Impact of rates and conditions of electric power development on the required tariff dynamics in Russia

Prof. Yu.D.Kononov, Dr. D.Yu.Kononov
Energy Systems Institute, Irkutsk

Some or other methods for electricity tariff regulation should take into account an adverse impact of their increase on consumers, on the one hand and their important role in provision of the expected electric power development with financial resources. This role will especially increase in the coming years due to drastic aggravation of the investment problem. It seems impossible to solve this problem without tariff increase. However, dependence of the required tariff dynamics on the rates of electricity production growth and demands for investments is ambiguous and determined by many factors. The results of study on the impact of some of them on the tariff increase are described below.

Conditions to be considered and the calculation method

Among a great number of available scenarios (options) for the economy and electric power development in Russia till the year 2020 two extreme ones were chosen for the analysis [1-5, 11]. Scenario 1 (minimum) assumes that the Russian economy will grow at average annual rates of no more than 4.5% and electricity production will increase at no more than 1.9%. In Scenario 2 (maximum) the rates of GDP growth account for up to 5.5-6.0% and those of electricity production growth – up to 3.0-3.2% (Table 1).

Table 1. Scenarios of economy and electric power development in Russia

Scenarios, years / Indices	Scenario 1			Scenario 2		
	2005	2010	2020	2005	2010	2020
Average annual rates of GDP growth (for period), %	4.4	4.6	4.0	4.9	6.0	5.9
Electricity production, billion kWh	927	1016	1215	953	1110	1560
Installed capacity, million kW	218	230	248	223	248	309
Including HPP	46	48	52	47	50	59
NPP	23.3	29	35	25	31	49
TPP	148.7	153	161	151	167	201
Fuel cost, USD/tce						
Coal	23	30	34	23	30	36
Gas	32	48	61	32	48	68
Heavy oil	40	70	85	40	70	87

In both scenarios it is supposed that the sharp deficit of investment resources stipulates low-cost measures as the basic trends in investment. They include extension of service life of operating hydro (HPP), nuclear (NPP) and a great number of thermal (TPP) power plants (about 50 million kW [3]) with replacement of key nodes and components; completion of objects with a high degree

of availability; re-equipping and updating of thermal power plants with a limiting service life by the replacement of equipment with similar new one. In this case the following specific investments were assumed in the calculations, USD/kW: in extension of service life – 100 at TPP and 150 at HPP and NPP; updating (modernization) – 300-550; completion – 200-300 at TPP and 300-650 at HPP and NPP; construction of new capacities: gas/heavy oil-fired TPP – 730-850, coal-fired TPP – 950-1150, NPP – 1100-1400, HPP – 1300-1500 [7-10]. Modernization suggested installation of equipment similar to the existing one, however with a somewhat higher unit capacity (by 10-12%) and with better technical and economic characteristics [7].

The tariff dynamics for each scenario was determined by the simulation model INTAR constructed at Energy Systems Institute (Fig.1). Here account was taken of changes in operation conditions (fuel prices, depreciation rates, etc.), technical and economic indices of the considered types of power plants (coal- and gas-fired TPP, NPP, HPP), taxes, terms of crediting, period of construction, etc.

Production cost and tariffs were determined for existing, updated and new power plants and then they were averaged.

The tariffs in the model were determined from the principles of self-repayment (self-financing), i.e. the minimum offered price of producer. For an operating plant such a price must guarantee that the annual costs will be met, taxes will be paid and the minimum profit for normal operation will be gained. For a new plant or developing company the self-repayment price must also comprise an investment component. For the considered period (for the service life of the plant or the shorter time period) the latter should provide the return of borrowed funds with interests and the receipt of reasonable average annual profit on capital invested (no lower than the market rate).

Calculation results

The expected electric power development in both scenarios till the year 2020 calls for commissioning, updating and re-equipping from 142 to 203 million kW including 104-144 million kW at thermal power plants, 18-25 million kW at hydro power plants and 20-35 million kW at nuclear power plants. This requires no less than USD113-185 billion of investments prior to 2020 (Table 2).

A noticeable increase in the cost of electricity production is expected in the considered time horizon, particularly in the next 10 years (Table 3). At TPP it is caused basically by the fuel cost increase (especially gas and heavy oil), at HPP – by the sharp increase of water tax and at NPP - the increasing share of depreciation. Fuel price rise will be partially covered by decrease in its specific consumption for electricity production: 14-18% at TPP on coal within the time span of 20 years and 18-25% at TPP on gas. Higher figures refer to Scenario 2 with a large share of new generation capacities (including highly efficient combined cycle and gas turbine plants).

The calculations performed show that on the average for Russia the tariffs for electricity (self-repayment prices) will increase approximately threefold in the minimum scenario and almost fourfold in the maximum one. Their increase will be most noticeable for TPP (Table 3).

