Response to Reviewers

Dear Prof. Asongu,

Thank you very much for bringing such valuable comments back to us and giving us a chance to improve this manuscript. The manuscript is seriously revised in accordance with all the reviewers' comments. Their opinions and concerns are answered and explained point by point, as will be been below.

Reviewer: 1

Congratulations! You have done a great job. I have following suggestions: English should be improved. Usage of I, we, you should be avoided. Same word/s should not be used more than once in a sentence. The text should have continuity.

Responses: Thank you very much for your valuable comments. The entire study is rewritten and its readability should have been improved substantially. Thank you very much.

I suggest to add the following papers in the literature part:

Rehman S., Natarajan N., Vasudevan M., Alhems L.M., (2019). Assessment of Wind Energy Potential across Varying Topographical Features of Tamil Nadu, India, Energy Exploration & Exploitation,

Zahid Hussain Hulio, Wei Jiang, Rehman S., (2019). Techno - Economic assessment of wind power potential of Hawke's Bay using Weibull parameter: A review, Energy Strategy Reviews 26, (2019), 100375.

Shoaib M., Siddiqui I., Rehman S., Khan S., and Alhems L.M. (2019). Assessment of wind energy potential using wind energy conversion system. Journal of Cleaner Production 216, 346-360.

Rafique M.M., Rehman S., Alam Md. M., Alhems L.M., (2018). Feasibility of a 100 MW installed capacity wind farm for different climatic conditions, Energies 11(8), 2147, doi: 10.3390/en11082147

Baseer M. A., Meyer J.P., Rehman S., Alam Md. M., (2017). Wind power characteristics of seven data collection sites in Jubail, Saudi Arabia using Weibull parameters. Renewable Energy, 102, 35-49.

Bagiorgas H.S., Mihalakakou G., Rehman S., Al-Hadhrami L.M. (2016). Wind Power Potential Assessment for Three Buoys Data Collection Stations in Ionian Sea Using Weibull Distribution Function, International Journal of Green Energy, 13(7), 703-714.

Bassyouni M., Saud A. G., Javaid U., Awais M., Rehman S., Abdel-Hamid S. M. S., Abdel-Aziz M. H., Abouel-Kasem A., Shafeek H. (2015). Assessment and analysis of Wind Power Resource using Weibull Parameters, Energy Exploration & Exploitation 33(1), 105 - 122.

Rehman S., Mahbub A. M., Meyer J. P., and Al-Hadhrami L. M., (2012), Wind Speed Characteristics and Resource Assessment using Weibull Parameters, International Journal of Green Energy,9: 800-814.

Bagiorgas H.S., Mihalakakou G., Rehman S., Al-Hadhrami L.M., (2012) Wind Power Potential Assessment for Seven Buoys Data Collection Stations in Aegean Sea Using Weibull Distribution Function, Journal of Renewable and Sustainable Energy, v. 4(1), February 2012, pp. 013119-013134.

Himri Y., Rehman S., Draoui B. and Himri S. (2008). Wind Power Potential Assessment for Three Locations in Algeria. Renewable and Sustainable Energy Reviews, v. 12, pp. 2488 – 2497.

Rehman, S., Halawani, T. O. Statistical Characteristics of Wind in Saudi Arabia, Renewable Energy, 4(8), (1994), pp. 949-956.

Rehman, S., Halawani, T. O., Husain, T. Weibull Parameters for Wind Speed Distribution in Saudi Arabia. Solar Energy, 53(6), (1994), pp. 473-479.

Responses:

Thank you very much for your insightful comments. We have updated the references and included following the most relevant studies into our work.

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1. Baseer M. A., Meyer J.P., Rehman S., Alam Md. M., (2017). Wind power characteristics of seven data collection sites in Jubail, Saudi Arabia using Weibull parameters. Renewable Energy, 102, 35-49.
2. Bagiorgas H.S., Mihalakakou G., Rehman S., Al-Hadhrami L.M. (2016). Wind Power Potential Assessment for Three Buoys Data Collection Stations in Ionian Sea Using Weibull Distribution Function, International Journal of Green Energy, 13(7), 703-714.
3. Bassyouni M., Saud A. G., Javaid U., Awais M., Rehman S., Abdel-Hamid S. M. S., Abdel-Aziz M. H., Abouel-Kasem A., Shafeek H. (2015). Assessment and analysis of Wind Power Resource using Weibull Parameters, Energy Exploration & Exploitation 33(1), 105 - 122.
4. Rehman S., Mahbub A. M., Meyer J. P., and Al-Hadhrami L. M., (2012), Wind Speed Characteristics and Resource Assessment using Weibull Parameters, International Journal of Green Energy,9: 800-814.
5. Bagiorgas H.S., Mihalakakou G., Rehman S., Al-Hadhrami L.M., (2012) Wind Power Potential Assessment for Seven Buoys Data Collection Stations in Aegean Sea Using Weibull Distribution Function, Journal of Renewable and Sustainable Energy, v. 4(1), February 2012, pp. 013119-013134.
6. Rehman S., Natarajan N., Vasudevan M., Alhems L.M., (2019). Assessment of Wind Energy Potential across Varying Topographical Features of Tamil Nadu, India, Energy Exploration & Exploitation, 38 (1): 175-200.
7. Shoaib M., Siddiqui I., Rehman S., Khan S., and Alhems L.M. (2019). Assessment of wind energy potential using wind energy conversion system. Journal of Cleaner Production 216, 346-360.
8. Rafique MM, Rehman S, Alam Md M, Alhems LM (2018) Feasibility of a 100 MW installed capacity wind farm for different climatic conditions. Energies, 11(8), 2147. doi: 10.3390/en11082147

