Wroclaw, 21 March 2024

Dr hab. inż. Arkadiusz Piwowar, prof. UEW
Wroclaw University of Economics and Business
Faculty of Economics and Finance

REVIEW

of the doctoral dissertation by Oleh Ożarowski, MSc

entitled "*The role and performance of wind and solar energy policy in energy transition process in Germany and Poland*"

prepared under the supervision of Prof. dr hab. Sławomir Śmiech and Dr Lilia Karpinska

1. Formal and legal basis for the review

This review was prepared on the basis of a letter dated 25 January 2024 from the Head of the Doctoral School in the Cracow University of Economics, Prof. dr. hab. inż. Stanisław Popek. Legal framework was art. 187 of the Act of 20 July 2018 – Law on Higher Education and Science [*Journal of Laws of 2023, item 742 as amended*]. The review has been prepared based on reference to the subject of the research, research goals and problems, hypotheses, methodology of the research and the substantive and formal value of the dissertation.

2. Choice of topic and relevant research areas

Energy transformation towards green energy, while maintaining physical and economic availability of energy for citizens, is an important direction of socio-economic changes. This transformation is

driven by the dynamic development of technology and the evolution of social preferences, where the basis is an increase in ecological awareness and care for the natural environment. Active policy, especially at the national and higher levels, along with all the instruments, is also extremely important in this area. Without reducing, of course, the role of conducting appropriate energy market policy, e.g. at the commune and district (poviat) scale, which is crucial from the point of view of creating clusters, networks and energy communities.

Support policy instruments, mainly of an economic nature, are undoubtedly an important element in the development of renewable energy sources. This dissertation contributes to the discussion in this area and aims to fill the research gap by providing a comprehensive study on the outcomes of wind and solar support policies. Solar and wind energy are one of the best renewable energy sources with least negative impacts on the environment. The basic geographical scope concerns Poland and Germany, and the time range covered the years 2005-2021. The choice of the topic of the work is an important research area within economic sciences. It is part of the research trend in the area of the electricity market, including support systems for renewable energy sources.

As a rule, the analysed work is consistent with the topic. However, reading it leads to the conclusion that, on the one hand, the topic adopted for research is too broad. On the other hand, various issues relating to it were not addressed (or not addressed sufficiently). The two objections just formulated are, of course, closely related. In my opinion, the topic of the work could be clarified by specifying the time range or specifying the scope of "energy policy". Energy policy is a subset of economic policy, foreign policy, and national and international security policy. The attributes of energy policy may include legislation, international treaties and incentives to investment. Defining the basic concept of "energy policy" could consist in identifying the most important aspects (political, economic, planning, environmental, social aspects). Nevertheless, the research issues undertaken by the PhD student are very important both from the cognitive theory perspective and from the perspective of economic practice.

3. Structure of the dissertation

The doctoral dissertation consists of 5 chapters, a list of 240 references, a list of abbreviations, a list of 33 pictures and 17 tables and an appendix. The acknowledgments and abstracts in English, Polish, and German are given before the table of contents on the first ten pages. The dissertation is written in English. The structure of the work is the right structure. The layout of the work is typical for doctoral dissertations. The titles of chapters and subchapters have been formulated correctly and reflect their content.

Nevertheless, the location of the basic scope of work in the work system in the form of energy systems (solar, wind) and spatial systems (Poland, Germany) is puzzling. It seems that, in particular, the issue of separating the technical and economic specificity related to wind and solar energy should be reflected in the chapter titles. This would, of course, require changing the content and probably separating a part of the work.

The has defined the objective of the dissertation differently. This doctoral dissertation's main objective is to evaluate comparative policy effectiveness and efficiency in terms of solar and wind energy in Germany and Poland (on background of EU member states). The Author also presented many research questions: How have wind and solar markets evolved in Poland and Germany during the last few decades, based on the background of other EU countries? What main policy instruments have been implemented to support the mentioned RE technologies in the EU? What criteria should be employed to measure cross-country policy performance of wind and solar energy sources? How Germany and Poland rank in terms of policy effectiveness and efficiency in the presence of other EU countries? Which types of policy instruments have been most and least effective and efficient among analysed countries? What are effects of some external factors such as wind speed and solar power theoretical potential?

