



# **Neutrosophic Multi-Criteria Decision Making COMET Method for Evaluation Sustainable Electricity Generation Considering Renewable Energy Sources**

**Tamer H. M. Soliman<sup>1\*</sup>**

<sup>1\*</sup>Faculty of Computers and Informatics, Zagazig University, Zagazig 44519, Sharqiyah, Egypt

Emails: [tamer.hasan.comp@o6u.edu.eg](mailto:tamer.hasan.comp@o6u.edu.eg)

## **Abstract**

Considering renewable energy sources in assessments of sustainable electricity production is essential for accelerating the shift to a greener and more sustainable energy system. The evaluation takes into account a wide range of factors, such as the renewable energy source, carbon footprint, energy efficiency, environmental impact, grid integration, policy support, cost, social and economic implications, technological progress, and certification for transparency. Sustainable power deployment may be hastened via careful consideration of these aspects by policymakers, energy planners, and other stakeholders. This paper shows the hybrid multi-criteria decision-making method with the single-valued neutrosophic set. The single valued neutrosophic set was used to overcome the vague information. The single valued neutrosophic set hybrid with the Characteristic Object METHod (COMET) method. The COMET method is an MCDM method. It is used to rank the alternatives. This paper used ten criteria and ten alternatives. The application is conducted to show the results of the proposed method.

**Keywords:** Renewable Energy; Sustainability; Electricity; MCDM; COMET; Neutrosophic Set

## **1. Introduction**

The assessment of sustainable electricity production is of critical importance as the globe struggles to solve the pressing need to address climate change and move towards sustainable energy systems. Power plants that use renewable energy sources to generate electricity are the focus of this analysis. Decarbonizing the power sector and decreasing dependency on fossil fuels may be accomplished in part via the use of renewable energy sources including solar, wind, hydropower, geothermal, and biomass. Sustainable electricity production from renewable energy sources may be evaluated for its sustainability, efficacy, and contributions to a greener future by taking all relevant factors into account[1], [2].

Many aspects go into an analysis of sustainable power production when renewable energy sources are taken into account. Carbon footprint, energy efficiency, environmental effect, grid integration, legislative support, cost, social and economic ramifications, technology advances, and certification are a few of the many factors to consider when deciding on a renewable energy source. Policymakers, energy planners, and stakeholders may accelerate the adoption of sustainable power production by examining these factors and making educated judgments, setting objectives, and developing strategies[3], [4].

The assessment of sustainable electricity production offers a framework for measuring the performance and potential of renewable energy sources in this age of fast technical breakthroughs and growing awareness of the need for

sustainable development. It aids in determining where the energy sector now stands and where it may be strengthened for a more sustainable and environmentally friendly future. Energy security, local economic growth, and reduced greenhouse gas emissions are only a few of the benefits of increasing the use of renewable energy sources in power generation[5], [6]. This paper assesses the green sustainable electricity by the several factors in renewable energy by the MCDM tools such as COMET method[7], [8].

Zadeh initially established the concept of fuzzy sets (FSs) in 1965; since then, they have been used in a wide variety of contexts to deal with the ambiguity that arises when only certain elements of a set may be considered to be members of that set. Unlike probability, which uses a discrete interval between 0 and 1 to describe uncertainty, a fuzzy set (FS) uses a continuous range between 0 and 1 to indicate membership and non-membership. Researchers have now developed several generalizations to better effectively deal with imprecise, ambiguous, and incomplete data. One such extension that has proven beneficial in dealing with fuzziness and uncertainty is Atanassov's intuitionistic fuzzy sets (IFSs). To ensure that the total of the membership degree and the non-membership degree falls inside the unit interval [0,1], both are defined between 0 and 1 in IFSs. A person's level of uncertainty may be calculated by subtracting the total of their membership and non-membership values from 1. There are several examples in the literature of how FSs and IFSs have been put to use[9], [10].

