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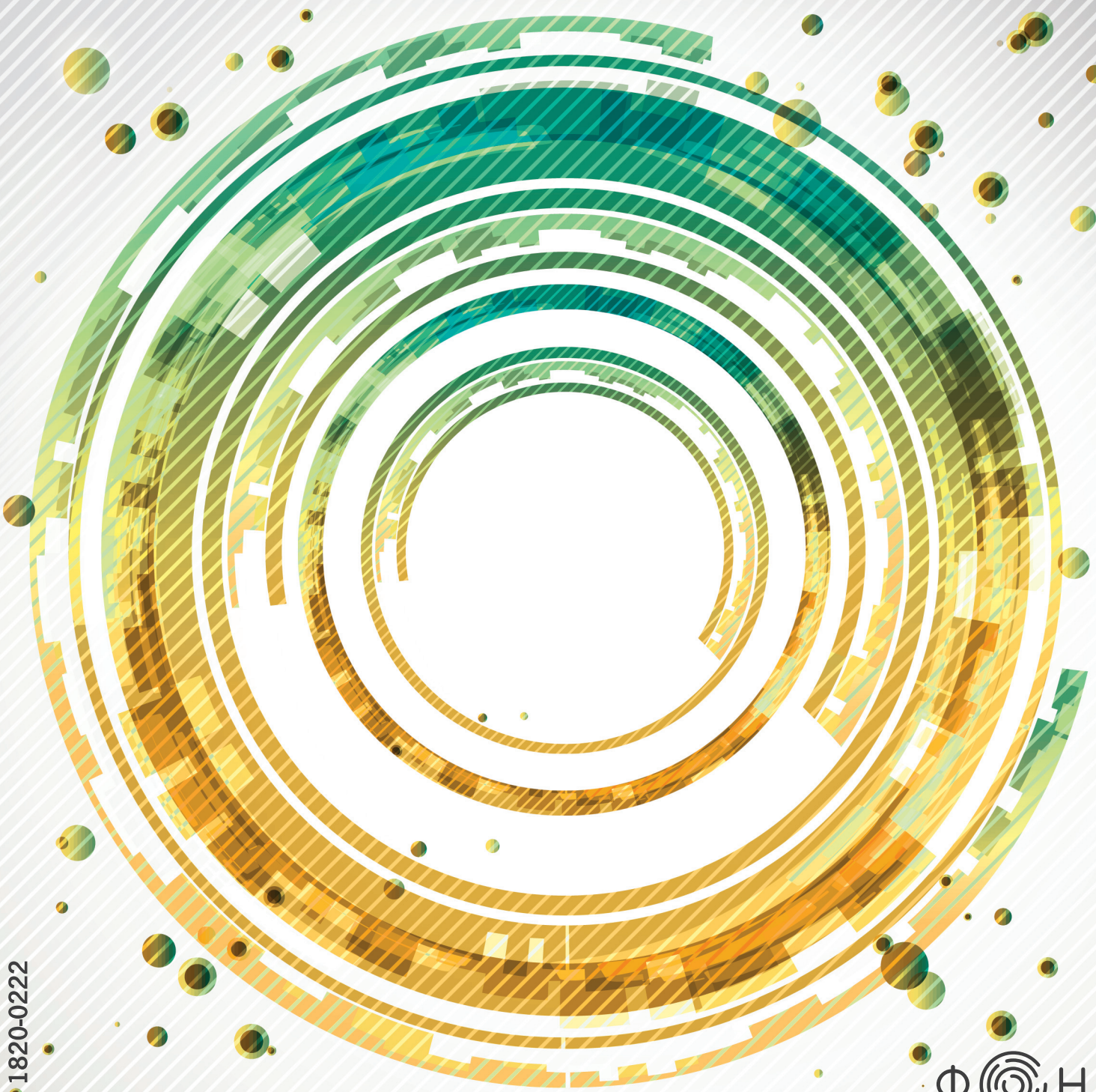

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УНИВЕРЗИТЕТ У БЕОГРАДУ
ФАКУЛТЕТ ОРГАНИЗАЦИОНИХ НАУКА

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# Cost-Benefit Analysis of the Project of Power Generation from Renewable Sources