Based on a review of the literature in the subject, striving to solve research problems, the Author also formulated three research hypotheses:

H1: German wind and solar energy policies are more effective and efficient in comparison with those of Poland

H2: Countries with FIT (feed-in tariff) and quota-based instruments deliver better results than the ones with tenders

H3: Resource endowment has a positive impact on efficiency of wind and solar energy policies

My reservations are particularly raised by the content of hypothesis 1, which does not provide a basis for comparison. I understand the attempt to formulate a short content, but in this case the effect is a thesis, in a sense a conclusion, with too general a statement. It should be noted that there are a lot of ways to produce clean energy (e.g., onshore, offshore), as well as possible incentives for their implementation. On the one hand, it requires a very careful approach to the base values adopted for analysis, and on the other hand, it requires taking into account all considerations at the macroeconomic level of analysis. Moreover, effectiveness, as well as profitability and environmental benefits, in the researched topic depend on many factors, not only political and economic, but also physical and technical.

The adopted research objectives set the course of literature and empirical research. The first chapter is introduction. In this part of the dissertation, the Author present the importance of research, objectives, questions, and hypotheses. Additionally, motivation and structure of the doctoral thesis is highlighted. The second chapter, the longest part of the thesis, presents a comprehensive analysis of literature on the topic. The third chapter deals with the research methodology. The chapter also covers data collection process and selected data sets. The next chapter characterizes the results of empirical research. The Author presented in detail and meticulously researched the statistical analysis of the

collected data. The last, fifth chapter contains conclusions from the research. The Author also indicated the direction for further study, which may pose an important challenge for other researchers. In general, the work is valuable, interesting, and of a high substantive level.

4. Detailed substantive evaluation of individual parts of the dissertation

The results are derived logically and well described. They are analyzed and interpreted in accordance with the scientific standards. The PhD candidate effectively accomplished the thesis's research goals and offered a creative solution to the issue. He used a wide set of modern and well-selected methods and techniques. Based on a review of the literature on the subject, although it wasn't a systematic review, he created his own quantitative approach, which includes methods based on indicators, DEA (Data Envelopment Analysis) and regression modeling.

The doctoral thesis clearly demonstrates that Oleh Ożarowski can conduct independent scientific research and future research work carried out by him independently will meet the standards of his scientific community. I consider the following aspects to be the major strengths of this dissertation:

- the importance of the undertaken topic, including filling the research gap in the research topic of gap by providing a comprehensive study on the policy performance of wind and solar energy technologies,
- a solid methodological framework, including the proper selection of research methods and their detailed description.

The literature on the subject emphasizes that different types of policy instruments are effective for different renewable energy sources [Johnstone, N., Haščič, I., & Popp, D. (2010). *Renewable energy policies and technological innovation: evidence based on patent counts*. Environmental and Resource Economics, 45, 133-155]. The results of this work indicate that even implementing the same policies to support wind and solar energy may work differently depending on the country. This is of interest to, among the others, political economy. Varieties of capitalism and clean energy transitions in the

European Union: When renewable energy hits different economic logics [Ćetković, S., & Buzogány, A. (2016). *Varieties of capitalism and clean energy transitions in the European Union: When renewable energy hits different economic logics*. Climate Policy, 16(5), 642-657]. Robust but flexible policy mixes are recommended for a sustainable transition. The discussion of the obtained results is logical, which demonstrates knowledge of the subject literature. Analysing the entire discussion, however, I feel a certain dissatisfaction, I miss discussing the obtained results with those obtained in studies with a broader scope (than the EU, Poland, Germany). The main contribution is the critical evaluation of the elements supporting and impeding the transition process using a few broad lenses (technological, investment, market, environmental, institutional, governmental, policy, social, etc.). This allows for a broader viewpoint. Broader contexts (political economy, institutions, cultural norms and technical systems) create more (or less) favorable conditions for the intended acceleration. It is a pity that this topic is not developed in the work. It is very interesting cognitively and inspiring for research. For this purpose, it would be advisable to use a systematic literature review. This, of course, requires a clear reporting of the criteria for searching for publications, but a priori it makes it possible to search for and include in the analyses all works in accordance with the intentions/hypotheses/theses/questions formulated by the researcher. This doctoral thesis should also discusses a review about the different solar energy policies implemented on the different countries of the world. Nevertheless, the Author's scientific inquisitiveness should be emphasized and appreciated, as theoretical issues were presented thoroughly (chapter 3). The method of analysing the subject literature and drawing conclusions was carried out correctly and with due care, which is the basis for a positive assessment of the entire work.