While IFSs have shown effectiveness in dealing with ambiguity, they cannot address the indeterminacy and inconsistency of information that is typical of belief systems and real-world situations. Samarandache saw this, and he created the concept of neutrosophic sets (NSs) as a means to portray uncertain, fragmented, and contradictory data. In a logical structure, NSs generalize both finite sets and infinite fusion sets. Independent membership in the truth, falsehood, and indeterminacy are what define a neutrosophic set (NS). These truth, falsehood, and indeterminacy membership functions may also be members of a subset of a real standard or non-standard unit interval. It is not necessary for the unit interval [0,1] to have the total of these truth, falsehood, and indeterminacy memberships[11], [12]. Since the NS generalization theory is philosophical in nature, it is challenging to apply it to real-world engineering and scientific challenges. Therefore, Wang et al. proposed the concept of single-valued NSs (SVNSs), a subclass of NSs in which the values of truth membership, falsity membership, and indeterminacy membership all fall within the unit range [0,1], and the total of these three memberships should be between 0 and 1. Its theoretical beauty and practical efficacy mean that it may be used to better illustrate imprecise, partial, and inconsistent data and to solve actual scientific and technical challenges. After that, many researchers were interested in SVNSs and developed several approaches to deal with real-world issues arising from different disciplines and their own peculiar needs and specifications[13], [14].

This study will examine the value of renewable energy sources in the context of a more extensive assessment of sustainable power production. Sustainable and efficient evaluation of power-generating techniques that make use of renewable energy sources is the focus of this article. To successfully create policies, investments, and efforts that encourage the shift to a sustainable, low-carbon, and resilient electrical system, it is essential to grasp the many dimensions of this assessment. By doing this analysis, we can lay the groundwork for a cleaner, more prosperous future for current and future generations[15], [16].

## **2. Green Sustainable Electricity**

Setting goals and creating plans for making the switch to a greener and more sustainable energy system is greatly aided by the assessment of sustainable power production. Some ways in which the assessment may aid in this procedure are as follows.

Assessing the Potential of Renewable Energy Sources Identifying the availability and potential of renewable energy sources is an important part of evaluating sustainable power supply. It is possible to determine which renewable energy technologies are most suited for a certain location by analyzing data like sun irradiation, wind speeds and directions, hydrological information, and biomass reserves. The greatest possible capacity and contribution of renewable energy in the electrical mix may be determined using this data, allowing for more reasonable objectives to be established[17], [18].

In order to evaluate sustainable power production, it is necessary to evaluate the environmental implications and carbon emissions of various renewable energy systems. Emissions reduction goals may be established by assessing the emissions reduction potential of each technology and comparing it to the already existing carbon emissions from fossil fuel-based energy production. Strategies for prioritizing the deployment of certain renewable energy sources that give the greatest advantages in terms of emissions reduction may be developed with the use of this data[19], [20].

In order to define goals and create plans, it is necessary to assess the competitiveness and affordability of sustainable power production. Various renewable energy technologies' leveled cost of electricity (LCOE) is compared to that of more traditional energy sources. It is possible to make green power more affordable by setting goals based on an analysis of renewable energy's cost competitiveness. To make renewable energy more financially feasible, strategies may be devised to reduce costs through technological improvement, economies of scale, and encouraging legislation.

Tracking technical progress and new developments in the renewable energy industry is a crucial part of any assessment of the viability of this kind of power production. Goals may be established to promote the adoption of more sophisticated and efficient renewable energy technologies by evaluating the progress made in areas like efficiency, storage capacity, and grid integration. Then, plans may be made to fund R&D, encourage innovation, and push for the widespread adoption of promising new technology[21], [22].

**Policy and Regulatory Frameworks:** Assessing the efficacy of current policies and regulatory frameworks is aided by evaluating sustainable power production. Feed-in tariffs, tax incentives, renewable energy objectives, and grid integration regulations are all examples of encouraging measures that may be studied for their effects in order to establish goals for their improvement and expansion. An enabling environment for renewable energy adoption may be achieved via the implementation of strategies to establish new policies, eliminate impediments, and improve regulatory frameworks.