The tariffs increase faster than the rise of production cost because of the growing share of investment component in them. According to calculations during the period from 2005 to 2020 it will increase from 5-10% to 35-49% at TPP, from 8.5-9.5% to 43-47% at HPP, from 5-13% to 36-45% at NPP.

In the studied time span the ratio of tariff increase rates to the rates of electricity production on the average for the Unified Power System (UPS) of Russia should be about 2.4-3.7%. This ratio, however, is not the same for different power plants. The tariffs grow faster with the increasing rates of electricity production at the most capital-intensive HPP and NPP (Fig. 2).

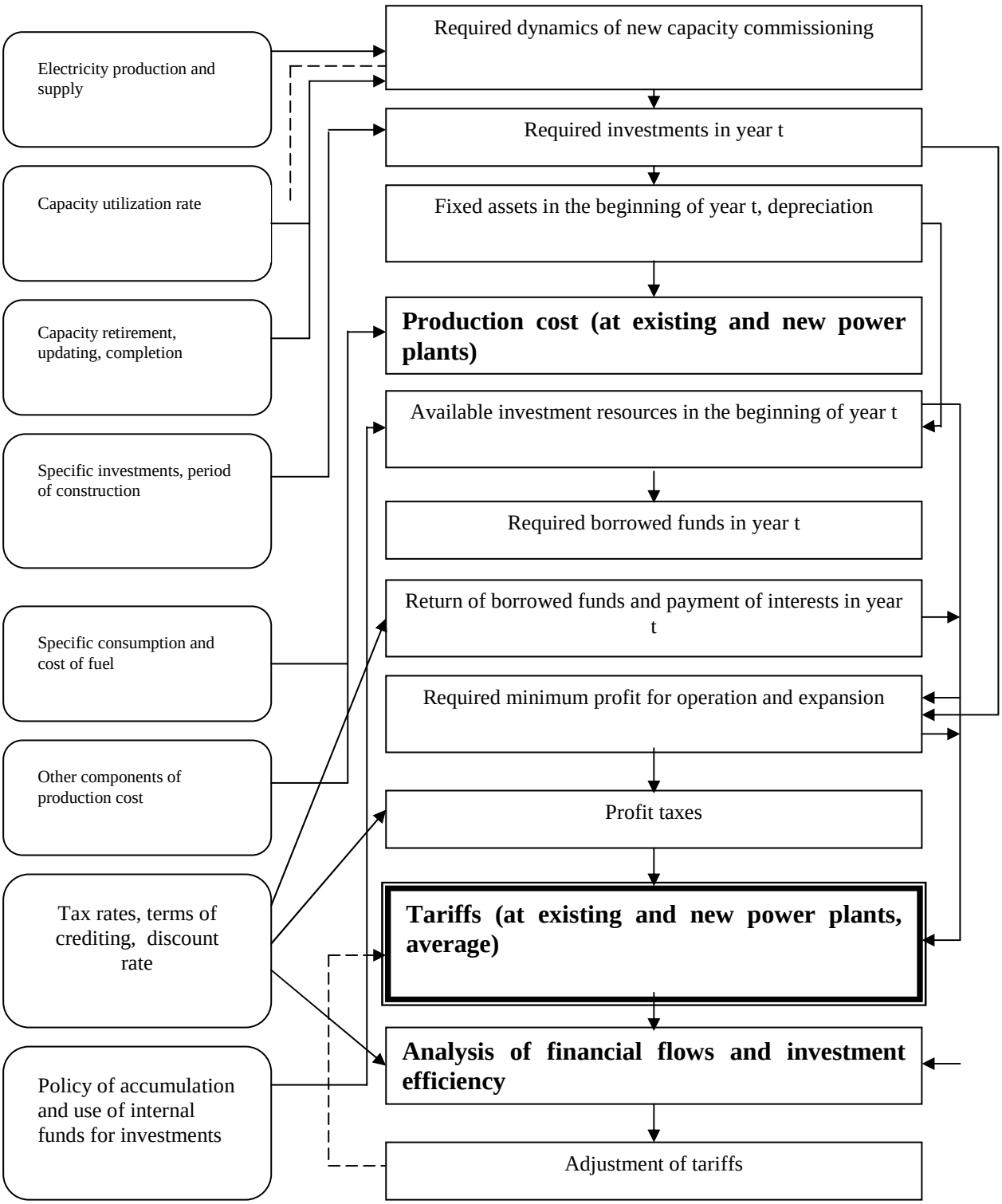

Fig. 1. Block diagram of INTAR model

Table 2. Required capital investments in generation capacities, billion USD

	Scenario 1		Scenario 2	
	2001- 2010	2011- 2020	2001- 2010	2011- 2020
TPP – total	16.1	67.5	29.8	96
including: Extension of service life	2.4	-	2.4	-
Updating	8.2	17.5	9.9	17.5
Completion and new construction	5.6	50	17.5	78.5
HPP – total	3.4	10.8	5.3	17.5
including: Extension of service life	0.4	-	0.4	-
Updating	0.5	2.1	1.1	2.5
Completion and new construction	2.5	8.7	3.8	15
NPP – total	4.2	10.9	7.4	30
including: Extension of service life	1.3	-	1.3	-
Updating	1.1	3.2	1.5	4
Completion and new construction	1.8	7.7	4.6	26
In all	23.7	89.1	42.5	143.5

