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Methodology For Assessing The Outlook For Innovation And Investment Projects In Energy-Related Enterprises

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Abstract

The article gives theoretical provisions and practical examples of the application of index methods of estimation and analysis of productivity in generating companies. This methodology is recommended primarily for innovative projects: certain methodological difficulties in predicting their results make it necessary to use an additional set of indicators to assess the «innovation» the impact of planned innovations.

Introduction

The article will discuss the role of technology foresight in planning and forecasting calculations of the performance of energy enterprises and examples of the use of such forecasting tools. Technology foresight (to use not only the investment but also the innovation of the equipment as a basis for analysis, taking into account all possible deviations and risks of uncertainty) the more relevant is the greater the degree of obsolescence of individual facilities and fixed assets (mining) of enterprises as a whole.

As practice shows, the most common method of measuring wear and tear on a piece of equipment in foreign and especially domestic settings is to account for physical wear and tear on the basis of a comparison of actual service life with the standard. The service life of fixed assets, which is assumed in the calculation of the depreciation charge for full refurbishment, is generally assumed to be normative. This approach leads to a situation where the rate of deterioration is much higher than the estimated (normative) wear-out rate, which in turn is the basis for the renovation of power plants. It seems that the solution to this contradiction should be to change the method of estimating wear and tear and to incorporate it into regulatory and methodological documents at the sectoral level.

Materials and methods

The study is based on theoretical provisions of technological forecasting and practical results of the use of the presented methodology in enterprises of the energy sector of Russia in 2015-2019.

It is important to take into account the following: replacing obsolete equipment with completely identical equipment cannot have a fundamental impact on power plants, since together with physical wear, fixed assets are subject to moral obsolescence. According to various scholars and researchers, including E.Ametistov, V.Fomina, P.Rogalev, A.Zubkova and others. Today in Russia practically all condensing heat and power generating capacities are morally obsolete. This point was also stressed by L.Gitelman and B.Ratnikov: «When new types of energy equipment with higher technical and economical characteristics are introduced, units of the same quality are devalued». Energy companies that use technology with lower technical and economic characteristics than the market as a whole inevitably lose in a competitive market. The term obsolescence, as defined in this source, means the loss of value of buildings, structures, machines, machines and other equipment as a result of scientific and technological progress and increased productivity. Thus, «constant revolutions in means of production», which with the development of «capitalist way of production» constantly increase, dictate necessity «changing the means of production and the necessity of permanent compensation for them due to moral wear and tear, coming long before they physically retire their time»; at that time it seems possible to use the works of K.Marx in this connection, That the patterns identified are the basis of modern capitalism, and that the pace of technological progressis only accelerated by changes in technological patterns over the last hundred years.

Results

From an economic and practical point of view, moral depreciation is expressed in the depreciation of equipment until the end of its physical life as a result of the creation of new more productive and economically advantageous types of equipment». The rate of obsolescence is determined by the rate of technological progress in the industry, and a correct assessment of the level of obsolescence makes it possible to determine the optimal time to upgrade or replace obsolete equipment. With regard to the distribution and generation enterprises «moral aging», as noted by the group of authors headed by E.Ametistov, in practice the fuel consumption for electricity generation is substantially higher. Obsolete equipment has poorer reliability, less manoeuvrability than advanced power plants.

The authors then present a ranking of the levels of obsolescence that would be useful as a basis for further comparisons. For example, obsolescence manifests itself in several forms: latent (occurring at the start of the development of the new equipment model); partial (from the start of the serial production of the new model); complete (The dominant position of the new model in a fleet of operational equipment, usually replacing the obsolete machine; in the electric power industry, most often the equipment is not dismantled at that time, but transferred to peak operation or reserve).

The value of moral wear and tear is determined by the ratio of the operational parameters of the new and existing equipment: unit capacity of the unit; specific fuel consumption (PBB); intended service life (technical life); specific weight (dimensions) of the unit; environmental characteristics.