**Including Stakeholder Input:** Governments, utilities, industry actors, and communities are all important participants in any analysis of sustainable power production. Goals that take into account the interests of all parties involved may be more effectively achieved. The public's knowledge, engagement, and inclusion in the energy transition process may all be improved with the right strategies[23], [24].

Evaluating sustainable energy production offers a framework against which to measure the attainment of goals and the success of tactics in meeting objectives. In order to resolve obstacles, make the most of possibilities, and guarantee the intended results, it is important to evaluate the progress of renewable energy deployment on a regular basis. As the energy transition advances, this iterative method will allow for ongoing improvement and adaptability[25], [26].

Overall, learning more about renewable energy potential, environmental impacts, cost competitiveness, technological advancements, policy frameworks, stakeholder engagement, and progress monitoring through assessing sustainable electricity generation is useful for setting goals and creating strategies. Policymakers and energy planners may use the results of this analysis to make well-informed choices, coordinate their efforts, and speed up the shift to a low-carbon, reliable electrical system[27], [28].

### **3. Methodology**

Multi-criteria assessment problems vary in structure depending on the nature and number of criteria used to assess them, as well as the number of options under consideration. This section provides the steps of the COMET method[7], [29]. Although the COMET technique is straightforward, it is helpful to have some familiarity with single valued neutrosophic sets theory in order to fully grasp how it works[30], [31]. Figure 1 shows the steps of the proposed method.