Table 3. Calculated dynamics of electricity production cost and tariffs, cent/kWh*

Power plants	2000	2010		2020	
		Scenario 1	Scenario 2	Scenario 1	Scenario 2
Production cost					
TPP on coal	1.3	2.2	2.3	2.45	2.6
TPP on gas	1.0	2.8	2.9	3.2	3.4
HPP	0.7	1.5	1.55	1.3	1.55
NPP	1.4	1.5	1.6	1.7	2.2
UPS of Russia	1.1	2.1	2.4	2.4	2.7
T a r i f f s					
TPP on coal	1.5	3.2	4.3	6.9	7.5
TPP on gas	1.2	3.6	3.9	5.8	6.4
HPP	0.9	2.0	2.35	3.3	4.5
NPP	1.6	2.1	2.55	3.4	5.4
UPS of Russia	1.25	3.0	3.5	5.2	6.2

* On the average for the considered type of power plants per kWh supplied (neglecting inflation)

Note that the above given quantitative estimates are average tariffs. They mean that the internal investment resources are formed by depreciation and invested profit of all power plants of the specified type. If the existing and new generation capacities are combined into individual groups and considered as independent energy companies, the tariffs for normal operation and development

of the companies will essentially differ from the average ones, particularly in the coming years (Table 4).

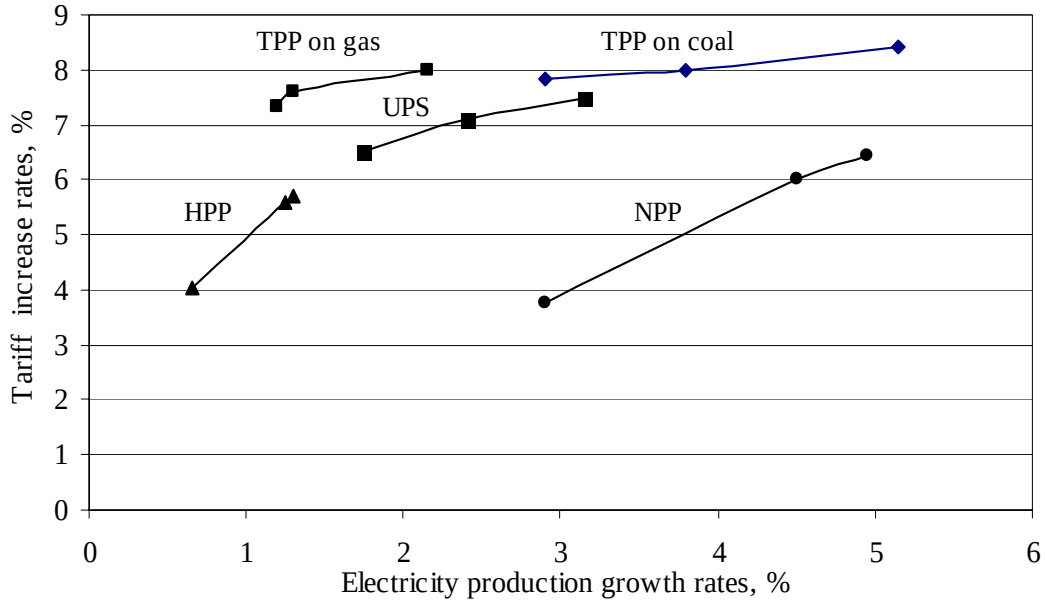

Fig. 2. Impact of electricity production growth rates on the rise of average tariffs for the time span 2002-2020

While the average tariff for UPS in 2020 can increase to 5.2 cent/kWh for the minimum scenario and to 6.2 cent/kWh for the maximum scenario, the average weighted tariff at new power plants can reach 6.6 and 7.8 cent/kWh respectively.

The tariff values for the electric power to develop effectively depend on both its growth rates and many other factors that determine costs for electricity production and an investment climate. The calculation results based on conditions for the years 2010-2020 illustrate the degree of this dependence (Table 5).