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The problem of exploitation of exclusively conventional sources of electricity points out the fact that environmental sustainability is seriously endangered, increasing the dependency of the state in the field of electricity supply, reducing the economic potential of the community by increasing the cost of repairs, etc. The consequences that arise as a result of perceived problems are: high emissions of CO2 into the atmosphere, coal reserves are reduced progressively, while the agricultural population increasingly tends to migrate from the countryside to the cities. The results of previous studies in the field of biomass from agricultural waste indicate an increase in energy efficiency. This study analyzes the current state of Kolubara and performs a socio-economic evaluation of the cost-effectiveness of a gradual transition from conventional to alternative energy sources. The results are obtained using the Cost Benefir analysis. The results of this study highlight the potential benefits of biomass from agricultural waste compared to conventional energy sources through the implementation of positive evaluation received in the CBA[1]

**Keywords:** Cost-Benefit Analysis, renewable electrical energy sources, biomass from agricultural waste, investment projects

## 1. Introduction

The problem under investigation is a sad fact that the reserves of coal which is used as a non-renewable energy source in the RB Kolubara in the Municipality of Lazarevac are smaller and smaller. Reserves are almost exhausted. In addition to this problem, it seems that environmental problems and the problems of underdevelopment of the economy of the region and therefore the high unemployment rate, are increased. As it is well known, electrical energy produced at Kolubara, supplies approximately fifty percent of electricity the Republic of Serbia needs. One must not ignore the fact that coal pollutes the environment and causes negative environmental effects, and therefore has an effect upon cost increase. Hence the control of climate change [1] is one of the biggest historical challenges facing humanity in the 21st century [2]. According to the Kyoto Agreement [3] which was ratified by the Republic of Serbia, Serbia is committed to reduce harmful emissions of $CO_2$ into the atmosphere by 5.6% by the end of 2012 [4]. Also, a national consensus was reached that Serbia should increase its production of energy from renewable sources (only in the form of hydropower), from the present 7% of renewable energy production to 20% [5].

The results of previous studies in the field of using the biomass from agricultural waste indicate an increase in energy efficiency. In connection with these allegations are the facts that suggest that countries such as Denmark, Austria, Sweden and Germany, produc enough energy for their own needs, and export 5% of the energy to other countries [6]. An important fact is that after the 1970s' global economic crisis Denmark exited the crisis by adopting a number plans as part of its energy policy and proved that it was possible to exploit the potential of biomass for the production of electricity and heat. It should be noted that Denmark, together with Norway, Sweden and the Netherlands, is today a state that not only meets its own needs for

[1] The paper reports some of the results of the project "Investigation of the modern tendency of strategic management through specialized management disciplines in the competitiveness of the Serbian economy," the document number – 179 081, funded by the Ministry of Science and Technological Development of the Republic of Serbia.

electricity using biomass from agricultural waste, but also shows a constant increasing trend in exports [7]. With such a dynamic development of power generation [8], the use of biomass from agricultural waste there is a constantly present trend of increasing employment in the sector of renewable energy, so that on the basis of realistic forecasts, Germany is expected to create 400 thousand new jobs (about 2-3% per year) by 2020 [9]. Velimirovic and Djuric [10] point out that the industries based on renewable sources of electricity recorded the highest growth over the last six years. The study included the results that were obtained in the Laboratory for Thermal Engineering and Energy (Institute of Nuclear Sciences "Vinča"), and the results of the projects (NPEE 262 004) and (PTR-2022B), show that the concentration of $CO_2$ in the products of combustion amounts to about 150 mg/m3, a value below the permissible limit of 250 mg/m3 [11]. Oka [12] points out that the utility value of electricity for all energy resources is equivalent to coal, and the emissions of $CO_2$ in the flue gases within the limits proposed by the Institute of Nuclear Sciences.

