Advances in Reliability, Safety and Security, Part 8 – Kołowrocki, Magryta-Mut (eds.)
© 2024 Polish Safety and Reliability Association, Gdynia, ISBN 978-83-68136-20-3 (printed), ISBN 978-83-68136-07-4 (electronic)

Advances in Reliability, Safety and Security
ESREL 2024
Monograph Book Series

Optimizing Tidal Power Plant Turbine Selection Through AHP And SMART Decision Making Methods

Rachmat Hermawan, Andika Eri Trianto

Indonesia State Electricity Company (PLN), Jakarta, Indonesia

---

Abstract

The configuration of a Tidal Power Plant (TPP) typically revolves around the selection of turbines. Choosing the TPP design involves considering the conditions observed in the coal-fired power plant (CFPP) 4 x 315 MW. The optimal determination of the TPP design entails selecting the most suitable turbine types through the application of the Analytical Hierarchy Process (AHP) and Simple Multi-Attribute Rating Technique (SMART) methodologies. The AHP method, a hierarchical decision-making approach, initiates by defining the criteria for comparing the two turbine types. The turbine selection criteria encompass factors such as installability, affordability, operability, and environmental impact. Subsequently, data regarding the turbine options, specifically the Savonius turbine and Darrieus turbine, are collected. The final phase involves the distribution of a questionnaire to experts in marine energy, employing the SMART method for evaluation. The calculated results reveal the sequence of turbine preferences as follows: Savonius turbine preceding the Darrieus turbine. Consequently, the chosen TPP design for implementation in the CFPP will incorporate the Savonius turbine.

Keywords: renewable energy resources, tidal power plant, multi criteria decision making

---

1. Introduction

The limitation of existing energy sources has triggered researchers to explore and develop renewable energy sources. Several examples of renewable energy sources include the utilization of solar energy, wind energy, marine energy, etc. Marine energy is one of the clean, renewable, and abundant energy sources(Awad et al., 2024).

TPP harness tidal currents as a source of energy, utilizing the kinetic energy of these currents to propel turbine blades. The technological advancement in converting tidal energy essentially adopts the operational principles of wind energy conversion(Roberts et al., 2016). Tidal currents are defined as the flow of seawater mass from one place to another (Finkl, 2009). Not all potential sources within tidal currents can be converted into electrical energy; there are numerous types of tidal currents distinguished by their location, causation, and temperature (Mada et al., 2021).

In Indonesia, a significant potential for tidal energy exists in the waters of canal outfall cooling water CFPP with tidal current speeds approximately around 0.5 - 2.5 m/s. Tidal energy can be harnessed as TPP wherein turbines serve as devices to convert kinetic energy into electrical energy that is then transmitted to an electrical generator. There are several types of turbines suitable for TPP, namely horizontal axis turbines and vertical axis turbines (Schmitz et al., 2019).

The selection of the best design for a TPP is crucial to ensure optimal energy generation upon its construction and to avoid unnecessary losses(Guy et al., 2024) (Agit Prakoso et al., 2022) (Samo et al., 2020). This final project involves a comparative study to select turbines by assessing the advantages and dis-advantages of various turbine.

Vertical-axis hydroturbines (VAHTs) employ blades positioned perpendicular to the seabed and water flow direction, making them advantageous for generating high-er torques at lower tidal current speeds and smaller tip-speed ratios (TSRs). This characteristic is particularly beneficial in low tidal current conditions (Li et al., 2023). VAHTs offer cost-effectiveness, simplicity in construction, and their vertical-axis configuration allows them to efficiently harness tidal flows from any direction without requiring adjustments for tide direction changes (Hantoro et al., 2021). Several project that have been implemented as seen as Table 1.

Table 1. Other current commercial VAHT product.

Company	TCEC name	Power Capacity	Current stage/site location
DesignPro Renewables	DesignPro Renewables Hydrokinetic Turbine	25 Kw	Operational/Bordeaux, France
Instream Energy System	Vertical Axis Hydrokinetic Turbines	25 Kw	Operational/Morlais Demonstration Zone, UK
New Energy Corporation	EnCurrent Turbine	250 Kw	Operational/Strait of Georgia, Cananda
	EG-025	25 Kw	Operational/Portsmouth, New Hampshire, US

In determining the turbine types for the Tidal Power Plant, several factors are taken into consideration, including tidal current speeds, location, energy output, reliability, among others(Mozafari et al., 2021). Hence, this research will analyse the selection of the best design for a TPP by comparing different turbine types while considering these relevant factors. Spesification of canal as Table 2:

Table 2. Canal design spesification.

