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Original Article

The Effect of the Investment Implementation Time on the Solar Energy Investment Justification: The Case of Bosnia and Herzegovina

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Abstract: *Investment in solar energy is a very attractive venture for investors, but at the same time it is an under-researched topic, especially if the research questions are focused on developing markets such as the market of Bosnia and Herzegovina (BiH). There is a solar incentive system in BiH, but it is not sufficiently large to accept all producers. Therefore, the question arises whether solar incentives in BiH are necessary in the context of determining the profitability of solar power plants and whether it is worth investing without using the solar incentives of BiH. The empirical part of the research answers whether the attractiveness of investment in solar power plants is conditioned by doing business in the incentive system and how important the investment implementation time (IIT) is. Since IIT differs for companies in the incentive system and for those that are not, this indicator, using an adequate correlation regression analysis, may offer the answer to the question regarding the attractiveness of investment in solar power plants. The obtained results point out that IIT has a statistically significant influence on return on assets (ROA). However, by introducing the control variables in the model, it is evident that other factors also determine the profitability of these investments. It is important to emphasize that the results of this research do not point to the conclusion that producers that are not in the incentive system are unprofitable, which imposes new questions and inspires further research.*

Keywords: *Investment Implementation Time (IIT), Investment, Solar Energy, Bosnia and Herzegovina.*

I. INTRODUCTION

The constant growth of the need for electricity happened simultaneously with the increased pollution of the planet, but environmental awareness also grew in parallel. The fact is that renewable energy sources do not pollute the environment. In addition, as their name suggests, they can be renewed independently or through certain processes, so they can be used indefinitely. That is why renewable sources emerge as a logical solution to the pollution problem. Fossil fuels are to blame for climate change, and it is crucial for the world to replace them with renewable energy sources in order to achieve the goals agreed upon at the climate summits. Over the last century, it was unthinkable that solar power plants were more profitable than fossil fuels, but that has changed with the advancement of technology. The price of solar panels and other equipment necessary for the construction of a solar power plant has decreased so much that now solar power plants (as well as wind power plants) are cheaper than any other fossil fuel power plants, even without financial assistance from the state (the International Renewable Energy Agency – IRENA). In many countries, incentive systems were abolished as they are no longer needed to make investment in renewable energy cost-effective. In such countries, incentive systems are overcome and considered unjustified as they fulfilled their role. However, although IRENA and many other sources claim and provide concrete evidence that solar power plants no longer require incentives from the state, fostering the construction and operation of solar power plants varies around the world. In fact, incentive systems for the construction and operation of renewable energy power plants are still present in a large part of the world. Generally speaking, awareness of the need and benefits of solar power plants, the possibilities they offer, a proactive approach to construction, and the share of solar power plants in electricity production are all important factors that differ from country to country. Consequently, there are also deviations in the segment of (non)existence of the need to foster the construction of solar power plants.

There is an evident increase in the popularity of the construction of solar power plants, as well as a huge interest in investing in this type of electricity production. In addition, the fees for renewable sources constantly increase, and investment costs constantly decrease due to a drop in the prices of solar power plant components, with a projected increase in competitiveness compared to other power plants. There are the results of numerous researches on the markets of other countries available, but similar research in Bosnia and Herzegovina (BiH) does not exist. All these elements serve to motivate attempts to determine whether and how IIT or the fact that somebody uses the incentive system or not influences the justification of investment in solar energy projects in BiH.

