SOME POSSIBILITIES FOR APPLICATION OF DYNAMIC CRITERIA IN ESTIMATION OF THE ECONOMIC VALIDITY OF INVESTMENT PROJECTS IN AN ELECTRIC ENERGY DISTRIBUTION COMPANY

Stojan Vasović
Elektrodistribucija Cacak, Krenov prolaz bb, Serbia, stojan.vasovic@gmail.com

Jasmina Vesić Vasović*
University of Kragujevac, Tehnical Faculty Cacak, Svetog Save 65, Serbia, jasmina.vesic@gmail.com

ABSTRACT

The paper presents some aspects of application of various economic criteria for evaluating the investment projects in an electric energy distribution company. Starting with the specific properties of investment projects in electric power industry, it is necessary to perform a correct analysis and estimation of all relevant project elements, in order to take into consideration all the aspects of validity of investing into implementation of that project. In that sense, in this paper, specific properties of investment projects in electric energy distribution companies were taken into account – long investments period, unbalanced realisation dynamics, limited financial resources etc. Companies use various project evaluation techniques to determine the feasibility and profitability of a project. The criteria based on discounting represent the dynamic aspect of investing and are suitable for economic evaluation of investment project from many various aspects, as is the case with investment projects in electric power industry.

Key words: dynamic investment criteria, investment projects in electric power industry

1. INTRODUCTORY CONSIDERATIONS

Dynamics and complexity of modern business and economy impose the need for the company to invest in order to become more competitive in increasingly stricter business circumstances, i.e. to make certain investments at present with the aim of accomplishing the effects and benefits in the future. By using investments, as a development factor, the company undertakes measures to ensure the efficiency of its business in the future. The total process of investing is characterized by series of disposable and reusable investments, whose aim is to contribute to certain economic and non-economic effects in the near and far future; such effects are realistically expected to satisfy the validity of invested resources and realisation of one investment project. Diversity of relevant factors in investment project and their constant variability impose the need for estimating the results in relation to planned project values. The existence of alternative economic possibilities for using resources necessary for realisation of investment projects imposes the need for estimating its efficiency, because the selected project can be considered useful only if it is somehow better than the other ones. Its advantage can be based on financial profitability, i.e. on net income from which the investor makes profit and/or on social profitability, the total influence of project on state economy, as is the case with investment project in electric power industry.

Since electric energy distribution companies within Electric-power Industry of Serbia operate as monopolists on the electric energy market, it is logical that the work of those companies is controlled by independent regulatory agency of the Republic of Serbia, i.e. Energy Agency of the Republic of Serbia (AERS). The aspirations of AERS are: to provide good quality of electric energy for the buyers; higher efficiency of electric energy distribution companies in utilization of available potentials; lower operating costs of electric energy distribution companies. The main task
of electric energy distribution companies regarding resources control is the increase of reliability, with simultaneous reduction of participation of human and financial resources. Management of resources of electric energy distribution system, which are limited anyway, is a complex process which must include geographic diversity and all other particularities of certain electric energy distribution companies. Starting with the specific properties of investment projects in electric power industry, it is necessary to perform a correct analysis and estimation of all relevant project elements, in order to take into consideration all the aspects of validity of investing into their implementation. In that sense, in this paper, specific properties of electric power industry, i.e. electric energy distribution, long investments period, unbalanced realisation dynamics, limited financial resources etc. should be taken into account.

The importance of improving the process of investments management and investment projects evaluation in electric energy distribution companies is shown by many performed investigations, published in various papers. The aim of the paper (Biezma, Cristóbal, 2006) is to develop a clear description and understanding of the uses and limitations of many different project evaluation techniques. The paper (Sauma, Oren, 2007) focuses on different economic criteria that should be considered when planning electricity transmission investments. The approach (El-Khattam, et al, 2004) proposes a new heuristic approach for distributed generation (DG) capacity investment planning from the perspective of a distribution company. This article (Andersson, Taylor, 1985) examines the investment criteria used by the Swedish power industry. This paper (Lee, Yang, 1998) presents a comparative study of three evolutionary algorithms related to the optimal reactive power planning problem. The paper (Moreira, et al, 2009) proposes a project prioritizing method for investment decision in electrical energy distribution networks, based on a multi objective genetic algorithm. In the work (Rivera, Vargas, 2007), the subject of hierarchical expansion planning and the basis for an investment decision methodology for determining the investments that electric distribution utilities are presented. This work (Fawzi, et al, 1983) presents an efficient algorithm for the static investment planning of large radial distribution systems. Companies use various project evaluation techniques to determine the feasibility and profitability of a project. Within the evaluation of investment projects, it is necessary to take into account all the advantages and expected effects of evaluated project application. Measuring of total effects brought by exploitation of one investment project and their quantitative expression by particular criteria makes it possible to estimate whether the expected effects will exceed the total necessary investments.