Detail Spesification	Value
Velocity, V (m/s)	1.43
Canal width (m)	4
Canal wall height (m)	3
Water Level (m)	1.8
Slope (m/m)	0.0003
Length of discharge channel (m)	2,400

Based on condition tidal current speeds approximately around 0.5 - 2.5 m/s in the waters of canal outfall cooling water CFPP, technology selected in VAHT is darrieus and savonius.

Another research (Kumar et al., 2020) explore the flow patterns and performance of a small Savonius water turbine operating at a low water velocity of 0.5 m/s. In this investigation, a two-bladed Savonius water turbine with an aspect ratio of 1.58 was created and simulated, along with a model of an open channel. The Realizable k-e turbulence model was employed for the numerical study. The study involved analyzing and discussing the flow distributions around the rotor based on the numerical findings. Additionally, an experimental setup was devised and constructed to validate the numerical results. The research revealed that the Savonius water turbine achieved a peak power coefficient value of 0.23 at a Tip Speed Ratio (TSR) of 0.7 in the Computational Fluid Dynamics (CFD) investigation, which aligned well with the experimental outcomes.

Selecting an inappropriate tidal turbine for a power plant poses a multifaceted problem with potential impacts on risk, cost, and performance(Rodrigues et al., 2021). The wrong choice may introduce operational risks, including increased downtime, maintenance issues, and potential environmental harm, leading to compliance challenges. From a cost perspective, the selection error could incur higher capital and operational expenses, as modifications or additional investments may be required to address turbine inefficiencies. Moreover, the performance of the tidal power plant may suffer, with suboptimal energy production, output variability, and challenges in meeting expected power generation levels. The interplay of these factors emphasizes the critical need for a meticulous turbine selection process, utilizing Multi-Criteria Decision Making (MCDM) to ensure alignment with specific environmental conditions and operational requirements, thereby mitigating risks, controlling costs, and optimizing overall plant performance.

Multi-Criteria Decision Making (MCDM) is a decision-making approach that involves considering multiple criteria or factors when evaluating and selecting from alternative courses of action(Wu et al., 2016). In many real-world situations, decisions are complex and involve conflicting objectives or considerations. MCDM methods help decision-makers systematically analyze and prioritize alternatives based on a set of criteria, taking into account the relative importance of each criterion(Wu et al., 2016). Analytic Hierarchy Process (AHP) and SMART (Simple Multi-Attribute Rating Technique) are two MCDM methods commonly used to support decision-making processes (Lee et al., 2018).

The Analytical Hierarchy Process (AHP) is a structured technique developed by Thomas L. Saaty for dealing with complex decision-making problems. It decomposes a decision problem into a hierarchical structure of criteria and alternatives, allowing decision-makers to make pairwise comparisons to determine the relative importance of criteria and the performance of alternatives. AHP involves creating a hierarchical structure of criteria and alternatives, assigning numerical values to pairwise comparisons, and using mathematical processes to derive priority weights. It is particularly useful when there are dependencies and interactions among criteria and alternatives. AHP helps in synthesizing complex decision matrices and obtaining a comprehensive view of the decision problem and have utilized in any research for renewable energy (Susiati et al., 2022).

The Simple Multi Attribute Rating Technique (SMART) is a straightforward MCDM method that assigns ratings to alternatives based on multiple criteria (Barron et al., 1996). It is a simpler approach compared to AHP, suitable for situations where the decision problem is less complex and the interactions among criteria are relatively straightforward. SMART involves defining a set of criteria, determining the importance weights for each criterion, and then rating alternatives on each criterion. The ratings are usually ordinal or numerical values representing the performance of alternatives with respect to each criterion. SMART is more intuitive and less mathematically involved compared to AHP, making it a practical choice for simpler decision scenarios.

SMART is utilized to support turbine selection, wherein the determination of weights for each criteria is achieved using the AHP method. Additionally, the best-ranking tidal turbine are identified through the SMART.

This study relies on data collected from tidal currents in the waters surrounding the canal outfall CFPP 4 x 315 MW, where tidal turbine selection was conducted through the implementation of Analytic Hierarchy Process (AHP) and Simple Multi-Attribute Rating Technique (SMART) methods. Given the region's insufficient electricity supply, coupled with the presence of high tidal current speeds in its surrounding waters, this area is deemed suitable for the implementation of a Tidal Power Plant (TPP) to harness and utilize the available tidal energy resources.