Reviewer: **2**

Comments to the Author

The article “An Economic Analysis on Taiwanese Wind Power and Regional Development” is based on hourly real wind data. The authors studied the power curves fit and analysis the electricity Potential; and investigated the economic and environmental effects of wind farm sites in Taiwan. The findings are interesting, but it looks as it has been written in a rush.

There are many grammatical, structural and formatting mistakes, which make the manuscript difficult to follow. For instance; the first two sentences of the Abstract should be improved. Page#15, section economics effect. The authors mentioned their thoughts and opinions, which is unacceptable.

Responses: Thank you very much for your valuable comments. We have modified the manuscript and the grammatical, structural, and formatting mistakes are avoided. We also rewrite the abstract and the discussions about economic effect. Thank you very much.

In Eq. (1), alpha is not defied; how authors calculated the value of wind shear exponent? How the authors calculated the root mean squared error/(NRMSE) no mathematical formula or reference is given? The authors should specify the meaning of red color values in the Tables.

Responses:

1. The setting of alpha value in Eq. (1) is from heuristic perspectives corresponding to local terrain. In this study, we follow the settings from Kim and Hur (2017).

[Page 6]: The value of wind speed shear exponent follows the setting of Kim and Hur (2017)

2. To enhance the contribution of this paper, we remove Table 3, together with definition of NRMSE. The definitions of RMSE and NRMSE can be referred from Kung et al. (2019).

"The error criterion is determined by the root mean squared error (RMSE) shown in the following equation:

where is the estimated monthly average wind speed from Weibull distribution and is the adjusted monthly average wind speed. The normalized root mean squared error (NRMSE), can be calculated by RMSE/Actual."

3. Red color values in the Tables represents the cost, negative cash flow. This is our mistake of using different colors. We have unified font colors of all tables.

The authors do not mention the source/procedure of life cycle analysis and economic effects data (components cost etc.)
Responses: Thank you very much for your insightful comment. The components and stages, as well as the detailed description and data sources of these components associated with this lifecycle analysis have been provided in Table 1. The results are displayed in Table 3 and we have provided more details about how we obtain these estimates in the section 4.2. Thank you very much.

The authors should improve the quality of English writing in the manuscript, and its current version is not suitable for the academic style.
Responses: Thank you very much for your valuable comments. The entire study is rewritten and its readability should have been improved substantially. Thank you very much.

Reviewer: 3

Comments to the Author
I have carefully considered and read the manuscript entitled, An Economic Analysis on Taiwanese Wind Power and Regional Development, and have following points for the authors to address before the consideration of this work:
1- In the introduction section page no. 1 line nos. 45-51, must put a suitable citation here (Renewable energy is considered to be an effective approach to enhance energy security and mitigate climate change. In 2017, Taiwanese government announced that it will replace nuclear power with renewable energy such as solar energy, bioenergy, and wind power by 2025).
Responses:
Thanks for your suggestions. We have cited the references in this paper.

[Page 2]: Renewable energy is considered to be an effective approach to enhance energy security and mitigate climate change. (Rainer 2013; Owusu and Asumadu-Sarkodie 2016; Rafique et al. 2018; Wang et al. 2018) In 2017, Taiwanese government announces that due to environmental consideration, all nuclear power will be phased out by 2025, implying more than 18 billion kWh must be replaced by other sources.

2- Update the literature in the "Introduction" section as well as in the "Literature

Review" by citing latest studies upto 2019.

Responses:

Thanks for your suggestions. We have cited some 2019 papers in this study.

[Page 2]: Because capital rationing and budget constraints generally exist for such a large-scale development of renewable energy, a detailed examination that integrates economic and environment consequences to ensure it is beneficial to the society is usually necessary (Kung et al., 2013; McCarl et al., 2009; Hulio et al., 2019).