2. EVALUATION OF INVESTMENT PROJECTS

Evaluation of investment projects involves overview and estimation of all relevant factors, i.e. determining of economic and non-economic effects obtained by exploitation of one particular investment. The company - investor is mostly interested in direct economic investment effects, while other business entities and society are interested in indirect effects brought by development-investment project. Therefore, when evaluating the investment project, the estimation of economic-financial efficiency and estimation of social validity of the specified investment should be included as well. The estimation of economic validity includes only those effects which the project brings to the investor, while the estimation of social validity includes overview of all the effects which the investment project brings to the society as a whole. The essence of evaluation of investment projects efficiency is the same, whether it is economic-financial or social profitability, and it consist of three stages: identification of quantities, quality and time synchronisation of physical input and output; determining of appropriate prices at the input and output with the aim of calculating proper values of costs and benefits; presentation of project costs and benefits in the way which facilitates comparison with alternative projects.

Estimation of validity of investment projects realisation implies the comparison of performed investments and effects achieved by projects exploitation. In order to provide conditions for comparing these values, it is necessary to reduce them to appropriate values at the same moment of time, i.e. to perform their discounting. Criteria based on discounting – dynamic criteria – unlike static ones, take time into account in adequate way in the process of analysis and estimation of investment projects efficiency, including the whole period of investments and exploitation of one investment project. These criteria represent the dynamic aspect of investing and they are suitable for economic evaluation of the
3. THE SELECTION OF THE MOST FAVOURABLE INVESTMENT PROJECT BASED ON APPLICATION OF DYNAMIC CRITERIA

The estimation of validity and usefulness of investment projects can be carried out by setting the dynamic criteria values as eliminatory categories, by determining the minimal value of each of them, as well as by using the necessary condition of investment acceptability. By this it is implied that the present value is bigger than zero, internal profitability rate is bigger than some minimally acceptable rate at which the invested resources can be paid back, while annuity is bigger than zero. Among valid and useful investment project, the most favourable one was determined by maximisation of dynamic criteria, which represented a sufficient condition for making rational investment decision.

The demonstration of determining the most profitable investment project in an electric energy distribution company will be performed on the practical example, where it was necessary to determine the most favourable one out of three offered projects. The estimated investment projects arose from the Study “Development of distribution network and selection of the mean voltage in the region of Electric Energy Distribution of Čačak for the period up to 2020”.

- The project ED-92 represents the replacement of the conductor of section Al/Č 25 mm$^2$ with the conductor of section Al/Č 50 mm$^2$ in the first part (4.57 km long) of the power line 10 kV from TS 35/10 kV/kV “Bresnica”, branch for Mrcajevci. The value of the necessary investments is 27420 €, and total reduction of losses which will be accomplished by realisation of this investment project is about 19 kW, i.e. the planned business effect in the ten-year exploitation period is 5970 € on the annual level.

- The project ED-145 represents the replacement of the conductor of section Al/Č 16 mm$^2$ with the conductor of section Al/Č 50 mm$^2$ of the total length of 3.1 km, of the power line 10 kV from TS 35/10 kV/kV “Separacija”, branch for Vinogradi. The value of the necessary investments is 18600 €, and total reduction of losses which will be accomplished by realisation of this investment project is about 14 kW, i.e. the planned business effect in the ten-year exploitation period is 4400 € on the annual level.

- The project ED-169 represents the replacement of the conductor of section Al/Č 25 mm$^2$ and Al/Č 30 mm$^2$ with the conductor of section Al/Č 50 mm$^2$ in the total length of 3.93 km, of the power line 10 kV from TS 35/10 kV/kV “IKG”, branch for Goracici. The value of the necessary investments is 23580 €, and total reduction of losses which will be accomplished by realisation of this investment project is about 15 kW, i.e. the planned business effect in the ten-year exploitation period is 4700 € on the annual level.