The purpose of the study is to analyze the current situation of RB Kolubara, to give a clear and precise estimate of the investment and outline the benefits of re-orientation from the conventional to the non-conventional sources of electricity in the RB Kolubara. Also, as regards the fact that the Kolubara is a state company that owns coal reserves for 25-30 years, the research is to find out whether this project based on the system of rational investment into a portfolio of new products, can be self-sustaining. Furthermore, the results of this research should point out that the advantages of using biomass from agricultural waste are meeting the environmental criteria for combustion, low investment and exploitation costs (operating effectiveness – increasing from the current 13% to 21%) and employment opportunities for the entire area of RS, (about 2-3% per year), [13] and development of other economic sectors.

The aim of the research is to establish whether there are and what are the impacts of indirect effects this project will have, and which are concerned with the reduction in energy imports, with raising the environmental protection to a higher level, with the development of regional economy, reduction of unemployment, migrations, and other.

## 2. Research method

All calculations as well as choice of technology and market coverage were made for the RB Kolubara. The survey was conducted in 2010. using the cost-benefit analysis. In developed countries, the cost-benefit analysis is used in the evaluation of investments in the government (public) sector [14] Private companies evaluate their projects, taking into account only the effects that they receive [15]. In many developing countries, because of imperfect markets, cost-benefit analysis can be used for almost all investments [16].

Zerbe and Bellas [17] list the core principles of cost-benefit analysis:

1. Cost-benefit analysis believes that there is a difference in the contribution of individual projects and the overall social goals, and there is a difference in the effects of the individual project and the overall social standpoint.
2. Cost-benefit analysis should take into account all the benefits and costs, regardless of who actually enjoys them.
3. Lost benefits should also be taken into account as costs. The benefits are costs reduction.
4. All benefits and costs should be established, modified and expressed in a monetary way.
5. In the use of cost-benefit analysis in imperfect markets (developing countries), corrected market prices (accounting prices) should be used.
6. Cost-benefit analysis is suitable for projects that deliver multiple effects that enjoyed by a broad range of users.
7. Cost-benefit analysis helps optimize the allocation of limited resources.

Due to the fact that this research is conducted for the purpose of determining the cost-effectiveness of the investment project of introducing alternative energy sources in the RB Kolubara, the procedure of implementation of the cost-benefit analysis of investment projects proposed by the CBA Guide [18] consists of the following five steps:

– Conversion of market prices into accounting prices
– Assessment of indirect effects
– Including indirect effects into calculations
– Discounting the estimated benefits and costs
– Calculation of economic indicators (economic NPV, economic IRR and economic B / C ratio).

Key analyses used in this research are the following: feasibility and optional analyses, financial analysis and economic analysis of investment projects. Due to the fact that the Republic of Serbia is an imperfect markets, it is important to point out that the survey used corrected market prices, i.e., accounting prices.

## 3. Research Results

Table 1 shows the optional parameters obtained by the analysis of the RB Kolubara, Lazarevac. Optional analysis was performed on the basis of the business of the Kolubara. The source of the data is the authors' research into the business oprations of the RB Kolubara.

**Table 1:** Optional analysis of Kolubara

| **Optional analysis of Kolubara** |
|---|
| **Option 1 - Do nothing** |
| The annual loss of 11 million euros<br>Coal reserves decrease<br>The need for permanent imports of electricity<br>High level of pollution<br>Permanent layoffs |
| **Option 2 - Small changes in current business** |
| Expansion of Mines - MZ Vreoci<br>Investment costs - 2 billion euros<br>Release of five thousand workers<br>Coal reserves - maximum 50 years<br>Loss identical to option 1 |
| **Option 3 - Do something** |
| Electricity production from agricultural waste.<br>Employing six thousand workers, reducing energy imports by 1%. |

The results show that the option 1 shows the current business of the RB Kolubara that records a steady annual loss of 11 million euros, that coal reserves are being exhausted, which results in a permanent increase in electricity imports, in the increase in environmental pollution, but also in an ever larger number of lay offs. Option 2 suggests that the expansion of the mines in the Local Community of Vreoci increases investment costs, threatens with layoffs, coal reserves will be exhausted in another 50 years, which proves that option 2 is very similar to option 1 except that it means a short delay of the current problems. The results obtained in option 3show that, if the production of electricity uses renewable sources, the results will be hiring new employees, reducing emissions of harmful particles, as well as reducing energy dependence of RS. In order to solve the current financial problems a financial assessment of electricity production from biomass from agricultural waste was made, namely the financial analysis of option 3.