The level of obsolescence of E.Ametistov et al. is proposed to be determined using the formula:

$$L_o = L_v / P_o * 100\%$$
$$L_v = P_o - P_n * \Sigma r \quad (1)$$

where

L_o- level of obsolescence of active equipment, %;

L_v - loss of value of obsolete unit due to obsolescence;

P_o, P_n - price of old and new units respectively;

r - ratio of the i-th operating parameter for new and old appliances (< 1.0 if the new appliance is better than the first parameter; > 1.0 if the new appliance is worse than the first parameter);

n - number of operational parameters considered for a given purpose.

V.Fomina proposes two forms of moral wear: the first type (with production becoming cheaper as a result of productivity growth, the same equipment at a lower price) and the second type (The market offers equipment for the same purpose but with improved technical and economic characteristics, more economical - as a result, old equipment, even if not fully worn out physically, becomes an obstacle to overall productivity improvement; obsolete fixed assets produce products at higher cost that cannot withstand competition in the market).

Formula for calculating the first type of moral obsolesce is given below:

$$MO_1 = C_p - C_c \quad (2)$$

where

C_p - cost of capital assets at the time of the previous revaluation;

C_c - the current capital assets cost.

The current replacement cost of property, plant and equipment should be mathematically less than the replacement cost of the property, plant and equipment for the previous revaluation year.

Formula for calculating the second type of moral obsolesce is given below:

$$MO_2 = C_{old} – C_{new} * (EP_{old} * UL_{old}) / (EP_{new} * UL_{new}) \quad (3)$$

where

C_{old} and C_{new} - restoration value of old and new capital assets, plant and equipment;

EP_{old} and EP_{new} - annual electricity production in old and new capital assets;

UL_{old} and UL_{new} - useful life of existing and new property, plant and equipment, years.

Discussion

In the opinion of the authors of the article, all the above calculations do not fully correct the value of obsolescence, since the replacement cost is, by definition, an amount of depreciation, This would include both moral and physical obsolescence.

As a solution to this contradiction, one of the authors of the article proposed in earlier publications to define moral depreciation of the second kind as the difference between the inventory value of existing and new capital assets, adjusted for productivity (production) of existing capital assets.

$$MO_2 = C_{old} – C_{new} * (EP_{old} * UL_{old}) / (EP_{new} * UL_{new}) \quad (4)$$

where

IV_{old} and IV_{new} - inventory value of old and new capital assets, plant and equipment;

EP_{old} and EP_{new} - annual electricity production in old and new capital assets;

UL_{old} and UL_{new} - useful life of existing and new property, plant and equipment, years.

The proposed mechanism, however, is not applicable if there is an additional parameter of «innovation» (i.e. when the project is «innovative-investment»). Solidified with the opinions of experts of the industry, including A.Filatov and others. The authors of the article consider it useful to predict the efficiency of innovation by comparing the value of investments for early replacement of an object at the end of the moral depreciation period with the corresponding indicators for old objects using «Minimum Cost, Maximum effect, Maximum profit» criteria (see Table 1).

Table 1. Criteria and Conditions for Comparisons of Investments for Early Change of Facilities after Obsolescence

Applied criterion	Economic effect condition	Calculation formula
Minimum cost	High value of total costs brought to the end of the calculation period for option one (continued operation) versus option two (renovation)	$AC_{NS} - AC_{new} – d^* CI_{new}>0$ where AC_{NS} - annual cost of production before the end of its normal service life, AC_{new} - annual production cost of a new facility, d - discount rate for difference in time CI_{new} - capital investment in a new facility.
Maximum economic effect	Comparison of the value to be obtained from the operation of an existing facility with the same value in the case of its renovations	Calculation of the total effect given by the latest year of operation of the facility (NPV)
Maximum profit	The capital investment required for the construction of a new facility in this variant is time-shifted to Tō years in comparison with the second variant; an increase in profitability is projected for the period Tō years	Early replacement of an existing facility is economically feasible if the condition is met $AC_{NS}>AC_{new} + d^* CI_{new}$