3.1 Net present value criterion (NPV)

First of all, comparison according to present value criterion will be performed; this criterion represents the net benefit of the investment, determined by discounting to a certain time period with appropriate discount rate of future courses of its income and costs. Starting with the fact that the present value of an investment project represents a difference between realised (present) values of accumulation accomplished by project exploitation and realised value of invested resources, it can be calculated as follows (Radojicic, 2009):

$$NPV = A_S - I_S$$
where: \( A_S = \sum_{n=1}^{\ell} \frac{A_n}{(1+i)^n} \) - total present value of investment project accumulation realised in exploitation period \((\ell)\);
\[
\frac{1}{(1+i)^n} - \text{discount factor, realisation coefficient;}
\]
\( A_n \) - accumulation (amortisation calculated as well) in \( n \) year of exploitation period;
\( I_S = \sum_{n=1}^{q} \frac{I_n}{(1+i)^n} \) - total present value of resources invested in realisation of an investment project;
\( I_n \) - value of investing into investment realisation in \( n \) year of investing period;
\( q \) - period in which investing into investment project is made.

By applying the described procedure, the present value of project ED-92, at interest rate of 12%, would be equal to: \( \text{NPV}_{ED-92} = A_{SED-92} - I_{SED-92} \), since
\[
A_{SED-92} = \frac{5970}{1+0.12} + \frac{5970}{(1+0.12)^2} + \frac{5970}{(1+0.12)^3} + \ldots + \frac{5970}{(1+0.12)^{10}} = 33721.1 \text{ €}
\]
\( I_{SED-92} = I_{SE-92} = 27420 \text{ €} \), because the investing would be performed at once, in the year preceding the exploitation beginning, so it is not necessary to discount the values of invested resources; therefore, the following is obtained: \( \text{NPV}_{ED-92(12\%)} = 33721.1 - 27420 = 6311.1 \text{ €} \)

In an identical way, the present value of project ED-145, i.e. ED-169 was calculated, so the obtained values are \( \text{NPV}_{ED-145(12\%)} = 6260.44 \text{ €}; \text{NPV}_{ED-169(12\%)} = 2975.47 \text{ €} \)

Each of the three estimated projects is economically valid according to the present value criterion, because the present value of each of them is bigger than zero. Present value can be used as an indicator of validity, i.e. usefulness of investing, acceptability or unacceptability of an investment project in global sense. This is the absolute indicator of investment efficiency and it shows whether the project is economically efficient or not, but it does not specify the efficiency extent.

For comparing different projects, it is more convenient to use the following indicator as a relative value: present value reduced to investment unit, as an indicator of the relative economic efficiency (REE) of the project. It is defined as the ratio of present project value and total present value of invested resources: \( \text{REE}_S = \frac{\text{NPV}_S}{I_s} \)

For project ED-92 it is \( \text{REE}_{ED-92} = 0.23 \), for project ED-145 - \( \text{REE}_{ED-145} = 0.34 \) and for project ED-169 - \( \text{REE}_{ED-169} = 0.13 \). Since project ED-145 accomplishes the highest unit present value, i.e.: \( \text{REE}_{ED-145} > \text{REE}_{ED-92} > \text{REE}_{ED-169} > 0 \), that makes the most favourable basis for making the decision on accepting its selection.

### 3.2 Criterion of internal rate of return (IRR)

Criterion of internal rate of return is an universal and complex indicator of investment efficiency, which helps in finding the one discount rate which indicates which part of the project is “lost” due to inflation, and which part serves for compensation of risks and further development, i.e. it indicates at which smallest discount rate the project realisation is still valid.

Internal rate of return represents the discount rate at which the present value of the project equals zero, i.e. for which the realised value of investment project accumulation equals the realised value of invested resources: \( \text{NPV} = A_S - I_S = 0 \Rightarrow A_S = I_S \)

One of the methods for determining internal rate of return implies determining of two close realisation rates \( (p_1, p_2) \), for which the present value changes the mark, so that the internal rate of return is in interval \( p_1 - p_2 \). Calculating of internal rate of return is done by the following expression:

\[
\text{IRR}_S = p_1 + \frac{\text{NPV}_1}{\text{NPV}_1 - \text{NPV}_2} (p_2 - p_1)
\]

For the estimated example, we shall first calculate the present project values at interest rate of 20% (condition \( \text{NPV} < 0 \) is fulfilled), whose values are: \( \text{NPV}_{ED-92 (20\%)} = -2391.37 \text{ €}; \text{NPV}_{ED-145(20\%)} = -153.44 \text{ €}; \text{NPV}_{ED-169(20\%)} = -3875.72 \text{ €} \).
By replacing the appropriate values in the expression for calculating the internal rate of return, the following is obtained for project ED-92:

$$\text{IRR}_{ED-92} = 12 + \frac{6311,1}{(6311,1 + 2391,37)} (20 - 12) = 17,80\%$$
i.e. for project ED-145 - $\text{IRR}_{ED-145} = 19,81\%$; ED-169 - $\text{IRR}_{ED-169} = 15,47\%$.