2. Methods

Based on the method used, which is AHP, the first step is to establish criteria and the best choices for turbines. An expert in the Analytic Hierarchy Process (AHP) possesses a comprehensive understanding of decision problems and the ability to translate complex scenarios into a hierarchical structure of criteria and alternatives. Proficient in both qualitative and quantitative assessments, the expert excels in eliciting and analyzing subjective judgments through pairwise comparisons, ensuring consistency and reliability in the decision-making process (Rostampoor, 2016). With a keen mathematical acumen, the expert utilizes eigenvalue and eigenvector analysis to derive precise priority weights, synthesizing results and conducting sensitivity analyses to gauge the robustness of the model. AHP experts not only adeptly aggregate judgments but also excel in interpreting and effectively communicating the outcomes to decision-makers, bridging the gap between mathematical rigor and practical decision support. Their expertise lies not only in the mastery of AHP's methodologies but also in the application of nuanced domain knowledge, enabling them to guide decision-makers in making well-informed and strategically sound choices. The criteria for selecting turbines are: installability, affordability, operability, environability. As previously mentioned, the alternatives include: darrieus and savonius as VAHT selected and summarized on Table 3.

Table 3. Selected criteria for turbine tidal selection.

Criteria	Remarks	Alternatives	
		Darrieus	Savonius
Installability	Power Coefficient (Cp)	0.3-0.45	0.2-0.3
	Velocity Minimum (m/s)	1-3	0.45-1.5
	H/d ratio (Aspect ratio)	0.5-1.5	1.2-1.8
Affordability	Tip Speed Ratio	4-7	0.5-0.85
	unit cost ($/kW) for 25 kW sizing	Medium-Low (around 4,023)	Low (1490)
Operability	Starting Capability	poor starting characteristic, therefore some external power source requires	Drag driven turbine with Excellent self-starting capability and perform well at smaller TSR
	efficiency	12%	7%
	Mechanical performance	low torque	high torque
Environability	rpm	High Speed (34)	Low Speed (7)

Installability refers to the ease and efficiency with which a particular alternative can be installed or implemented. It encompasses factors such as the simplicity of the installation process, the need for specialized equipment or skills, and the time required for deployment. Installability is essential in assessing the feasibility and practicality of implementing a solution. A high installability score indicates that the alternative can be installed relatively easily and without significant complications.

Affordability assesses the overall cost and financial feasibility of implementing a particular alternative. It includes considerations such as initial capital costs, ongoing operational expenses, and any potential hidden costs. Affordability is a critical criterion as it helps decision-makers understand the financial implications of each alternative. A cost-effective solution with reasonable financial requirements is generally preferred.

Operability evaluates how well an alternative can be operated and maintained over its lifecycle. It considers factors such as reliability, ease of maintenance, and the availability of necessary resources for smooth operation. Operability is crucial for ensuring the long-term success and sustainability of a project. An alternative with high operability scores indicates that it can be effectively managed and maintained, reducing the likelihood of disruptions.

Environability assesses the environmental impact and sustainability of each alternative. It considers factors such as the ecological footprint, impact on local ecosystems, and adherence to environmental regulations and standards. In the context of renewable energy projects like tidal power plants, environability is paramount. A high environability score indicates that the alternative aligns well with environmental goals and minimizes adverse effects on the ecosystem.

The AHP evaluation scale for criteria based on Table 4 in this method are as follows:

Table 2. AHP evaluation scale.

Definition	Value
Both options have the same value	1
One of the options has a slightly higher value than the other option	3
One of the options has a superior value compared to the other option	5
One of the options has significantly superior value compared to the other option	7
One of the options has a vastly superior value compared to the other option	9
The value where one of the options falls between the aforementioned criteria	2,4,6,8

The next step involves distributing the questionnaire among experts in renewable energy expert. Subsequently, calculating the Consistency Ratio (CR) that should be under 0.1 or 10%.

The Following step with utilize SMART method, it will be conducted to select the alternative tidal turbine. Assigning criteria values for each tidal turbine (in this case, tidal turbine are the alternatives being considered) as shown in Table 5.

Table 5. SMART criteria scoring.

