

Calculations and analysis of the power export and import formation terms shows that it is recommended firstly to use the most profitable method- the method of consumption management in order to increase the level of the consumers' electricity security indicator i.e. to reduce electricity tariffs. If the result of consumption management method is not enough it is recommended to increase the volume of power export and import or to check possibility of necessary expenses reduction.

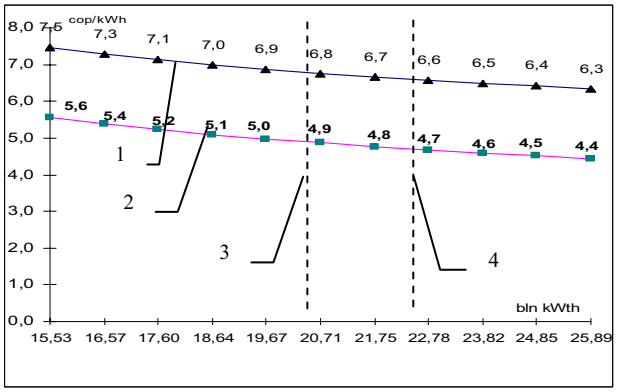

Fig.3. Impact of consumption managing on the energy tariffs
1 - Retail tariff;2 - wholesale tariff ; 3- – wholesale and retail tariffs defined by calculations; 4- wholesale and retail tariffs defined by consumption managing

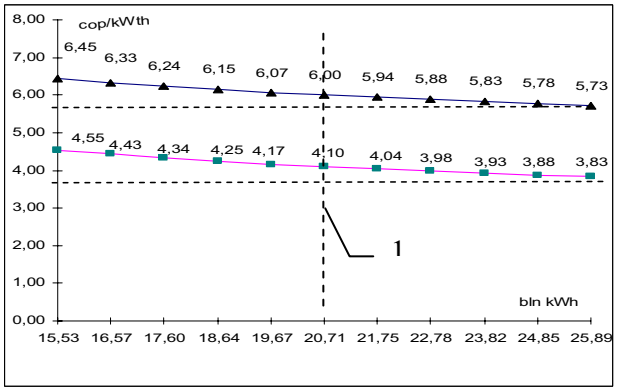

Fig.4. Impact of consumption managing and optimization of expenses on the energy tariffs: 1- current tariffs (tariffs meeting the requirements of consumers` power security)

In scope of conditions mentioned above carried out calculations shows that it is possible to increase the coefficient of inequality of load graphic from 0.57 to 0.8 through the consumption management (i.e. by producing and consuming additional power in period of night minimum). In this case it is possible to produce additionally 1.65 billion kW/h electricity with minimal expenses. Consequently it means the 4% reduction of electricity tariff. So it raises an opportunity to reduce the wholesale tariffs from 4.9 kopeck/kWh to 4.7 kopeck/kWh through the consumption management. Reduction of whole sale tariff by 4% through the consumption management provides an opportunity to increase rationality the tariff indicator. There is necessary to take additional measures for the reduction of whole

sale tariffs from 4.7 kopeck/kWh to 4.1 kopeck/kWh, and this problems can be solve through the reduction of expenses by certain methods (Figure 3, 4).

3. Conclusion

It is necessary to note that in any case level of several electricity security indicators needs to be controlled at the same time. It's necessary to realize interdependency between energy system sustainability and reliability indicator which defines as capable operation and the level of tariff rationality.

4. References

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