Since the internal rate of return for each of the estimated projects is bigger than interest rate on capital market, they are efficient for realisation. Project ED-145 has the highest value of this criterion, so it is the most favourable according to this criterion as well.

By applying the internal rate of return criterion, the subjective influence of the decision maker is reduced and better quality of decision-making process is provided, because the smallest interest rate at which the project realisation is still valid is calculated (not assumed).

3.3 Criterion of annuity

Annuity criterion represents the annual measure for estimating the efficiency of undertaken investment. It represents the difference between the average realised annual accumulation and average realised amount of invested resources. Conversion into average annual values is done by annuity factor, determined according to:

$$a_f = \frac{i \cdot (1 + i)^n}{(1+i)^n - 1} = \frac{0,1 \cdot (1 + 0,1)^5}{(1+0,1)^5 - 1} = 0,18$$

Annuity criterion is determined based on expression $A_n = A_S a_f - I_S a_r$;
i.e. for project ED-92: $A_{n,ED-92} = 33721,1 \cdot 0,18 - 27420 \cdot 0,18 = 1135,1$
For project ED-145 it will be $A_{n,ED-145} = 1126,88$, i.e. ED-169 $A_{n,ED-169} = 535,58$
According to this criterion as well, the projects are valid because the annuity is bigger than zero, i.e. the projects are valid if the average project income is sufficient for compensating for amortisation and minimally acceptable interest costs, presented in selected interest rate.

Project ED-92 has the highest positive value of annuity criterion, which is the proof of its advantage over other estimated projects.

3.4 Payback period criterion

Payback period criterion estimates the time needed for accomplishing the income equal to investment by exploitation of investment project. Therefore, payback period represents the time period expressed in years, in which the net effects made by exploitation of investment project will pay back the total invested resources. To be precise, that is the time period in which the total present value of investing into development-investment project will be compensated and equal to total present value of accumulation realised by that project: $A_S = I_S$

Payback period (t), is calculated by the following expression: $PP_j = I_j / A_j$

According to this criterion, the project can be considered efficient if its payback period is shorter than some maximally acceptable value of payback period of a suitable branch, group or similar activity.

The final overview of the results of evaluation of the estimated investment projects is given in Table 1, in which it can be seen that the project ED-145 is the most favourable for realisation according to all the criteria, because when compared to competitive projects ED-92 and ED-169, it offers optimal possibilities for fast payback of invested resources and realisation of particular income from investing.

<table>
<thead>
<tr>
<th>Investment criterion</th>
<th>Investment project</th>
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<th>Rang</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>ED-92</td>
<td>ED-145</td>
<td>ED-169</td>
</tr>
<tr>
<td>Relative economic efficiency</td>
<td>0,23</td>
<td>0,34</td>
<td>0,13</td>
</tr>
<tr>
<td>Internal rate of return</td>
<td>17,8 %</td>
<td>19,81 %</td>
<td>15,47 %</td>
</tr>
<tr>
<td>Annuity</td>
<td>1135,1</td>
<td>1126,88</td>
<td>535,58</td>
</tr>
<tr>
<td>Payback period</td>
<td>7</td>
<td>5,5</td>
<td>8</td>
</tr>
</tbody>
</table>
4. CONCLUSION

Decision-making related to investments and selection of the most favourable alternative represents one of the most important managerial activities which take place in various business areas. The accomplishment of investment project goals implies analysis and comprehensive estimation of relevant elements of the investment project on one hand, with necessary conclusions based on optimisation process results; on the other hand, it implies investment project realisation in line with foreseen investment programme performances (technical-technological solutions, foreseen time, and foreseen financial resources). The complexity of evaluation process and selection of investment project imposes the need for a complex approach, i.e. application of estimated dynamic criteria. They provide gradual introduction into techno-economic analysis of particular relevant elements, technological, market, financial, staff, ecological, social and other variables, with regard to specific properties of electric power industry and its significance and role in social and economic development. The effectiveness of investments can be considered from many aspects – economic, social, political, strategic etc. Different aspects of project estimation contribute to heterogeneity of criteria and methods for determining investments efficiency. In spite of the numerous criteria available, virtually the only ones used to determine whether to reject or to accept a project have been the net present value (NPV), internal rate of return (IRR) and payback period (PP). The optimisation of investment options is an important consideration for an electric energy distribution company if it is to remain competitive in an ever demanding market. The calculation of investments is an expensive tool of enterprise management used in planning the investments. It can be perceived as the harmonization and evaluation of the models for investment decision-making.

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