No	Criteria	Score
1	Installability	
	Easy	5
	Moderate	3
	Difficult	1
2	Affordability	
	Cheap	5
	Standard	3
	Expensive	1
3	Operability	
	Good	5
	Enough	3
	Minus	1
4	Environability	
	Compliance	5
	Standard	3
	Not compliance	1

Determine the value of the utility to convert the value of the criteria for each criterion into the value of the raw data criteria. Utility value is obtained using the equation:

$$u_i\left(a_i\right)=\frac{c_{out}-c_{\min}}{c_{\max}-c_{\min}} \tag{1}$$

Where $u_i(a_i)$ is the utility value of the criteria to-1 for the criteria to - I, $c_{\max}$ is the maximum value criteria, $c_{\min}$ is the value of the minimum criteria and $c_{out}i$ is a value criterion to - I. The importance of these values are:

$$c_{out}\ i = u_i(a_i),1 = 0\ ;\ 3 = 0.5\ ;\ 5 = 1 \tag{2}$$

Determine the final value of each criterion by shifting the values obtained from the normalized value of the raw data criteria with weight normalized value criteria. Then total value of the multiplication.

3. Result and Discussion

3.1. The analysis of turbine selection criteria

The analysis of turbine selection criteria involves evaluating and examining the criteria used to select turbines. This process includes assessing factors such as power generation installability, affordability, operability, and environability. Evaluating these criteria helps in making informed decisions regarding the most suitable turbine options for the intended tidal energy project (see Table 6 and Table 7).

Table 6. AHP normalization value.

Criteria	Installability	Affordability	Operability	Environability
Installability	1	2.29	1.06	1.82
Affordability	0.44	1	0.91	1.82
Operability	0.94	1.1	1	1.91
Environability	0.55	0.55	0.52	1
Sum	2.9281	4.9404	3.494	6.5472

Table 7. Eigenvector of the criteria.

Normalized Principal Eigenvector
0,35
0,22
0,28
0,15

Consistency Index (CI) = 0.10
Consistency Ratio (CR) = 2.7% = 0.027

In the context of AHP, a CI value of 0.10 is relatively low, suggesting a moderate level of consistency. Lower CI values indicate better consistency in the pairwise judgments. However, CI alone does not provide a clear indication of whether the inconsistency is acceptable or not; it needs to be compared with a threshold value.

The consistency ratio from processing the questionnaire is 2.7%, is considered acceptable in the AHP context. Typically, if the CR is below a certain predefined threshold (commonly set at 10%), the consistency in the pairwise comparisons is considered satisfactory. In this case, the decision-maker's judgments are deemed reasonably consistent, given the context of the decision problem.

In summary, the CI and CR values you provided suggest that the pairwise comparisons made in the AHP process have a relatively low level of inconsistency, and the level of consistency is within an acceptable range. Decision-makers aim to keep these values low to ensure that the AHP results are reliable and the priority weights assigned to criteria and alternatives are consistent with the provided judgments. If the CI or CR is high, it may indicate a need for a review of the pairwise comparisons to improve their consistency

The questionnaire processing resulted in the order of criteria and their values as follows: installability (0.35), affordability (0.22), Operability (0.28), environability (0.15).

3.2. Turbine selection analysis

Determining utility values. At this stage, we need to consider the nature of each criterion, including whether it follows the 'bigger is better' or 'smaller is better' type. In Table 8, it represents result of the initial data for all criteria falling under the 'bigger is better' type. Therefore, the final score on Table 9.

Table 8. Normalization Data from SMART Method.

Tidal Turbine	Installability	Affordability	Operability	Environability
Darius	1	0.5	0,5	1
Savonius	1	0.5	1	1

Table 9. SMART final value.

No	Turbine	Final Value
1	Darius	0,73
2	Savonius	0,87

The final value of 0.73 suggests that, based on the criteria used in the SMART evaluation, Darius received a score indicating moderate suitability or performance. It may have strengths in certain criteria but may also have areas where it falls short compared to the other turbine.

The final value of 0.87 indicates that Savonius received a higher score compared to Darius, suggesting better overall performance based on the criteria considered. Savonius may excel in specific aspects that are critical to the decision-making process for selecting a turbine for the Tidal Power Plant.