While the above methodologies are of unquestionable practical value, they do provide a measure of what has already been achieved (for example, the number of years of obsolescence, provided that they have already expired). However, in the practice of evaluating innovative projects, it is often the case that the introduction of equipment is more promising, taking into account the results of the evaluation of the innovation according to traditional methodologies and the resulting financial indicators, The year of development and start-up of a production series is less than that of the alternative, i.e. the technology or equipment is more obsolete than that of another project.

The authors suggest that this contradiction should be allowed by supplementing the methodology for calculating the efficiency of innovations (and more specifically, innovation and investment projects in energy-related enterprises) with the indicator of moral wear of equipment. In this case, it is a question of predicting the technical and technological parameters of innovation (that is, essentially the technology foresight mentioned earlier, with all the characteristics described above). In studies by A.Ilyshev, N.Ilysheva, I.Voropanova and others. Methods are given for assessing the possible durations of the competitive advantages (resulting from the creation of fundamentally new products or technologies) and the degree of market demand for the results of IIP based on the agreed opinion of experts. The Concept of Innovation in Electricity also provided examples of the use of scoring; a three-point system (unsatisfactory, satisfactory, good) for estimating innovation parameters was used.

The methodology of the expert study in general includes the preparation of assessment scales, organization, conduct, processing of the results of the survey, obtaining the estimates / analysis of the results.
Analysis of the results of the retrospective assessment of innovation, which is analogous to the innovation and investment project being developed (this is done by comparing individual expert estimates of the indicators of analog with the actual values of these parameters) leads to the following conclusions:

- the majority of «expert candidates» have individual deviations of the ratings less than 50% from the actual value and less than 20% to deviate the ratings from the actual value;
- the value of the coefficient of variation on expert estimates of the duration of the competitive advantage of an innovation-analogue is 31.5 per cent for 24 experts and 13.5 per cent for the degree of demand of the object of the evaluation;
- with the exclusion of four specialists with the most different results from other experts from the group of «candidates for experts» the homogeneity of the group increases significantly - of 20 experts is 22.2%, - 8.3 per cent.

In the second phase, each of the 20 experts was interviewed to obtain their estimates of a possible period of competitive advantage and demand for innovation. The average duration of the competitive advantage is thus taken to be 11.8 years, which is almost equal to the equivalent. The degree of demand for the results at the end of the term is markedly lower (63.2 per cent compared to 72 per cent for the counterpart), which is due to increased competition in the innovation market.
The coefficient of variation on expert estimates of the duration of the competitive advantage of the proposed innovation is 27.5 per cent for 24 experts, and 15.0 per cent for the degree of demand for the subject of the evaluation, the range of individual ratings for individual experts is significant.
The analysis of the survey results begins with the summary table. At the intersection of each row and column, the space assigned to the 1st topic by the 1st expert is indicated.
In order to improve the consistency of experts' opinions, a second round of expert survey is possible, during which the possibility of supplementing the list of evaluations with the indicator «degree of novelty», which characterizes the «innovation» of the project is investigated (the degree of innovation in the results of the project), and therefore the importance of the measure of «moral depreciation» in this case.
The Innovation and Investment Rating Scale is:

- 10 points for the first time in the world;
- 7 points for the first time in the country;
- 5 points for the first time in the region;

Implemented in the form of an improvement of the previously created project - 2 points.
In this case, the grading of degrees for innovation projects and innovation investment projects are based on a combination of the duration of the main competitive advantage and the average level of demand for project outputs over the relevant life cycle.
The period of retention of the main part of the competitive advantage is taken to be the period during which less than 50 per cent of the initial value of the competitive advantage is lost. A uniform scale of changes in demand values for project results is conditionally adopted.
The following is an example of a possible combination of the two prognosis of the projects with the example of the power plant (see Table 2).