Table 4. Deviation of tariffs at the existing and new power plants from the average values (Scenario 2), %

Type of power plants	Existing power plants		New power plants	
	2010	2020	2010	2020
TPP on coal	52	33	165	103
TPP on gas	78	55	191	124
HPP	68	28	289	200
NPP	69	43	185	128

Conclusions

The given quantitative estimates are tentative. Real tariffs may prove to be somewhat different due to inevitable errors in the applied initial data and some neglected factors (such as state regulation). However, the analysis makes it possible to reveal some trends and regularities in the expected tariff dynamics (self-repayment prices of electricity producers):

1. Even with the policy of minimum capital costs through the extension of service life and modernization of equipment and with the minimum growth rates of electric power demands no less

than USD 110 billion will be needed to develop generation capacities in the next 15-20 years, which will inevitably lead to sharp increase in the investment component of tariffs and hence their essential rise.

Table 5. Possible tariff decrease in response to individual factors, %

Factors	Change	TPP on coal	TPP on gas	HPP	NPP
Capital intensity of new capacities	10% decrease	5.4-6.4	3.7-4	5.7-6.5	6.3-7.4
Installed capacity utilization rate	10% increase	7-8	7-8	25-30	14-17
Fuel price (at TPP and NPP) and water tax (at HPP)	20% decrease	4-6	8-10	2-4	3-5
Tax on invested profit	Decrease from 24 to 12 %	5-6	3-4	5-6	5-6
Interests on credit	Decrease from 15 to 7 %	1-2	1-2	1-2	1-2

2. The growth rates of average tariffs for Unified Power System of Russia should exceed the rates of electricity production tentatively by a factor of 3.5-3.7 in the coming years and 1.8-3.0 in the next decade.

3. The required increase of tariffs and their response to electricity production growth rates essentially differ for different types of power plants and depend on both their capital intensity and fuel cost. The average tariffs at TPP are expected to increase to the greatest extent (to 6.5-7.5 cent/kWh by 2020 in the maximum scenario). They will be 50-60% higher than the tariffs for HPP and NPP in the minimum scenario and 30-40% in the maximum scenario. Difference in the average tariffs is leveled for new power plants. In the maximum scenario the self-repayment prices at NPP in 2020 are only 10-13% lower than at TPP and even exceed them at HPP.

4. Real tariffs may be 1.5-2.0 times higher than the indicated average values, if in the restructurized electric power industry they are formed from self-repayment prices of new and not highly economical power plants that close electricity balance. At the same time it is possible to considerably slow down tariff increases by reducing the electricity production cost, increasing the installed capacity utilization rate (especially at NPP and HPP), reducing taxes on the invested part of profit, attracting external investors and other factors.

References

1. Makarov A.A. Electric power and socio-economic development of Russia// Energetika, ekonomika, tekhnologiya. 2003. N 2 (in Russian).
2. Makarov A.A., Volkova Ye.A., Veselov F.V., Makarova A.S. Prospects in development of Russian electric power// TEK. 2002. N 1 (in Russian).
3. Volkov E.P, Barinov V.A., Manevich A.S. Problems and prospects in electric power development in Russia. M.: Energoatomizdat. 2001(in Russian).
4. Kucherov Yu.N. Electric power development in Russia and demand for investments// Vestnik FEK. 2002. N 5 (in Russian).
5. Basic concepts of the energy strategy of Russia for the time horizon till 2020. Minenergo RF. M. October 2002 (in Russian).
6. Veselov F.V., Novikova T.V. Increasing potential of depreciation charges as an investment source in electric power industry// TEK. 2002. N 1 (in Russian).
7. Zemtsov A.S., Yegorov V.M., Volkova Ye.A., Shulgina V.S. Estimation of economic efficiency of operating thermal power plants// TEK. 2001. N 4 (in Russian).
8. Favorsky O., Leontiev A. et al. Effective technologies of electricity production using fossil fuel// TEK. 2001. N 4 (in Russian).
9. Olkhovsky G.G., Tumanovsky A.G., Avtonomov A.B. Promising technologies for re-equipping thermal power plants. Trudy seminara “Ekonomicheskiye problemy energeticheskogo kompleksa”. M.: IEP RAN. 2002 (in Russian).
10. Malyshev A.B. Nuclear energy of Russia: role, potential and conditions of dynamic development// TEK. 2002. N 4. S.95-97 (in Rusiian).
11. Kononov Yu.D., Galperova Ye.V., Mazurova O.V., Posekalin V.V. Dynamics of energy intensity of Russia on the background of global trends// Teploenergetika. 2002. N 1 (in Russian).

Yu.D.Kononov is Head of laboratory at Energy Systems Institute, Doctor of Economic Sciences, Professor
130, Lermontov str.
Irkutsk-33, 664033
Tel. (395) 42-56-74
E-mail: kononov@isem.sei.irk.ru

D.Yu.Kononov is Senior Researcher at Energy Systems Institute
Candidate of Technical Sciences
130, Lermontov str.
Irkutsk-33, 664033
Tel. (395) 42-29-66
E-mail: dims@isem.sei.irk.ru