According to the outcomes obtained through SMART, it can be inferred that these ultimate values are instrumental for making an enlightened choice regarding the most appropriate turbine for the Tidal Power Plant. A superior final value, exemplified by Savonius, implies that it better corresponds to the criteria taken into account during the decision-making process. This indicates that Savonius is likely more aligned with the specified criteria, making it a more favorable choice for the Tidal Power Plant.

3.3. Challenges of tidal energy technologies

TPP exhibit promising commercial potential due to the predictability of tidal cur-rents over extended periods and their minimal susceptibility to weather conditions(Chowdhury et al., 2021)(Neill et al., 2018). Tidal stream technology eliminates the need for dam construction, with devices positioned directly within the water flow to generate energy. Various technologies, such as horizontal- and vertical-axis turbines, venturis, and oscillating foils, are utilized for harnessing energy from currents. Additionally, diverse methods, such as seabed anchoring through gravity bases or driven piles, as well as fixed positioning via mooring lines on floating or semi-floating platforms, are employed to secure these devices in place(Powertech Labs, 2009). Successful full-scale demonstrations of TPP have garnered substantial support from both governmental entities and private investors interested in tidal current energy technologies. Nevertheless, despite these advancements, there remain hurdles and obstacles that must be addressed for the continued progress of tidal current energy technologies:

1. Obstacles related to the construction, installation, and operation and maintenance (O&M) have emerged as significant challenges during the demonstrations of TPP. Heightened apprehensions have arisen concerning the technical risks associated with building infrastructure and facilities in coastal areas, as well as with the transportation, installation, and ongoing maintenance of TPP.
2. Typical challenges in maintaining TPP involve biofouling and corrosion. These issues have the potential to alter the shape of hydrofoil-shaped rotor blades in TPP and add weight to hydroturbines, ultimately diminishing their hydrodynamic performance, energy harvesting efficiency, and self-starting capabilities. To address these concerns, forthcoming TPP projects should prioritize the utilization of specialized coatings for structural surfaces to deter biofouling and corrosion. Additionally, the selection of sealing materials and electrical insulation for TPP should consider their effectiveness in saline environments.
3. Ecological concerns regarding the environmental impact assessments of TPP installation and operation are significant. The presence and operation of TPP directly influence benthic habitats by altering water flows, substrate composition, and sediment dynamics. The introduction of substantial foundation structures can modify water flows, potentially leading to localized seabed scouring or sediment deposition.

4. Conslusion

1. Indonesia Power Plant have a significant potential for tidal energy exists in the waters of canal outfall cooling water CFPP with tidal current speeds approximately around 0.5 - 2.5 m/s.
2. Based on studied, there is potential of energy from the tidal currents in the waters of the canal outfall CFPP 4 x 315 MW.

3. Criteria values as follows: installability (0.35), affordability (0.22), Operability (0.28), environability (0.15).
4. Savonius turbine is the selected alternative tidal turbine that applicable in the canal outfall CFPP 4 x 315 MW based on specification of prioritizing criteria.
5. Several challenging of tidal turbine from operation maintenance scheme to determine in the next reliability scenario for tidal power plant in the life cycle asset and ecological perspective.

Acknowledgements

The authors wish to thank the opportunity and financial support that permitted to carry on this project for Strategic Planning of Power Generation and Human Talent Development Division PLN Holding.

References

Agit Prakoso, Sayyid Alkahfi et al., 2022. Perancangan Dan Simulasi Performa Prototipe Turbin Air Tidal Tipe Propeler Naca S814 Sebagai Sumber Energi Petani Tambak Garam Daerah Cirebon. Jurnal Pendidikan Teknik Mesin Undiksha 10 (1): 86–103. https://doi.org/10.23887/jptm.v10i1.45389.

Awad, Mohamed et al., 2024. A Review of Water Electrolysis for Green Hydrogen Generation Considering PV/Wind/Hybrid/Hydropower/Geothermal/Tidal and Wave/Biogas Energy Systems, Economic Analysis, and Its Application. Alexandria Engineering Journal 87 (December 2023): 213–39. https://doi.org/10.1016/j.aej.2023.12.032.

Barron, F. Hutton, and Bruce E. Barrett., 1996. The Efficacy of SMARTER - Simple Multi-Attribute Rating Technique Extended to Ranking. Acta Psychologica 93 (1–3): 23–36. https://doi.org/10.1016/0001-6918(96)00010-8.

Chowdhury, M. S. et al., 2021. Current Trends and Prospects of Tidal Energy Technology. Environment, Development and Sustainability 23 (6): 8179–94. https://doi.org/10.1007/s10668-020-01013-4.