Table 2. Combinations of hours of use and retention of competitive advantage in thermal power plant innovation

Duration of competitive advantage, D_a, years	Time ranges in years	Number of hours of use of thermal power plant per year (% of annual values), H_u				
		1	2	3	4	5
		up to 60	61-70	71-80	81-90	91 or more
1	15-17	1.1	1.2	1.3	1.4	1.5
2	17-21	2.1	2.2	2.3	2.4	2.5
3	21-24	3.1	3.2	3.3	3.4	3.5
4	24-27	4.1	4.2	4.3	4.4	4.5
5	27-30	5.1	5.2	5.3	5.4	5.5

In the table, there are combinations of two features that form a gradation of the degree of prospectivity of innovation project. In this example, the dependency of obsolescence of the TES on the number of hours of use of the installed capacity per year is presented in the correspondence table, where the intersection of these values shows the degree of promise of the IIP (see Table 3).

Table 3. Ranking of Innovation and Investment Project Prospects (in a combination of two topics)

Degree of promise of Innovation and Investment Project		Combinations of competitive advantage retention and demand for Innovation and Investment Project outputs
code	Name	
A	Highest	5.5; 5.4; 4.5
B	Very high	5.3; 4.4; 3.5
C	High	5.2; 4.3; 3.4; 2.5
D	Above average	5.1; 4.2; 3.3; 2.4; 1.5
E	Average	4.1; 3.2; 2.3; 1.4
F	Below average	3.1; 2.2; 1.3
G	Very low	1.1; 1.2; 2.1

In this case, the following formula will be used to calculate the indicators of the table (each of which corresponds to some degree of prospectiveness of equipment (P_r):

$$P_r = N_h * D_{ca} * D_{inn} \quad (5)$$

where

N_h - number of hours of installed capacity, per cent per year;

D_{ca} - duration of competitive advantage, years;

D_{inn} - degree of innovation of Innovation and Investment Project.

Equation parameter evaluation formulae:

1. Number of hours of use of the installed power capacity of power equipment - as a private annual energy generation to the installed capacity of equipment.

The number of hours of installed capacity shall indicate the number of hours required to produce energy on a given machine equal to the actual annual generation provided that it is continuously running at full installed capacity. For power plants operating in different modes, this indicator has the following values:

- forbase-mode stations. . 6,500 - 7,000 hours a year
- for half-Peak operating mode 4,500. 6,500 hours a year
- for peak operating mode 3000. . . 4500 hours a year

2. The period of maintaining the competitive advantage of D_{ca} is taken as equal to the number of years before the date of moral obsolescence and in the table corresponds to the values of the column «Time ranges in years». The authors suggest that this indicator should be calculated with the following ratios in mind:

$$D_{ca} = MO_{full} - MO_{fact} \quad (6)$$

where

MO_{full} - prescribed period of obsolescence of equipment, years;

MO_{fact} - state of moral obsolescence for the present, for years.

As the duration of the competitive advantage of D_{ca} increases, the degree of demand (perspective) of the equipment increases. As expected, this is the second type of obsolescence (MO_2), i.e., the degree of change in technical and economic indicators over time. The period of complete obsolescence of the equipment is considered, taking into account that this period exists for each type of equipment but is not of a certain quantitative value.

3. The degree of innovation of the project is based on the scoring of innovation on the 10-point rating scale described above. When the degree of innovation is increased (from «realized for the first time in the world» to «realized in the form of an improvement of the previously created project»), the degree of demand (perspective) of the equipment is increased accordingly.

Possible combinations of features are indicated in the table by the lines connecting the values of the indicators of the rows and columns of the table. The numerical values in the received cells correspond to the values of the prediction parameters. A shaded area is an area of lifetime limitations whose values are excluded from the calculation (see Table 4).