[Page 3]: Wind power development is considered to be an effective approach to enhance energy security and mitigate climate change (Gavard, 2016; Kaygusua, 2010; Thomson et al., 2017; Wheatley, 2013; Xia and Song, 2009; Zhao et al., 2016), but its effectiveness is highly dependent on wind power expansion, distribution assumption, and system integration (Hyeplund et al., 2017; Rehman et al, 2019)

[Page 4]]: Therefore, although a considerable amount of wind power studies have been conducted (Gillenwater, 2013; Hu et al., 2013; Partridge, 2018; Shoaib et al., 2019; Thøgersen and Noblet, 2012), no single parameter can be applied universally due to the above reasons, and the estimation of turbines' power curves for different sites must be implemented and tested prior to any wind power development.

3- Why are you discussing results of this study in the last paragraph of introduction, you need to demonstrate only objective of this study and methods.

Responses: Thank you very much for your insightful comments. We have modified the entire manuscript and we have stated the objectives and methods clearly in the introduction. The last paragraph specifying the potential contributions of this study has also been properly introduced in the introduction. Thank you very much.

4- Some more implications of the core findings of the research should be provided.

Responses: Thank you very much. We have modified the research implications in section 4.4, which now read as:

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This study integrates several important issues in wind power development by exploring a more precise approach to estimate the power curves, estimating the power potential of 370 proposed sites, illustrating potential economic and environmental benefits from average sites, and depicting the influences of uncertain parameters. Some policy implications can be derived from these results.

(1) Monitoring of global circulation patterns must be implemented. Since the stability and strength of wind resource is highly dependent on the global circulation pattern, it is necessary to monitor the global circulation patterns. This issue is important because the global climate shift that potentially alters the circulation patter is unprecedentedly fast, and it will not be feasible to simply use the estimates from previous studies. Adoption of updated global circulation models, as well as climate change projections released by IPCC can be an option. A greater effort may be required, but such an effort may benefit multiple industries such as agriculture and fishery. For example, a better forecasting in climate change and global circulation pattern means that we may be able to predict the precipitation, temperature, and hunter-gathering mode of fish more precisely, and provide more information on crop selection, land-use improvement, resource allocation, and fishing strategy.

(2) Profitability and efficiency may not be maximized simultaneously. We show

that the most proposed sites can generate a significant amount of electricity and end up with profits. However, profitability cannot be always translated to efficiency. For example, there are 2 sites (A, B), whose construction and maintenance cost defined as ($1million, $5 million), and suppose their profits are ($3 million, $9 million). It is easily to see that A's profit is less than that of B, but it is too early to conclude that B is the better choice because efficiency is ignored. This situation is extremely crucial when we are limited in budgets. If the government decides to develop these sites by its own, this situation must be taken into account. But if the sites are to be developed by many companies, profitability may be of priority because individual companies only need to develop a small number of sites. Therefore, whether to focus on profitability or efficiency depends on the characteristics of developers.

(3) Social-economic factors such as inflation and consumer price index must be integrated in the decision-making process. Factors involved in wind farm construction can be highly uncertain. For example, the construction cost consists of material, transportation, labor, and miscellaneous items, all of which are subject to change in the face of uncertain market operations. Therefore, it is necessary to investigate how changes in these factors may vary the results. The sensitivity analysis or scenario analysis may be applied, and Monte Carlo analysis may be conducted if the probability of such changes can be predicted. A thorough and comprehensive investigation on these factors can improve the quality and robustness of the results.

(4) Promotion policies that integrate multiple renewable energy technologies must be encouraged. We show that wind power can contribute a significant amount of electricity, but it is still very unlikely to recover the lost nuclear power only from wind power. Therefore, other renewable energy technologies may be conjunctive applied to enhance energy security. Joint application of solar energy and bioenergy can also be attractive to Taiwan, but the overall economic and environmental effects require additional investigation. For example, issues regarding energy crop selection, technology (liquid or non-liquid) determination, cropland utilization, and competition among renewable alternatives should be explored and the impacts on social welfare associated with these issues must be estimated.

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5- A comparison of the results and discussion with the previous related researches should be provided.

Responses: Thank you very much for your insightful comments. The usefulness of this study is now clearly stated in the discussion section. In policy implication section, we also compare our results to other studies so that the decision makers may gain additional knowledge from our study. Thank you very much.

6- Precise the conclusion section according to study findings.

Responses: Thank you very much. The conclusion has been modified so that the most important findings and insights are clearly stated in this section. Thank you very much.

7- There are also some grammatical errors in the paper, it also needs to check with the help of an English native speaker.

Responses: Thank you very much for your valuable comments. The entire study is rewritten and the revised manuscript has been verified by a professor working in School of Foreign Language at Hubei University of Finance and Economics. We believe that the readability of this study might have been improved substantially.

Thank you very much.