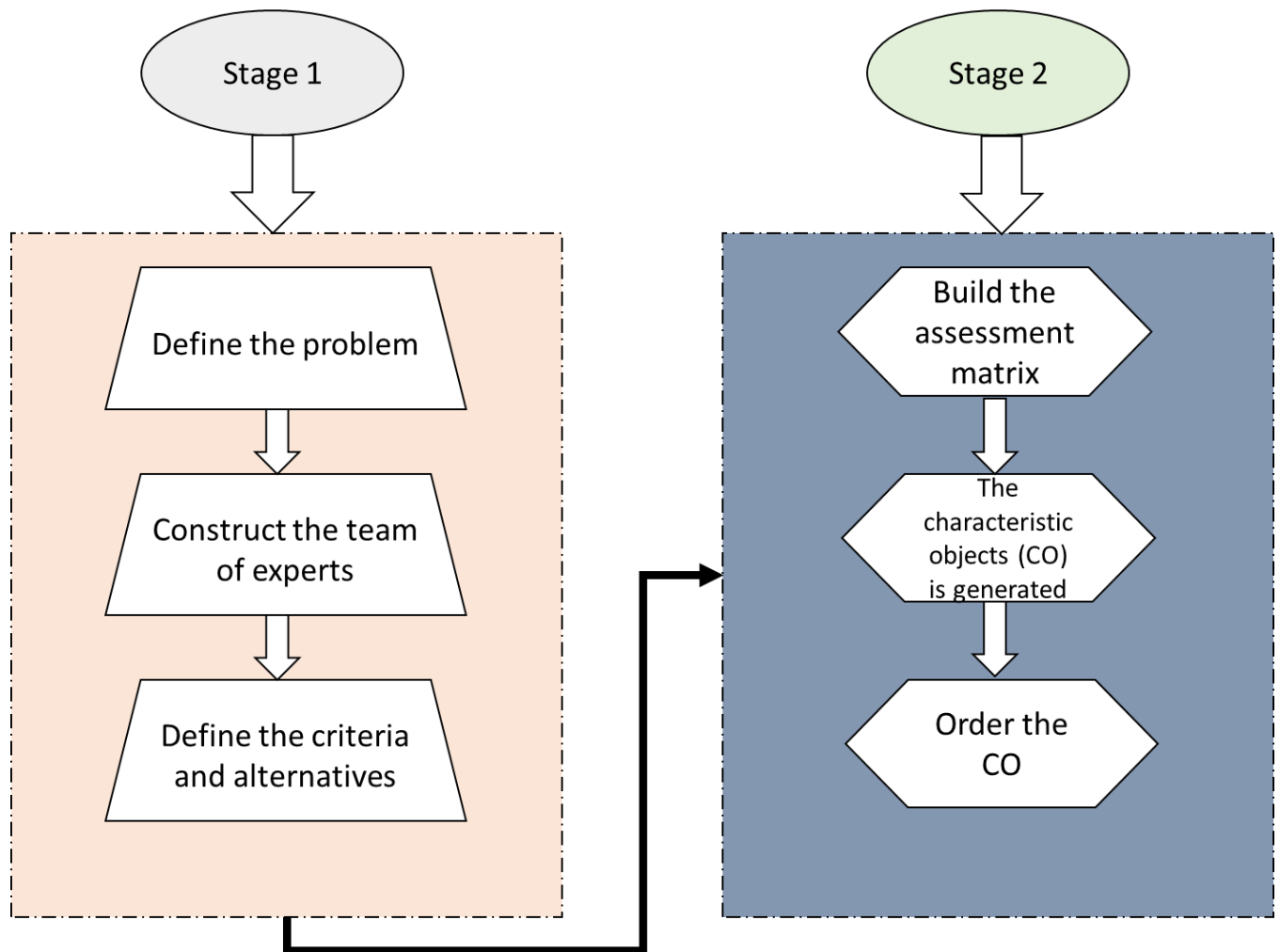


Figure 1: The Steps of the single valued neutrosophic COMET method.

The COMET approach is formally given in the following phases.

1. Select the set of criteria
2. Build the assessment matrix
3. The characteristic objects (CO) is generated

$$O = (GELC_1 \times GELC_2 \times GELC_3 \times \dots \times GELC_r) \tag{1}$$

$$O_1 = (GELC_{11} \times GELC_{21} \times GELC_{31} \times \dots \times GELC_{r1}) \tag{2}$$

$$O_2 = (GELC_{11} \times GELC_{21} \times GELC_{31} \times \dots \times GELC_{r2}) \tag{3}$$

$$t = \prod_{i=1}^r GELC_i \tag{4}$$

4. Order the CO

$$JM = \begin{bmatrix} \alpha_{11} & \dots & \alpha_{1t} \\ \vdots & \ddots & \vdots \\ \alpha_{t1} & \dots & \alpha_{tt} \end{bmatrix} \tag{5}$$

$$\alpha_{ij} = \begin{cases} 0.0 & f_{exp}(O_i) < f_{exp}(O_j) \\ 0.5 & f_{exp}(O_i) = f_{exp}(O_j) \\ 1.0 & f_{exp}(O_i) > f_{exp}(O_j) \end{cases} \quad (6)$$

$$\alpha_{ij} = 0.5 \quad (7)$$

$$\alpha_{ji} = 1 - \alpha_{ij} \quad (8)$$

$$p = \binom{t}{2} = \frac{t(t-1)}{2} \quad (9)$$

We can compute the vertical vector of summed judgments as

$$S_i = \sum_{j=1}^t \alpha_{ij} \quad (10)$$

#### 4. Application

This section shows the application of the single valued COMET method on the assessment green electricity. We collected ten criteria and presented as:

Green power may be evaluated on its viability, environmental impact, and overall efficacy using a number of different metrics. Key factors for assessing the quality of green power are as follows:

Primary consideration is given to the kind of energy utilized to produce the electricity itself. Clean power comes from renewable resources including the sun, the wind, the water, the earth, and biomass. The evaluation needs to confirm that the energy source is long-lasting, plentiful, and infinite.

The carbon impact of green power has to be assessed. In order to do this, we must examine the emissions produced throughout the whole energy production process, from initial resource extraction to final decommissioning. Greener power is one which produces the fewest amount of carbon emissions.

It is essential to evaluate the energy efficiency of renewable power plants before they are put into operation. Renewable energy conversion efficiency is measured against that of more traditional power plants. A more sustainable and efficient method of producing power is indicated by a higher energy efficiency.

It is important to think about how green power production affects the environment as a whole. Ecosystems, biodiversity, water resources, land use, and air quality are just a few of the areas that need to be considered. It's crucial to account for environmental considerations including habitat loss, water use, and land conversion while planning any development.