II. THEORETICAL FRAMEWORK OF THE RESEARCH

The justification of investment in any project, solar energy projects included, is best measured through their profitability and ability to provide the investor with a satisfactory level of return on investment (ROI). The profitability of solar power plants and its determinants were investigated by numerous authors using different perspectives. In 2016, a scientific study was published on the profitability of small solar power plants in Italy without state incentives (Cucchiella, F. *et al.* 2016). After setting investment costs and assessing technical characteristics as well as macroeconomic indicators based on the literature data, profitability assessments were made for solar power plants of 3 kW, 6 kW and 20 kW by calculating the net present value (NPV) and the payback period. The results showed that small solar power plants in Italy are profitable without incentives (Cucchiella, F. *et al.* 2016). In an extensive study from 2018, which analyzed solar power plants in Spain and Germany (Prol, 2018), it was concluded that incentives should be adjusted so as not to create unnecessary costs for the state. It also showed that there are three main steps in the development of a consistent renewable energy policy: (i) focusing on research and development (R&D), (ii) fostering construction and production, and (iii) abolishing incentives and transferring to tender schemes when the industry matures (Lopez Prol, J., 2018).

Many authors investigated the relationship between incentives and the business success of producers of renewable energy sources. Chinese scholars conducted a regression analysis for the companies listed on the Shenzhen Stock Exchange and came to the conclusion that incentives did not have a statistical significance on the relationship between financial reserves and investments in innovation or the relationship between investments in innovation and the performance of small and medium-sized enterprises (Guo, F. *et al.* 2019). Peng and Liu (2018) conducted research on 58 companies in the "green industries" in China. They concluded that government incentives provided before the start of R&D activities and investments through financial allocation have negative effects on the relationship between R&D investment and company growth, while government incentives after projects achieved the expected results or after they were completed through refunds or tax reductions have positive effects on the relationship between R&D investment and company growth.

In another Chinese study, Zhu *et al*. (2019) collected data from the Shanghai Stock Exchange for 98 companies that use renewable energy in the period from 2012 to 2016. They analyzed the relationship between investment in innovation and business and how incentives affect this relationship. The study concluded that the incentives were not significant. Another Chinese study that analyzed the data from 88 companies for the period from 2001 to 2015 showed that incentives can compensate for R&D costs, which significantly encourages innovation (Shao, W. *et al*. 2021). It is important to mention another Chinese study which found that incentives had a positive effect on investments (Wang S. *et al.* 2020), as well as the research that showed that incentives increased the risk of solar power plant overload (Zhu, Z. *et al.* 2019).

As expected, certain studies have results that conflict with the mentioned studies. When it comes to the United States of America, which has a different incentive system compared to the European Union because it is predominantly based on tax incentives, the study by Hay, F. J. (2016) showed that participation in the incentive system was still a prerequisite for the construction and operation of a solar power plant to be profitable. The study was made using numerous economic and investment assumptions and through case simulation (Hay, F. J. 2016). Also, Hansen, Simmons and Yonk found that although solar panel prices fell from $60/W to $2/W in the period from 1976 to 2010, solar energy was still an expensive energy source and dependent on government incentives. However, only a few years later, the situation is such that the cost to build and operate a solar power plant (as well as a wind power plant) is lower than that of a new fossil fuel power plant. The already-built fossil fuel power plants are, however, more cost-effective than both of these options (America's Power, 2020).

However, the most important studies that are useful for this research and empirical analysis should be emphasized. First, that is the study in which Wang, S., Zhao, S. *et al.* (2020) discussed the impact of incentives on innovation in China. The postulated hypothesis was that incentives had a positive effect on innovation investments. The data were collected for manufacturing companies listed on the Chinese Stock Exchanges Shanghai and Shenzen for the period 2011-2019. The dependent variable was innovation investments expressed as R&D expense/business income. On the other hand, incentives were used as independent variables. The control variables were used in the model, i.e., the dummy variables for political connections as well as return on equity (ROE), solvency, etc. The analysis confirmed that incentives had a positive effect on innovation investments.

Another important source is the study by Shao W. *et al*. (2021). The data from 88 car manufacturing companies for the period from 2001 to 2015 were used, and the hypothesis was confirmed that incentives can compensate for R&D costs in companies, which significantly encourages innovation. In the model, the dependent variable, R&D intensity, was used, while the independent variables were incentives, profit, income, funds, etc.

