

## REVIEW

by Prof. Dr. Stefan Simeonov

on a dissertation on:

„INVESTMENTS IN PHOTOVOLTAIC PLANTS –  
FINANCIAL AND ENVIRONMENTAL ASPECTS“

author: Todor Dimitrov Georgiev,

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Doctoral program: "*Finance, monetary circulation, credit and insurance*"  
(*Finance*)

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Form of doctoral studies: *Full-time*

### 1. Relevance and importance of the topic

The actuality of the topic stems from the ever-increasing global trends for environmental friendliness in technology and, in particular, the use of renewable sources in the production of electricity, the goals set by the EU to reach a share of energy from renewable sources in the total energy balance of 27% compared to the total energy consumption and the goals set in Bulgaria's energy strategy. On the other hand, every investment requires efficiency, a key role for which is the price. And the price of electricity is variable, which is influenced by a number of factors, both market and regulatory.

### 2. Fulfillment of the formal requirements for the dissertation and presentation of the dissertation

The dissertation submitted for review contains all the components of a completed dissertation.

The introduction presents the mandatory elements that characterize the problem area of research as follows: topicality, object, subject, thesis, goal, tasks and methodology. In this regard, the development fully meets the standards and requirements for a dissertation work.

The purpose and tasks of the dissertation work are clearly and logically set.

*„Investments in photovoltaic plants in Bulgaria are defined as the object*

of the research.”

*„The subject of the dissertation is the financial and environmental aspects of decision-making for investments in photovoltaic plants, justified by the price levels and volumes of demand and supply on the national and international electricity market.*

*The research thesis of the dissertation is “based on the claim that the "Green Deal" in the EU creates a growing demand for low-carbon electricity production, which creates a positive outlook for investments in photovoltaic plants based on financial models for returns while complying with environmental regulations in the country and EU“.*

*„The purpose of the research is to make a financial and economic analysis and propose justified decisions for investments in low-carbon production of electricity, with justification of the advantages of photovoltaic plants, taking into account the environmental regulations in Bulgaria and the EU, the price levels and the volumes of demand on the independent energy exchanges, as well as the strategic advantages of the country's geographical location in southern Europe.“*

There are 3 specific **tasks**:

*“First. To analyze the theoretical studies in the sector and the empirical evidence for the development of the "Electricity" sector in Bulgaria in the light of the "European Green Deal" with the tendency to increase the share of renewable energy sources in the country's electricity mix.“*

*Second. "To make an econometric analysis for the period 2019-2023 of the "Day Ahead" segment of the independent energy exchange based on the example of Bulgaria and economies from Central and South-Eastern Europe to determine the price characteristics (in Euro/MWh) as a leading indicator in the models for investments in photovoltaic plants.'*

*Third. "To justify an investment intention to build a network of photovoltaic plants in Bulgaria, combining the best technological indicators for the performance of solar panels with options for credit financing of a project company."*

### **3. Volume and structuring**

The dissertation has a total volume of 239 pages and includes 122 tables and 55 figures.

The structure of the dissertation is classical in three chapters. It is logical, balanced and contributes to the realization of the set goals.

Chapter One - *"Theoretical, Market and Environmental Aspects of Investments in the Electricity Sector"*.

Chapter Two - *"Day Ahead Price Segment as a Determinant of Return on Investment in Solar Plants"*

Chapter Three - *"Financial Analysis and Evaluation of a Project Company for Investment in the Construction of a Photovoltaic Plant"*

#### **4. Methodology**

Various research methods were used for the purposes of the research, as among the most important are correlation analysis, stepwise multifactorial regression model and a wide range of tools of financial and investment analysis. Quantitative models were used correctly, which shows a high degree of econometric training and the ability to conduct in-depth scientifically sound research.

#### **5. Empirics**

The empirical part of the dissertation includes a huge amount of data on market prices in 12 Central and Eastern European economies - the "Day Ahead" stock exchange segments in the Czech Republic, Slovakia, Hungary, Romania, Slovenia, Greece, Poland, Germany, Austria, Italy, Croatia and Bulgaria.

#### **6. Citation and used literature**

The citation is correct in the accepted APA-standard. The list of used literature contains 150 scientific publications and 31 normative acts.

#### **7. Style**

The style is good and corresponds to the professional financial language and terminology related to the generation of electricity and in particular photovoltaic plants.