Integration into the electrical grid and dependability in fulfilling power demands are two factors that should be considered while evaluating green electricity. It is crucial to examine the accessibility of dependable backup systems and energy storage options, as well as the grid infrastructure's capability of handling intermittent renewable energy sources.

The legislative framework and incentives that encourage the creation and spread of green power should be taken into account throughout the assessment. Whether or whether the government is serious about encouraging green power may be gauged by looking at laws, feed-in tariffs, tax incentives, renewable energy objectives, and other supporting measures.

The extensive use of green power requires careful consideration of its cost. Green power's cost competitiveness may be evaluated by comparing its leveled cost of electricity (LCOE) to that of more traditional energy sources. Its long-term cost-effectiveness may also be gleaned by examining the likelihood of future cost reductions.

Assessing the repercussions of producing green power on society and the economy is crucial. Opportunities for economic growth, community involvement, and new employment are all factors to consider when planning renewable energy projects. Consideration of local community support and advantages is important for a full assessment.\

Assessment of technical development and innovation in green power production provides information about the field's future possibilities and improvement avenues. Research and development initiatives, new technologies, and emerging trends may all be evaluated to provide insight into the state of the sector and the potential for future growth.

Consideration of existing transparency and certification processes is important when assessing green power. Guarantees of origin (GOs) and renewable energy certificates (RECs) are two examples of reputable certification systems that may be used to verify that power has come from renewable sources.

A thorough assessment of green electricity's viability, environmental impact, cost-effectiveness, and overall efficacy as a renewable energy source may be attained by using these criteria. A future with low-carbon, clean energy is possible only with the help of such assessments, which are essential for guiding policy choices and supporting sustainable energy transitions.

1. We select ten criteria related to the green electricity.
2. We build the assessment matrix by the criteria and alternatives. We collected ten alternatives in this study.
3. we generated the characteristic objects (CO) by using Eqs. (1-4)
4. Then we rank the CO by using Eqs. (5-10) as shown in Table 1. The rank of alternatives shows in Figure 2. The alternative 3 is the best.

Table 1: The rank of CO.