In their research, Peng, H. and Liu, Y. (2018) analyzed the data from 2013 and 2014 annual reports for 58 companies in the "green industries" in China. A regression analysis showed that incentives given in advance had negative effects on the relationship between R&D investment and company growth, while subsequent incentives had positive effects. In this model, company growth expressed through income was set as the dependent variable, while R&D investment was the independent variable.

In 2019, Guo F. *et al.* postulated a number of hypotheses in their research, all of which were related to the effect of incentives on business operations. The study used the data from the Shenzhen Stock Exchange for the period 2007-2017. The sample consisted of 543 companies and 4489 observations, and a regression analysis was carried out. It was concluded that the relationship between incentives and business operations was not statistically significant.

The analysis by Zhu *et al.* (2019) collected data from the Shanghai Stock Exchange for 98 companies that produce new energy (solar, wind, biomass, lithium, and car industry on new energy) for the period 2012-2016. An empirical study was conducted to analyze the relationship of R&D investment with financial competitiveness and how incentives affected this relationship. The results showed that R&D investment had a positive correlation to financial competitiveness, while incentives had no effect on this relationship. One of the criteria of the model was the deletion of companies that registered losses for two or three consecutive years. The variables used were, for example, solvency or profitability, etc.

Zhang Z. *et al.* (2016) conducted a regression analysis to analyze the impact of incentives on the overcapacity of solar energy and wind energy companies. The results showed that incentives increased the risk of solar power plant overcapacity while they reduced it in wind power plant companies. The study concludes that incentives should differ for each industry. The model used data from the Shanghai and Shenzhen stock exchanges, while the companies with certain data missing were not included in the study. The sample included 21 companies in total for wind power plants and solar power plants for the period from 2009 to 2013. The dependent variable in the model was the return on net fixed assets, and the independent variables were the total annual incentives by companies, annual salaries, bonuses, assets, and production growth in the industries.

Schabek's research (2020) is also of great importance for this research. The analysis was conducted for the period from 2000 to 2017, and the author wanted to answer the question: What determines the financial profitability of renewable energy source producers, taking into account the type of power plant (solar or wind) and ownership structure (public or private)? A regression analysis was conducted for return on assets (ROA) and ROE for producers. The results showed that ROA was 0.09 higher for solar power plants than wind power plants and that the ownership structure had no effect on ROA, while ROE for public companies was by 0.09 lower. The independent variables used to explain ROA and ROE were also used in similar earlier studies. Company size was measured by the natural logarithm of the total assets, as in other studies. It was hypothesized that company size would have a positive effect on company business operations. The total income growth described demand for electricity and income management efficiency - both had a positive impact on financial performance, according to Iwata H. and Okada F.'s research (2011). Capital investments were also expected to positively affect ROA and ROE as they increase the company's production potential. The author also expected the debt/asset ratio to have a positive effect on financial profitability, as higher risk means higher expected return. Out of 2,504, it was possible to use 298 observations with the available data. The sample included the companies classified as 221119 Other Electric Power Generation and 221112 Fossil Fuel Electric Power Generation. A similar principle was followed in the study by Patatari S. *et al.* (2014). In order to create a clearer picture, a comparison of sustainable producers and those using fossil fuels was made. The result was that debt/equity had a negative impact on financial performance but not on ROE. Company size had a positive effect on ROE and ROA. The most interesting result was that solar power plants were more efficient than the other analyzed companies. The authors concluded that solar power plants were more profitable than wind power plants. Also, the authors stated that the greater the participation of renewable energy sources in the market, i.e., saturation, the lower the ROE and ROA.