#### **8. Layout**

The layout, both from a technical and content point of view, is very good. The appended list of tables assists the reader's orientation in the vast volume of data.

#### **9. Achieved results**

The assigned tasks have been completed. The following more significant results stand out:

- 1) Dissertation development is essential for practice not only from the point of view of an individual investor in photovoltaic power plants, but for the

entire sector.

- El. energy is a specific commodity that is practically not storable. The development of storage/battery manufacturing technologies is still prohibitively expensive to allow efficient longer-term storage in large volumes;
- Transporting over longer distances leads to significant losses, which limits the effective region of connectivity through the transnational electricity transmission network. This limits the potential market as well as the range of real competition.

2) I find the research very interesting, in terms of the applied methodology for analyzing and forecasting the price of electricity based on the objectively formed prices of the "Day Ahead" electricity exchange.

3) There is a substantial, with a serious methodological basis, a representative empirical econometric analysis of the market trends of the "day-ahead" electricity exchange in 20 countries of central and southeastern Europe for the period 2019-2023;

4) The researched correlation of national markets and overcoming price shocks from 2021. The scope of the analysis is the "Day Ahead" stock exchange segments in the Czech Republic, Slovakia, Hungary, Romania, Slovenia, Greece, Poland, Germany, Austria, Italy, Croatia and Bulgaria.

5) A large volume of data has been organized and processed, presented in 122 tables and organized in a detailed list of tables placed at the beginning of the dissertation.

In each of the three chapters, serious practical **results** are realized, based on a thorough and sustained scientific methodology, which are presented by the author in the following extremely synthesized form:

*First. The accelerated pace of investments and the growing share of renewable energy sources in the energy mix in Bulgaria and the EU are a logical consequence of the new environmental regulations, goals and schedules outlined in the "European Green Deal" and the gradual replacement of electricity production from polluting to low-carbon production.*

*Second. The econometric analysis of the "Day Ahead" segment of the independent energy exchange in twelve economies from Central and South-Eastern Europe is the basis for deriving models for forecasting the price (in Euro/MWh) of electricity. These forecasts are the basis for determining the most*

*important indicator in business plans for investments in photovoltaic plants. The general conclusion after examining twelve national electricity markets in the "Day Ahead" segment is an upward trend (from 2019 to 2023) in the correlation of price levels in the sector for countries that have high connectivity of electricity transmission systems.*

*Third. Project PV companies' profitable business models use financial leverage techniques combined with best-in-class solar panel performance technology. The investments themselves bear corresponding risks, the hedging of which is a matter of management judgment and professional analysis.*

## **10. Contributions**

The author presents 4 contributions, the first two of which have the character of serious and original practical-applied results, and the 3rd and 4th are perceived as scientific-applied contributions.

## **11. Publications**

The author has published 2 articles (one independently and one co-authored) and 2 reports (one independently and one co-authored), which fulfills the minimum requirements of 30 points. One of the papers has been published in a volume indexed in WoS.

## **12. Abstract**

The abstract is prepared according to the requirements, contains all the necessary components and objectively reflects the content of the entire dissertation work.

## **13. Notes and recommendations**

As a member of the department where doctoral student Todor Georgiev is enrolled and working, I am witness to the development of the dissertation in its final form. Essential notes of a critical nature do not stand out.

## **14. Defense questions**

Given the complex mix of factors that shape the price of electricity and, on the other hand, the relatively long-term buy-back period for an investment in PV, how do you assess the reliable term of forecasting the price of electricity? and to what extent such a forecast can serve as an objective judgment when making a decision to invest in the construction of a photovoltaic plant(s)?

## **15. Conclusion:**

The presented dissertation work for the educational and scientific degree "doctor" has the quantitative and qualitative characteristics required by the Regulations for RAS in CA "D. A. Tsenov". The dissertation contains original scientific and applied results. The dissertation clearly shows that the doctoral student has in-depth practical and theoretical knowledge in the field of investments in photovoltaic power plants, as well as abilities for serious practical-applied scientific activity. All this gives me reason to propose to the scientific jury that the ESD "**Doctor**" be awarded to doctoral student **Todor D. Georgiev**.

9.05.2024 г.

Reviewer: .....

***Prof. Dr. Stefan Simeonov***