DETERMINATION OF SELECTION CRITERIA FOR WAVE ENERGY CONVERTERS

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ABSTRACT

Considering the fact that Turkey's energy consumption has increased significantly over the past three decades as a result of economic and social development, the purpose of this paper is to evaluate wave energy conversion technology selecting criteria to be located in the Aegean Sea as a key way to address Turkey's energy-related challenges by generating potential from wave energy. In this paper, weights of the criteria are determined to compare wave energy conversion technology alternatives in order to achieve Turkey's energy sustainability goal. Three main criteria are determined with 8 sub-criteria. The study shows that the environmental aspect is the most important criterion in the selection process and the impact on the ecosystem has the highest importance among all sub-criteria.

Keywords: wave energy, sustainability, renewable energy.

1. Introduction

The amount of energy consumed globally more than doubled throughout the 20th century, with much of it coming from coal and oil and the advent of nuclear power for electricity. Renewable energy plays a key role to cover the increased demand for energy. The advantages of renewable energy for the environment and economy are enormous. Thus, if correctly utilized, renewable energy sources might offer sustainable energy production and energy security for nations worldwide, reduce greenhouse gas emissions, and assist in addressing global warming, one of the major issues of the 21st century. As a result, there's also a global trend toward using more renewable energy sources, and it is anticipated that in the next decades, their percentage of the world's power production will rise (Melikoglu, 2018). Significant progress has been achieved in the development of solar and wind energy generation, which are important sources of renewable energy, during the last three decades. Yet, there is another energy source with a huge potential that is rapidly emerging and piquing the scientific community's attention: wave energy (López et al., 2013). This study aims to determine the criteria weights to select the most suitable wave energy converter.

2. Literature Review

There are studies that suggest the usage of wave energy contributes to sustainable energy conversion. Falcão (2010) focused on how a wide variety of devices kept being proposed and studied, and how such devices can be organized into classes, the conception, design, model-testing, construction, and deployment into a real sea of prototypes, and the development of specific equipment. Mustapa et al. (2017) presented an overview of WEC devices that are incorporated with shore-protection systems. It evaluates current concepts and their operational applicability under various wave situations, and then provides further optimization options. It turned out to wave energy is one of the most significant untapped renewable energy sources. Astariz and Iglesias (2015) evaluated all the components that

must be addressed in an economic analysis of wave energy, including a number of elements that are sometimes omitted.
Considering the fact that Turkey's energy consumption has increased significantly over the past three decades as a result of economic and social development, the purpose of this paper is to evaluate wave energy conversion technology alternatives to be located in the Aegean Sea as a key way to address Turkey's energy-related challenges by generating potential from wave energy.

3. Research Design/Methodology/Results

The hierarchy of selection criteria for wave energy converters is shown in Fig.1 (see App.) Three main criteria and 8 sub-criteria are determined based on the literature review and used in the study. Economical aspect is one of the main criteria which has sub-criteria of investment cost, operation and maintenance cost, and land cost. The second main criterion is selected as the technical aspect that has sub-criteria of efficiency, distance to transmission lines, and energy capacity. The third and last main criterion is environmental aspect has sub-criteria of impact on the ecosystem and land requirement. The pairwise comparisons of the criteria are done by scientists who are focused on renewable energy and wave energy systems. In the analysis, the classical AHP and the geometric average of the judgments of three experts are used in the calculations.
The results of the analysis are given in Table 1 (see App.). The environmental aspect is found as the most important main criteria, followed by economical aspect and technical aspect. When the global importance's of the sub-criteria are analyzed, the impact on the ecosystem, investment cost, and energy capacity are found as the first three important sub-criteria.

4. Conclusions

The aim of the paper is to calculate the weights of the selection criteria for wave energy conversion technologies, and for this purpose, classical AHP is used. The findings indicate that the environmental (first impact on ecosystems, second land requirement) is the most crucial aspect, followed by economical (first investment cost, second land cost, last O&M cost), and last but not least, technical (first one is energy capacity, second one efficiency, and the third one is the distance to transmission lines). The number of options, standards, and survey respondents may be raised in a subsequent study.

5. Key References

Melikoglu, M. (2018). Current status and future of ocean energy sources: A global review. *Ocean Engineering,* 148, 563–573.
López, I., Andreu, J., Ceballos, S., Martínez de Alegría, I., & Kortabarria, I. (2013). Review of wave energy technologies and the necessary power-equipment. *Renewable and Sustainable Energy Reviews,* 27, 413–434.
Astariz, S., & Iglesias, G. (2015). The economics of wave energy: A review. *Renewable and Sustainable Energy Reviews*, 45, 397–408.
Falcão, A. F., & Henriques, J. C. (2016). Oscillating-water-column wave energy converters and air turbines: A review. *Renewable Energy*, 85, 1391–1424.
Mustapa, M., Yaakob, O., Ahmed, Y. M., Rheem, C. K., Koh, K., & Adnan, F. A. (2017). Wave energy device and breakwater integration: A review. *Renewable and Sustainable Energy Reviews*, 77, 43–58.

6. Appendices

The hierarchy of the criteria for the selection of wave energy converter technologies is given in Figure 1.

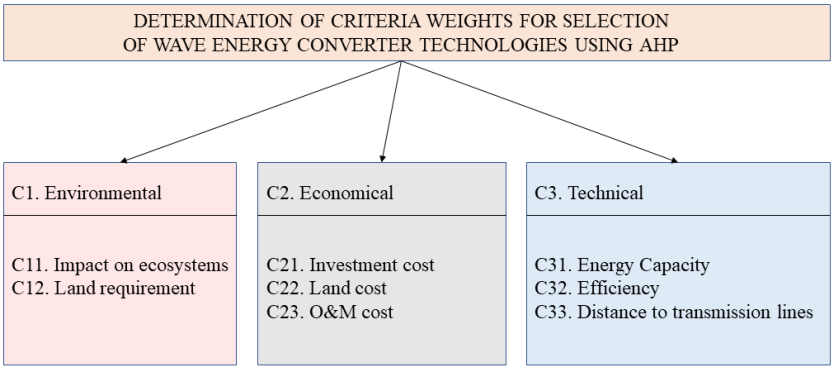

Figure 1. Structure of the method used for the research paper

Table 1 shows the global and local importance weights of the main and sub- criteria:

	Main Criteria Weights	Local Weights	Global Weights
Economical Aspect	0.300821742		
Investment cost		0.526561483	0.158401142
O&M cost		0.228198559	0.068647088
Land cost		0.245239958	0.073773511
Technical Aspect	0.227126885		
Efficiency		0.303572172	0.068949402
Distance to transmission lines		0.238036016	0.054064379
Energy Capacity		0.458391812	0.104113104
Environmental Aspect	0.472051373		
Impact on ecosystems		0.84833421	0.400457329
Land requirement		0.15166579	0.071594044