Finally, the study by Balsari, C. and Ucdogruk, Y. (2008) should be mentioned in which the panel data were used for 100 companies listed on the Istanbul Stock Exchange from various industries for three years (2004-2006). The results showed that incentives had a negative impact on ROA, ROE and return on sales - net profit/revenue from sales (ROS) regardless of the industry. Also, it was concluded that incentives had a negative impact on the growth of sales and income and a positive impact on the growth of assets. The set variables were, for example, the dummy variable - in the incentive system. The results showed that incentives had a negative effect on equity and ROE but not on ROA. A regression analysis of the company's growth was also made. The results showed a negative impact of incentives on the growth of sales and income and a positive impact on the growth of assets, based on which the authors concluded that the incentives were not effective.

All this undoubtedly points to the presence and popularity of an adequate analysis of the determinants of profitability for solar energy projects in markets around the world. Having covered the results of the aforementioned research as well as different methodologies, the need became evident for the analysis to define the factors that determine investors' decisions to invest in solar energy projects on the market of BiH. As can be seen from the studies presented, the authors defined and investigated numerous determinants of the profitability of solar energy projects. The results of numerous studies on the markets of other countries, as well as the absence of similar studies in BiH, motivate attempts to determine whether and how IIT or the fact that somebody uses the incentive system or not influences the justification of investment in solar energy projects in BiH.

III. RESEARCH METHODOLOGY

The primary goal of the research presented is to determine, based on the theoretical and empirical findings, whether IIT has a significant impact on the justification of investment in solar energy projects on the market of BiH.

The main research hypothesis presented in this paper is:
H_1 The investment implementation time has a significant impact on the justification of investment in solar power plants

Besides the primary research goal, the operational goals are defined, which allow for the realization of the main research goal, as follows :

- Determine or explain the impact of IIT on ROA,
- Determine the effect of the investment debt level and its liquidity on ROA for the investors in solar power plants on the market of BiH.

The data processing and analysis were performed in the SPSS25.0 program. Due to the need to test the effect of specific variables on profitability in the empirical research, a sample analysis was conducted with 174 observations for the companies whose main activity was the production of electricity and which had a solar power plant for the period 2015-2020. Based on the previous research, dependent, independent and control variables were set, and a correlation and regression analysis was performed.

The database of the Operator for Renewable Sources and Efficient Cogeneration of BiH Federation (OIEIEK) was used in the research. The database shows all the companies that produce electricity using solar energy. These are the companies with different activities, structured as limited liability companies or self-employment businesses. Using the web portal for the search of legal entities of the Financial and Intelligence Agency of BiH Federation (FIA), a check was carried out, and all inactive and blocked companies were excluded. The population consisted of 159 producers of electricity using solar energy, out of which 91 companies had the code of the basic activity 35.11 Production of electricity, established through a search on the FIA website. Fifty-one companies were in the incentive system, and 40 were not. The abbreviated financial reports for the period 2011 - 2020 were available for 51 companies structured as limited liability or joint stock companies in the LRC Business Intelligence System.

The financial reports were collected for 31 companies with the production of electricity as the basic activity, which were in the incentive system for the solar power plant, and for 20 companies with the same basic activities, which had the solar power plant but were not in the incentive system. However, 17 of those companies made their financial reports public for one or two years only. Out of the remaining 34 companies, there was a high number of data flaws in the financial reports, which is why detailed testing was used to evaluate that the highest number of observations for the analysis was available in the observed period 2015-2020. That is why the remaining years were eliminated from the sample, as well as the companies that did not have all the data for this period.

After that, the problem of forming the sample happened as the majority of the companies registered a loss in one of the selected years. If these companies were to be excluded from the sample, an insufficiently large sample would be formed with no normal distribution. As a solution to this problem, the dependent variable was transformed using a constant and a logarithm by the rules of statistics and the recommendation of IBM (2020), Kim, A. (2019), McDonald, J. (2015), Kassambara, A. (2020) or Wicklin, R. (2011). After the values that deviated much and violated the normality of the model were removed, the sample that fulfilled the regression assumptions was formed. Finally, a sample of 174 observations from 29 companies was obtained.