Reviewer: 4

Comments to the Author

The manuscript accommodated updated global circulation model and a threshold regression model to estimate the wind stability and turbine's power curves. To fully explore the economic benefits and environmental influences of Taiwanese wind farm development, this study applied the LCA and sensitivity analysis. The topic of this paper is certainly interesting and suited for this journal. The structure of the manuscript is also reasonable. However, there are some problems to be further improved as well. Detailed comments follow.

1) It is noted that the manuscript is not well written and needs careful editing by someone with expertise in technical English editing paying particular attention to English grammar, spelling, and sentence structure so that the goals and results of the study are clear to the reader.

Responses: Thank you very much for your valuable comments. The entire study is rewritten and its readability should have been improved substantially. We also restructure the sections so that the goals and results are clearer to readers. Thank you very much.

2) At the beginning of the introduction, the severity and importance of the problem are not shown by the data except for annual electricity. Perhaps such a description may lack some persuasiveness.

Responses:

Thanks for your suggestions. We have enhanced the importance of the problem at the beginning of the introduction.

[Page 1]: Taiwan is a small island with little natural resource and most of its energy relies on imports. In 2017, Taiwan relies on 98% imported energy. (Bureau of Energy, 2017) Up to date, more than 86% of its energy comes from fossil fuels and 8% from nuclear power, with less than 1% from renewable energy sources. (Bureau of Energy, 2017) Considering energy security and environmental sustainability, Taiwan government tends to reduce coal consumption and nuclear electricity generation. Renewable energy is considered to be an effective approach to enhance energy security and mitigate climate change. (Rainer 2013; Owusu and Asumadu-Sarkodie 2016; Rafique et al. 2018; Wang et al. 2018) In 2017, Taiwanese government announces that due to environmental consideration, all nuclear power will be phased out by 2025, implying more than 18 billion kWh must be replaced by other sources. Since the law forebodes the increase in fossil fuel use, the lost electricity can only be recovered by renewable energy sources.

3) The last paragraph of the introduction part is weird. I understand that authors want to put forward the innovation points of this article. It is suggested to incorporate this paragraph with section Literature Review. After classifying the existing research results or summarizing them in chronological order, their deficiencies can be summarized. Then, it is reasonable to lead out the innovation of this article on the basis of the deficiencies of previous studies.

Responses:

Thank you very much for your insightful comments. We have modified the entire manuscript and we have stated the objectives and methods clearly in the introduction. The last paragraph specifying the potential contributions of this study has also been properly introduced in the introduction. Thank you very much.

4) The structure of the article needs to be adjusted. The authors introduce the threshold regression model in a large paragraph, which was already shown in previous study, which has already presented in previous study (Kung et al., 2019). The authors need to introduce lifecycle analysis in more detail, rather than just showing a table in the manuscript.

Responses: Thank you very much for your scrutiny and insightful comment. This study follows the Kung et al (2019), in which no economic analysis is presented and discussed, and utilizes the lifecycle analysis to investigate how such implementation costs. To avoid confusion, we redo the tables and figures and also clearly state how this work is different from the previous one in the introduction section. We also add 2 appendixes to discuss the findings. Thank you very much.

5) There is at least one error in the manuscript, such as, in page 6, "3.1 Wind Speed Distribution" would be "3.1.1 Wind Speed Distribution". Please check the manuscript carefully.

Responses: Thank you very much for your detailed comment. The study has been modified entirely and these mistakes are corrected in this revision. Thank you very much.

6) Detailed life cycle inventory of various phases is not shown in the manuscript, which is necessary in LCA.

Responses: Thank you very much for your insightful comment. The components and stages, as well as the detailed description and data sources of these components associated with this lifecycle analysis have been provided in Table 1. We also add three equations (Equation 5 to 7) to illustrate how we calculate the economic and environmental benefits. The results are then displayed in Table 3 and we have provided more details about how we obtain these estimates in the section 4.2. Thank you very much.

7) In Table 5 and Table 7, what do the numbers in brackets with red color mean? And what are the units of numbers in Table 6?

Responses:

Red color values in the Tables represents the cost, negative cash flow. This is our mistake of using different colors. We have unified font colors of all tables.

8) The first two paragraphs of the conclusion may need to be adjusted. At the beginning of the conclusion, it is expected to see whether the research method effectively achieves the research objectives. Therefore, more attention may be paid to this aspect in the first paragraph. The specific conclusions described in the first paragraph can be considered to be combined with the second paragraph, and further generalization is suggested to reduce the length.

Responses: Thank you very much. Based on your valuable suggestion, the conclusion has been modified so that the most important findings and insights are clearly stated in this section. Thank you very much.

Thank you very much for providing us such insightful comments to help us improve this study.

Best regards,

Chih-Chun Kung