The strength of the assessed work is undoubtedly the analyses of the effectiveness of policy and efficiency of wind and solar energy technologies in Germany and Poland, presented in chapter 4. The methodological approach and the results of analyses based on bias-corrected DEA assessment deserve special attention. This was preceded by a thorough theoretical analysis presented in the

previous chapter. In this context, very good mastery of the research technique and high reliability in presenting the results deserve special recognition. Original ideas and carefully selected analysis of the results are the main advantages of this work.

In turn, the weaker points of the dissertation include the literature review in the area of effectiveness and limitations of renewable energy policy, including the issue of economic instruments, prepared in chapter 2. While the categorization itself is appropriate, the depth of analysis in terms of new thematic threads (taking into account contemporary concepts described in the literature, e.g. in the field of examining the impact of renewable energy consumption (REC) on environmental degradation and improving the green financial policy system) could be improved. The subject under study also requires a broader historical outline, which is the basis and, to a large extent, the starting point for the presented comparisons between two neighboring countries – Poland and Germany. More detailed data, including historical data, should be presented, among the others: in chapter 1.5. – "Energy transition in Poland and Germany".

The doctoral dissertation has been generally written clearly and richly illustrated with figures and tables (many of which are included in the appendices). The doctoral student did not avoid making minor editorial errors. These shortcomings do not significantly affect the scientific value of the doctoral thesis submitted to me for review. Summarizing, I consider the presented work very high, both in the terms of the importance of obtained results and of their formal presentation. The thesis is well-written in the English language. It is written carefully, with the use of comprehensible language and in a good style. The graphical applications - figures and tables are mainly made readable and clear. However, there are illegible drawings (e.g., Appendix H.1 - H.10). It is possible to notice inconsistencies in the bibliographic entry used, references in the text of the work or editing errors (e.g., page 41).

In the conclusion sections, the Author discusses the effectiveness and efficiency of wind and solar energy policies in European Union (EU) member states, with a strong focus on Germany and Poland. The first part of the research employed a Policy Effectiveness Indicator, which compared wind and

solar energy policy performance across different time periods and policy support mechanisms. Results showed that Germany had the most effective wind energy policy, while it was also among countries with the highest scores for solar policy during the early and take-off phases. Conversely, Poland had relatively low effectiveness scores for both wind and solar energy policies. The second part of the research analyzed policy efficiency across EU countries, using the DEA and regression methods. Results showed that, for wind energy, countries with quota-based mechanisms tended to be more efficient and that FIT had a negative impact on the efficiency of wind energy policies. For solar energy, countries with tenders as the main policy instrument tended to be the most efficient, and solar power theoretical potential had a strong positive correlation with policy efficiency. The research also presented data on wind and solar energy status in EU member states, including trends in generated electricity and installed capacity and the main policy instruments used. Conclusions align with the work's main findings, and the PhD candidate has highlighted the most relevant limitations.

The doctoral dissertation contributes to enhancing methodology knowledge in energy policy efficiency analysis. Nevertheless, a careful reading leads me to ask a few questions. It would be good to get answers to the following questions during the public defense:

Q1: *Does the Author agree with the thesis that more targeted subsidies, such as feed-in tariffs, are needed to induce innovation on more costly energy technologies, such as solar power?*

Q2: *In the Author's opinion, what should be the basic assumptions of energy policy in Poland in the field of wind and solar energy markets, taking into account the issues of energy security and energy transformation?*

5. Summary, conclusion and final evaluation statement

The dissertation presents an original solution to the scientific problem stated in the document. The methodology employed by the researcher is adequate and scientifically rigorous. The overall evaluation of Oleh Ożarowski's PhD thesis entitled: *The role and performance of wind and solar energy policy in energy transition process in Germany and Poland* leads to the conclusion that it represents a high standard and significantly broadens knowledge in the field of economics science. The PhD candidate demonstrates his ability to originally formulate and solve a research problem and her general theoretical knowledge in the field of economics and finance. This work also demonstrates that PhD candidate is able to conduct independent academic research. Therefore, I acknowledge that this thesis under review meets the statutory requirements and may constitute the basis for conferring a PhD degree in social sciences in the discipline of Economics and Finance.

Signed by /
Podpisano przez:

Arkadiusz
Piwowar

Date / Data:
2024-03-21 09:23