Profitability is most often measured by ROA and ROE. This was also shown by previous studies where ROA and ROE were used as indicators of profitability, for example, in the study on the determinants of profitability of companies in the energy sector (Fareed, Z. *et al*. 2016). Also, ROA and ROE were used as indicators of profitability in the study on the financial performance of producers of renewable energy sources in growing markets (Schabek, T. 2020) or the study on the impact of incentives for development investments on business operations of companies in Istanbul (Balsari, C. and Ucdogruk, Y. 2008) However, since the number of missing data for ROE in the sample is > 5%, the variable is excluded from the analysis.

The main independent variable used in the research is IIT, which was vital due to the postulated hypotheses. It is justified to ask whether a long procedure that lasts for months has a certain effect on the profitability of business operations. IIT differs for the companies in the incentive system (36 months) and those not in the incentive system (26 months). Time was also used as an independent variable in the research by Shao W. *et al.* (2021).

Other variables that were of less interest for this research also influenced the profitability of solar power plants. In order to better show the effect of other factors on the profitability of the solar power plant, the following control variables were selected:

Company size (assets) = ln (Total assets)

Company size as a determinant of profitability was used by Guo F. *et al.* (2019) in their research. In the same way, using a natural logarithm of assets, Schabek, T. (2020) expressed company size in his analysis.

Indebtedness = Debt/assets

This is how Schabek, T. (2020) used indebtedness in his study. Indebtedness as the independent variable was also set in the model for assessing the impact of incentives for innovation on the business operations of the companies in Istanbul (Balsari, C. and Ucdogruk, Y. 2008). Also, the same variable was used in the analysis of the determinants of profitability of the companies from the energy sector (Fareed, Z. *et al.* 2016).

Liquidity = Total current assets/Total current liabilities

Liquidity was used as the control variable in the study on government incentives for business innovation (Wang, S. *et al*. 2020). It was also used in the research on the impact of incentives on the intensity of innovation of new energy vehicles (Shao, W. *et al*. 2021). After the dependent, independent, and control variables were carefully selected, taking into account previous similar studies, it was possible to set up the regression model. So, the basic regression model of the research was as follows:

$$Y_i = \beta_0 + \beta_1 IIT + \beta_1 Liquidity + \beta_1 Debt/assets + \beta_1 Company\ size\ (assets) + \varepsilon_i$$

The defined model was used when testing the main hypothesis, which would determine whether IIT had a significant impact on the justification of investment in solar power plants.

IV. THE RESULTS OF THE EMPIRICAL RESEARCH AND DISCUSSION

The research model required for testing the hypothesis, which would determine whether IIT had a significant impact on the justification of investment in solar power plants, is presented below:

$$Y_i = \beta_0 + \beta_1 IIT + \beta_1 Liquidity + \beta_1 Debt/assets + \beta_1 Company\ size\ (assets) + \varepsilon_i$$

The most important independent variable in the first auxiliary regression model was the variable Investment Implementation Time (IIT), which showed whether the company was in the incentive system or not.

Table 1: Descriptive statistics

	Mean Value	Standard Deviation	N
ROA	.702333	1.7593205	174
Debt/assets	.830694	11.5337285	174
Liquidity	1.633729	203.1718390	174
Company size (assets)	13.096700	56.9940526	174
IIT	32.15	227.897	174

Table 2: Correlation analysis

		ROA	Debt/assets	Liquidity	Company size (assets)	IIT
Pearson Correlation	ROA	1.000	-.507	.208	-.013	.566
	Debt/assets	-.507	1.000	-.316	.172	-.277
	Liquidity	.208	-.316	1.000	-.019	.176
	Company size (assets)	-.013	.172	-.019	1.000	-.098
	IIT	.566	-.277	.176	-.098	1.000
Sig. (1-tailed)	ROA	.	.000	.003	.430	.000
	Debt/assets	.000	.	.000	.012	.000
	Liquidity	.003	.000	.	.404	.010
	Company size (assets)	.430	.012	.404	.	.100
	IIT	.000	.000	.010	.100	.