	<i>GELC</i> <sub>1</sub>	<i>GELC</i> <sub>2</sub>	<i>GELC</i> <sub>3</sub>	<i>GELC</i> <sub>4</sub>	<i>GELC</i> <sub>5</sub>	<i>GELC</i> <sub>6</sub>	<i>GELC</i> <sub>7</sub>	<i>GELC</i> <sub>8</sub>	<i>GELC</i> <sub>9</sub>	<i>GELC</i> <sub>10</sub>
<i>GELA</i> <sub>1</sub>	0.5	1	1	1	0	0	1	0.5	1	0.5
<i>GELA</i> <sub>2</sub>	0.5	1	1	1	1	1	1	0.5	1	0
<i>GELA</i> <sub>3</sub>	0.5	1	0	0.5	1	0	0	0.5	1	1
<i>GELA</i> <sub>4</sub>	0.5	1	1	1	1	0	0.5	0.5	1	1
<i>GELA</i> <sub>5</sub>	0.5	1	1	0.5	1	0	0.5	0.5	1	1
<i>GELA</i> <sub>6</sub>	0.5	1	0	0.5	1	0	1	0.5	1	1
<i>GELA</i> <sub>7</sub>	0.5	1	0	0.5	1	0	1	0.5	1	1
<i>GELA</i> <sub>8</sub>	0.5	1	1	0.5	1	0	1	0.5	1	0.5
<i>GELA</i> <sub>9</sub>	0.5	1	0.5	0.5	0.5	0	1	0.5	1	1
<i>GELA</i> <sub>10</sub>	1	1	1	1	1	1	1	1	1	1
	<i>GELC</i> <sub>1</sub>	<i>GELC</i> <sub>2</sub>	<i>GELC</i> <sub>3</sub>	<i>GELC</i> <sub>4</sub>	<i>GELC</i> <sub>5</sub>	<i>GELC</i> <sub>6</sub>	<i>GELC</i> <sub>7</sub>	<i>GELC</i> <sub>8</sub>	<i>GELC</i> <sub>9</sub>	<i>GELC</i> <sub>10</sub>
<i>GELA</i> <sub>1</sub>	1	0.5	0.5	0.5	1	1	0.5	1	0.5	1
<i>GELA</i> <sub>2</sub>	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
<i>GELA</i> <sub>3</sub>	1	1	1	1	1	1	1	1	1	0.5
<i>GELA</i> <sub>4</sub>	1	1	0.5	0.5	1	0.5	0.5	0.5	1	1
<i>GELA</i> <sub>5</sub>	1	1	0.5	1	1	0.5	0.5	0.5	1	1
<i>GELA</i> <sub>6</sub>	1	1	1	0.5	1	0.5	0.5	0.5	1	1
<i>GELA</i> <sub>7</sub>	0.5	1	0.5	0.5	1	0.5	1	0.5	1	1
<i>GELA</i> <sub>8</sub>	0.5	1	0.5	0.5	1	0.5	1	0.5	1	1
<i>GELA</i> <sub>9</sub>	0.5	1	1	0.5	1	0.5	1	0.5	0.5	1
<i>GELA</i> <sub>10</sub>	0.5	1	0.5	0.5	1	0.5	1	0.5	0.5	1
	<i>GELC</i> <sub>1</sub>	<i>GELC</i> <sub>2</sub>	<i>GELC</i> <sub>3</sub>	<i>GELC</i> <sub>4</sub>	<i>GELC</i> <sub>5</sub>	<i>GELC</i> <sub>6</sub>	<i>GELC</i> <sub>7</sub>	<i>GELC</i> <sub>8</sub>	<i>GELC</i> <sub>9</sub>	<i>GELC</i> <sub>10</sub>
<i>GELA</i> <sub>1</sub>	1	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	1
<i>GELA</i> <sub>2</sub>	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1
<i>GELA</i> <sub>3</sub>	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
<i>GELA</i> <sub>4</sub>	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	1	1
<i>GELA</i> <sub>5</sub>	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1
<i>GELA</i> <sub>6</sub>	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1
<i>GELA</i> <sub>7</sub>	0.5	1	0.5	0.5	0.5	0.5	1	0.5	0.5	1

$GELA_8$	0.5	1	0.5	0.5	0.5	0.5	1	0.5	0.5	1
$GELA_9$	0.5	1	0.5	0.5	0.5	0.5	1	0.5	0.5	1
$GELA_{10}$	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	1
	$GELC_1$	$GELC_2$	$GELC_3$	$GELC_4$	$GELC_5$	$GELC_6$	$GELC_7$	$GELC_8$	$GELC_9$	$GELC_{10}$
$GELA_1$	1	0.5	1	1	0.5	1	1	1	0.5	0.5
$GELA_2$	0.5	0.5	1	1	0.5	0.5	1	1	0.5	0.5
$GELA_3$	1	0.5	1	1	1	1	1	1	0.5	0.5
$GELA_4$	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
$GELA_5$	0.5	1	1	1	1	0.5	0.5	0.5	0.5	1
$GELA_6$	1	1	1	1	1	0.5	0.5	0.5	0.5	1
$GELA_7$	0.5	0.5	0.5	1	1	0.5	1	0.5	0.5	1
$GELA_8$	0.5	1	0.5	1	1	0.5	1	0.5	0.5	1
$GELA_9$	0.5	0.5	1	0.5	1	0.5	1	0.5	0.5	0.5
$GELA_{10}$	0.5	0.5	1	0.5	0.5	0.5	1	0.5	0.5	1