**Table 2:** Financial evaluation of the project of introducing biomass from agricultural waste

| **Investment costs** | **351,208,236.00 euro** |
|---|---|
| Credit | 73.29% |
| Net assets | 26.71% |
| The interest rate per annum | 3.5% (repayment of 5 years with a grace period of 1 year) |
| **The average annual inflow years after repayment** | **Around -9,000,000.00 euro** |
| **Financial payback from** | |
| From investment returns | Performed in the second year of investment |
| Financial discount rate | 3.65% |
| FNPV | -427,973,763.90 euro |
| FRR | -3.35% |

The financial results of the analysis indicate that the investment is not cost-effective in terms of financial evaluation of the project. The parameters that favour it are big investments, negative average annual flow after repayment of the loan. As indicated in the table, the score for profitability is performed in the second year of investment. The negative values of FNPV and FRR suggest that if the Kolubara shifts to exclusively alternative energy sources, and does not take into account the indirect effects of effectuation of investment, this investment project will not be profitable at all.

Based on these criteria, the CBA was conducted and the results are shown in Tables 3 and 4.

**Table 3:** Indirect effects of the investment in the project of introducing biomass from agricultural waste

| **Cost of the project** | |
|---|---|
| Investment expenditures + current investment costs | 353,118,711.38 euro |
| The average operating cost of the project per year + current operating costs / year | About 18 million euro |
| **Average outflows project / year** | **About 80 million euro** |
| **Project Benefits / year** | |
| Reducing electricity imports | 7,358,400.00 euro |
| Reducing pollution caused by the emission of $CO_2$ | 3,489,034.86 euro |
| From agricultural farms | 81,064,800.00 euro |
| Reducing expenses for the porpose of payouts | 2,000,000.00 euro |
| Development of tourism in the municipality of Lazarevac | 1,935,000.00 euro |
| Construction activity | 15,457,377.90 euro |
| Reducing migration of rural population | 1,239,000.00 euro |
| **Total benefit per year** | **Approximately 144 million euro** |
| **Total revenue from the project RS / year** | **About 10 million euro (0.03% of GDP)** |

**Table 4:** Economic evaluation of the project of introducing biomass from agricultural waste

| **Economic evaluation of investment returns** | |
|---|---|
| From investment returns | Performed in the second year of investment |
| Economic discount rate | 12% |
| ENPV | 320,727,994.24 euro |
| ERR | 1.28% |
| B/C ratio | 1.15 |

The results obtained in Tables 3 and 4 indicate that the project is cost-effective if the evaluation of profitability include all indirect effects. Indirect effects earn an income of 10,000,000 euros annually upon payment of the debt, which represents 0.5% of the total GDP of the Republic of Serbia. Positive parameters ERR and B / C ratio indicates that the investment project is profitable.

### 4. Discussion

Based on the results obtained in this study it can be seen that the value of the electricity produced power alternative sources of energy is equivalent to that obtained from conventional sources of electricity. It is also proved that option 3, feasibility analysis, shown in Table 1, is the only possible. Namely, the current business operations at the RB Kolubara will generate further losses and will not solve any of the problems stated above. Taking into account the results presented in Table 2, it can be seen that the investment project is not financially viable, and that it produce losses of about 9 million. However, Tables 3 and 4 show that, if we take into account all the costs and benefits of this investment, the project is cost-effective according to all the crietria of investment-based decision-making, and that the expected returns on an annual basis over a period of investment amounts to 10 million euros per year. If we compare the results in the third and fourth tables it can be concluded that the difference in the annual benefit option 3 in comparison with options 1 and 2,as shown in Table 1, amounts to about 20 million gain on an annual basis. It can be concluded on the basis of the conducted CBA that this investment project is viable, and that it solves the current problem of the RB Kolubara.