Table 4. Combinations of hours of use and retention of competitive advantage in thermal power plant innovation

Duration of competitive advantage, D_{ca}, years	Time ranges in years	Number of hours of use of thermal power plant per year (% of annual values), H_u				
		1	2	3	4	5
		up to 60	61-70	71-80	81-90	91 or more
1	15-17	1.1	1.2	1.3	1.4	1.5
2	17-21	2.1	2.2	2.3	2.4	2.5
3	21-24	3.1	3.2	3.3	3.4	3.5
4	24-27	4.1	4.2	4.3	4.4	4.5
5	27-30	5.1	5.2	5.3	5.4	5.5

When you cut the power utilization hours, which are limited by the assigned service life, you get the value P_r = 28 years.

An additional projection parameter should be the provisions set out in the organization's industry standard. This document considers the «Assigned Service Life» value, which is equal to the calendar life of the facility, at which point the facility must cease operation regardless of its technical condition. The assigned service life shall be calculated from the day the facility is put into operation.
An additional phase of research (evaluation of the degree of innovation of projects) yields the following results (see Table 5).

Table 5. Combinations of Competitive Advantage Retention Times, Innovation Demand and Project Innovation for Thermal Power Plants

Duration of competitive advantage, D_{ca}, years	Time ranges in years	Number of hours of use of thermal power plant per year (% of annual values), H_u				
		1	2	3	4	5
		up to 60	61-70	71-80	81-90	91 or more
15-17	2	1,1,2	1,2,2	1,3,2	1,4,2	1,5,2
	5	1,1,5	1,2,5	1,3,5	1,4,5	1,5,5
	7	1,1,7	1,2,7	1,3,7	1,4,7	1,5,7
	10	1,1,10	1,2,10	1,3,10	1,4,10	1,5,10
17-21	2	2,1,2	2,2,2	2,3,2	2,4,2	2,5,2
	5	2,1,5	2,2,5	2,3,5	2,4,5	2,5,5
	7	2,1,7	2,2,7	2,3,7	2,4,7	2,5,7
	10	2,1,10	2,2,10	2,3,10	2,4,10	2,5,10
21-24	2	3,1,2	3,2,2	3,3,2	3,4,2	3,5,2
	5	3,1,5	3,2,5	3,3,5	3,4,5	3,5,5
	7	3,1,7	3,2,7	3,3,7	3,4,7	3,5,7
	10	3,1,10	3,2,10	3,3,10	3,4,10	3,5,10
24-27	2	4,1,2	4,2,2	4,3,2	4,4,2	4,5,2
	5	4,1,5	4,2,5	4,3,5	4,4,5	4,5,5
	7	4,1,7	4,2,7	4,3,7	4,4,7	4,5,7
	10	4,1,10	4,2,10	4,3,10	4,4,10	4,5,10
27-30	2	5,1,2	5,2,2	5,3,2	5,4,2	5,5,2
	5	5,1,5	5,2,5	5,3,5	5,4,5	4,5,5
	7	5,1,7	5,2,7	5,3,7	5,4,7	4,5,7
	10	5,1,10	5,2,10	5,3,10	5,4,10	4,5,10

For the indicators considered, the scoring of the results of the two matched IIP scores differ by magnitudes well, corresponding to innovation scores.

Conclusion

The transition from two to three indicators of the future of the IIP makes it possible to calculate the absolute value and the additional economic effect of the more promising option.

In this example, all three characteristics of the second variation of the anta are inferior to those of the first variant, and the result of the comparison is predetermined. In most cases where these characteristics have been deviated from, the practice is different, which leads to the need for appropriate calculations.

Thus, in comparison with the calculation obtained by using the formulas proposed by A.Filatov and the values obtained by the expert forecasting method, we get that Tm will equal in each of the cases described:

P_{r_calc} = 24 years,

P_{r_expert} = 28 years

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