Finkl, Roger H. Charlier; Charles W., 2009.*Ocean Energy, Tide and Tidal Power*. Springer. https://doi.org/10.1007/978-3-540-77932-2.

Guy, Callum et al., 2024. Numerical Modelling of a 1.5 MW Tidal Turbine in Realistic Coupled Wave–Current Sea States for the Assessment of Turbine Hub-Depth Impacts on Mechanical Loads. Ocean Engineering 292 (June 2023): 116577. https://doi.org/10.1016/j.oceaneng.2023.116577.

Hantoro, Ridho et al., 2021. Site Test Performance and Numerical Study of Vertical Axis Hydrokinetic Turbine Straight Blade Cascaded (Vaht–Sbc). Journal of Engineering and Technological Sciences 53 (1): 1–16. https://doi.org/10.5614/j.eng.technol.sci.2021.53.1.2.

Kumar, Anuj, and Gaurav Saini., 2020. Flow Field and Performance Study of Savonius Water Turbine. Materials Today: Proceedings 46: 5219–22. https://doi.org/10.1016/j.matpr.2020.08.591.

Lee, Hsing Chen, and Ching Ter Chang., 2018. Comparative Analysis of MCDM Methods for Ranking Renewable Energy Sources in Taiwan. Renewable and Sustainable Energy Reviews 92 (May): 883–96. https://doi.org/10.1016/j.rser.2018.05.007.

Li, Gang, and Weidong Zhu., 2023. Tidal Current Energy Harvesting Technologies: A Review of Current Status and Life Cycle Assessment. Renewable and Sustainable Energy Reviews 179 (April): 113269. https://doi.org/10.1016/j.rser.2023.113269.

Mada, Universitas Gadjah et al., 2021. WAVE TO POWER : Optimalisasi Pemanenan Energi Listrik Pasang Surut Di, no. September: 0–13.

Mozafari, Babak et al., 2021. INTERNATIONAL JOURNAL OF COASTAL & OFFSHORE ENGINEERING Comparison of Horizontal and Vertical Axis Tidal Turbine with a New Design to the Renewable Energy Production of Marine Currents ARTICLE INFO ABSTRACT 6 (5).

Neill, Simon P. et al., 2018. Tidal Range Energy Resource and Optimization – Past Perspectives and Future Challenges. Renewable Energy 127: 763–78. https://doi.org/10.1016/j.renene.2018.05.007.

Powertech Labs., 2009. Ocean Energy: Global Technology Development Status - Implementing Agreement on Ocean Energy Systems. Energy.

Roberts, A. et al., 2016. Current Tidal Power Technologies and Their Suitability for Applications in Coastal and Marine Areas. Journal of Ocean Engineering and Marine Energy 2 (2): 227–45. https://doi.org/10.1007/s40722-016-0044-8.

Rodrigues, N. et al., 2021. Cost-Benefit Analysis of Tidal Energy Production in a Coastal Lagoon: The Case of Ria Formosa – Portugal. Energy 229. https://doi.org/10.1016/j.energy.2021.120812.

Rostampoor, Mahya., 2016. Definition of Analytical Hierarchy Process and Its Effect on Environmental Decisions in Engineering for Landfill Siting. Intech 11 (tourism): 13. https://www.intechopen.com/books/advanced-biometric-technologies/liveness-detection-in-biometrics.

Samo, Kamran Ahmed et al., 2020. Suitable Turbine Selection Based on the Parameters of a Potential Site at Sarawak, Malaysia. Engineering, Technology and Applied Science Research 10 (6): 6399–6402. https://doi.org/10.48084/etasr.3770.

Schmitz, C. et al., 2019. Multipole Optimization of Turbine Arrays in Tidal Flows. IOP Conference Series: Earth and Environmental Science 240 (5). https://doi.org/10.1088/1755-1315/240/5/052008.

Susiati, Heni et al., 2022. Site Suitability-Based Spatial-Weighted Multicriteria Analysis for Nuclear Power Plants in Indonesia. Heliyon 8 (3): e09088. https://doi.org/10.1016/j.heliyon.2022.e09088.

Wu, Yunna et al., 2016. Optimal Site Selection of Tidal Power Plants Using a Novel Method: A Case in China. Energies 9 (10). https://doi.org/10.3390/en9100832.