The results of the correlation analysis for the defined model showed that the correlation between ROA and IIT was statistically significant, with a positive direction and medium intensity. The correlation between ROA and two control variables proved to be significant. Namely, the correlation of ROA and the debt/asset ratio was of medium intensity and negative direction, while the correlation of ROA and Liquidity had a positive direction, but it was of weaker intensity. The control variable, Company Size (assets), was not significant for the model.

Table 3: Model outline

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.680[a]	.463	.450	1.3046683	1.590
a. Predictors: (Constant), IIT, Company size (assets), Liquidity, Debt/assets					
b. Dependent variable: ROA					
c. Weighted Least Squares Regression - Weighted by weight					

The model outline, as well as the correlations, was identical to the basic model.

Table 4: ANOVA

Model		Sum of Squares	DF	Mean Square	F	Sig.
1	Regression	247.806	4	61.952	36.396	.000[c]
	Residual	287.665	169	1.702		
	Total	535.471	173			
a. Dependent Variable: ROA						
b. Weighted Least Squares Regression - Weighted by weight						
c. Predictors: (Constant), IIT, Company size (assets), Liquidity, Debt/assets						

The model significance was 0 < 0.05, which is satisfactory. The F-ratio was also appropriate; more precisely, it was 36.396 > 1. Thus, the results of the ANOVA test showed that the model had sufficient statistical significance for the supporting hypothesis to be rejected.

Table 5: Coefficients

Model		Non-standardized coefficients		Standardized coefficients	T	Sig.	Collinearity statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.596	.029		20.421	.000		
	Debt/assets	-.060	.009	-.394	-6.358	.000	.828	1.207
	Liquidity	3.616E-5	.001	.004	.070	.944	.890	1.123
	Company size (assets)	.003	.002	.100	1.743	.083	.966	1.035
	IIT	.004	.000	.466	7.886	.000	.911	1.097

IIT showed significance in the model. IIT was the key variable for testing the hypothesis. Given the hypothesis reads, that the investment implementation time has a significant impact on the justification of investment in solar power plants and that the model showed a significant impact of IIT on company ROA, it was concluded that the hypothesis cannot be rejected.

The collinearity indicator variance inflation factor (VIF) was VIF < 10, so there was no problem with multicollinearity in the model. This means that the regressor variables were not correlated and, that no variable was constant, and that the regressor variables were significant and the parameter estimates were reliable.

V. CONCLUSION

The empirical analysis was conducted on a sample of 174 observations for 29 companies. The dependent, independent and control variables were set in the model, and the regression and correlation analysis was performed. The analysis was inspired by a large number of earlier similar studies in which different results were obtained. The analysis was carried out with precision, and all the necessary analyses were made to test the assumptions of the regression model. The results of this research were useful in the sense that they were used to evaluate the postulated hypotheses. After the analysis, several conclusions were made, as presented below.

The main hypothesis, *that the investment implementation time has a significant impact on the justification of investment in solar power plants*, cannot be rejected because there was a significant statistical relationship between IIT and ROA. The conducted empirical research showed that the attractiveness of investments in solar power plants in FBiH is conditioned by incentives if attractiveness is seen as the answer to the question of whether business operations in or outside the incentive system are a statistically significant variable for ROA. However, the results of the empirical research in no way eliminate the possibility of profitable business if the company is not in the incentive system.

The conclusions made about the rejection or no possibility of rejecting the hypothesis were crucial in achieving the main research objective. The primary research goal set in the paper was to analyze, based on theoretical and empirical knowledge, whether the time period of implementation had an impact on the justification of investing in solar energy projects on the market of BiH as measured by ROA. After the empirical analysis was completed, the primary goal of the work was successfully achieved.

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