## Conclusion

The survey results, the use of CBA, indicate that the starting hypothesis, according to which the project is socially profitable, solves macro-economic problems of the region, and significantly reduces environmental pollution, is proven to be correct. It also proves that alternative energy sources pollute the environment in a considerably leeser degree, and that the energy potential of alternative sources of electricity is equivalent to conventional energy sources. It is further proven that the implementation of this technology will help restore ecological balance in the devastated areas and also help establish a balance of biodiversity. What is extremely important to note is that this technology is the basis of all other activities that bring indirect effects upon the planned projects in the RB Kolubara. The realization of the proposed project is to reduce energy imports by 1%. A multiplication of the effects has shown that the use of this technology can produce 5% of the electricity for the needs of the RS; furthermore, under a contract of permanent employment about 5% new jobs can be created for the unemployed RS and also jobs for about 50,000 seasonal workers. This is also the opportunity for cooperatives to hire workers. As the RS agreed to increase the share of renewable energy sources in the overall balance of production, these projects are very popular for the region of AP Vojvodina. Using the multiplication it has been calculated, that within the period of 45 years, using this technology, the production of electrical energy in RS will be produced in the amount of 62% of the total electrical energy the RS needs. Following the presented arguments as to why this investment project is viable, the subject of further research should be the development of a sensitivity analysis which would answer the question concerning the conditions under which, in terms of risk, this project should be fully implemented.

## REFERENCES

[1] Petrović N., Drakulić M., Vujin V., Drakulić R., Jeremić V., Climate change and green IT, Management, Vol. 16, No. 59, pp. 35-43, 2011.
[2] Haščič I., Johnstone N., Kahrobaie N., International Technology Agreements for Climate Change: Analysis Based on Co-Invention Data, OECD Environment Working Papers 42, OECD Publishing, 2012.
[3] OECD, *OECD* Environmental Outlook to 2050: The Consequences of Inaction, OECD Publishing, 2012.
[4] Mihić M., Petrović D., Vučković A., Obradović V., urović D., "Application and Importance of Cost-Benefit Analysis in Energy Efficiency Projects Implemented in Public Buildings: The Case of Serbia", Thermal Science, Vol. 16, No. 3, pp. 915-929, 2012.
[5] Mihić M, Vučković A, Vučković M, Management benefits of energy efficiency projects in public buildings in Serbia, Management, Vol. XVII, No. 62, Faculty of Organizational Sciences, Belgrade, pp. 57-65, 2012.
[6] Brkić, M. i Janić, T, Biomass briquetting, Faculty of Agriculture Novi Sad, Novi Sad, 1999.
[7] Boemare, C., Quirion, P. Implementing greenhouse gas trading in Europe: lessons from economic literature and international experiences, Ecological Economics, Vol. 43, No. 2-3, pp. 213-230, 2002.
[8] World Commission on Environment and Development, Our common future. Oxford: Oxford University Press, 1987.
[9] Jordanović – Vasić, M, The use of biomass from agricultural waste as a renewable energy source, + Science Practice, vol. 12, No. 1, pp. 60-63, 2009.
[10] Velimirović, M., urić, A., Energy efficiency of utilization of biogas generated from anaerobic digestion of manure in Serbia Energy Technology, No. 1, pp. 27-29, 2009.
[11] Regulation on emission limit values, the method and terms of measuring and recording. Official Gazette, No. 30, 1997.
[12] Oka, S, The use of solid waste bio-mass for energy purposes, the Institute of Nuclear Sciences "Vinca", Belgrade, Vinča, 1997.
[13] Kukobat, M, The use of biomass to produce electricity, the Federal Ministry of Economics, 1998.
[14] French, M. i sar., Benefit-Cost Analysis of Addiction Treatment: Methodological Guidelines and Empirical Application Using the DATCAP and ASI, Health Serv Res, 37(2): 433–455. 2002
[15] Mihić M, Petrović D, Vučković A, Possibilities of application of cost-benefit analysis of energy efficiency projects in buildings, Economic issues,Vol. 49,No.3, Faculty of Economics, University of Nis, pp. 355-378, 2011.
[16] Banfi S., et al., Willingness to Pay for Energy-Saving Measures in Residential Buildings, Energy Economics, Vol. 30, No. 2, pp. 503-516, 2008.
[17] Zerbe, R. and Bellas, A, A primer for Benefit – Cost Analysis, Edward Elgar Publishing Inc, 2006.
European commission: Guide to COST-BENEFIT ANALYSIS of investment projects, 2008

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