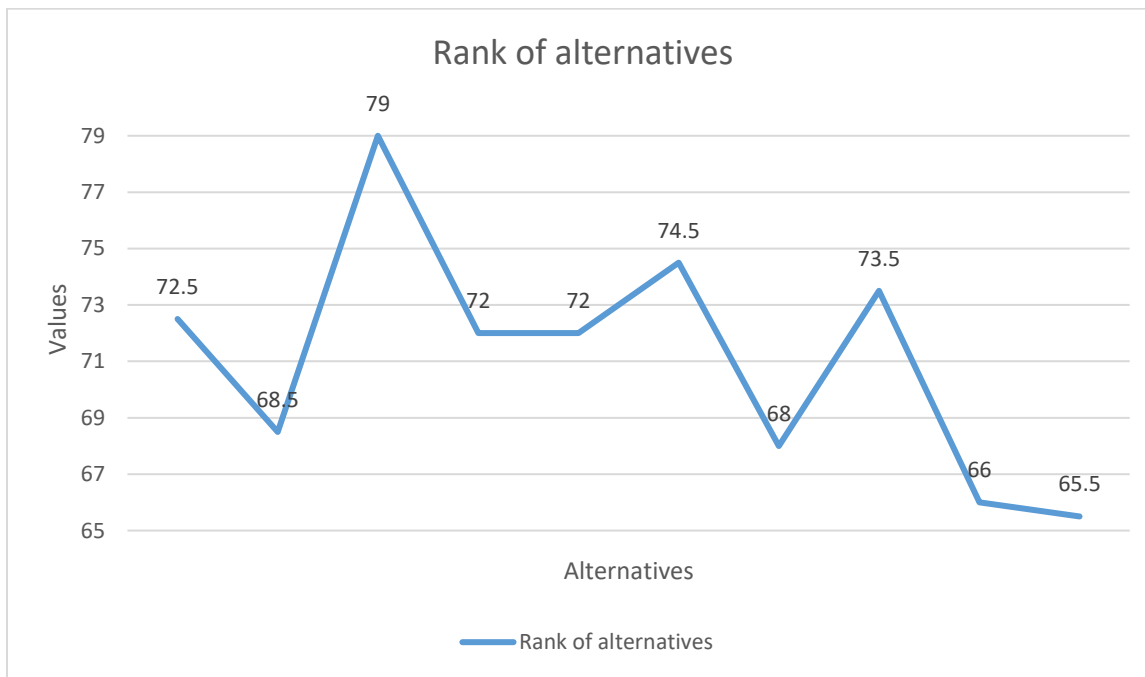


Figure 2: The ordered of alternatives by the COMET method.

## 5. Conclusion

Achieving a sustainable, low-carbon, and resilient energy future relies on the assessment of sustainable power production taking into account renewable energy sources. This analysis gives a thorough comprehension of the feasibility and efficacy of renewable energy sources in electricity production by examining a wide range of variables, including renewable energy potential, environmental implications, cost, legislative support, and technology improvements. It facilitates the transition towards a greener energy system by providing policymakers and energy planners with the information they need to establish goals and formulate policies that place a premium on the use of renewable energy sources, quicken the pace at which emissions are reduced, and so on.

This analysis reveals that renewable energy sources have several advantages, such as a lower carbon footprint, greater energy independence, and new business prospects. The analysis shows how vital it is to harmonize policy and

regulatory frameworks to facilitate the adoption of renewable energy sources. Facilitating inclusion and guaranteeing the efficacy of plans, the assessment process also includes stakeholder participation and monitoring progress. This paper proposed the single valued neutrosophic COMET method to assess the green sustainable electricity. This paper used the ten criteria and ten alternatives. The alternative 3 is the best by the rank of the COMET method.

## References

- [1] B. Truffer, C. Bratrich, J. Markard, A. Peter, A. Wüest, and B. Wehrli, "Green Hydropower: The contribution of aquatic science research to the promotion of sustainable electricity," *Aquat. Sci.*, vol. 65, pp. 99–110, 2003.
- [2] M. Ilic, L. Xie, and Q. Liu, *Engineering IT-enabled sustainable electricity services: the tale of two low-cost green Azores Islands*, vol. 30. Springer Science & Business Media, 2013.
- [3] K. Nguyen and B. D. Bruce, "Growing green electricity: progress and strategies for use of photosystem I for sustainable photovoltaic energy conversion," *Biochim. Biophys. Acta (BBA)-Bioenergetics*, vol. 1837, no. 9, pp. 1553–1566, 2014.
- [4] J. B. Valaki and P. P. Rathod, "Investigating feasibility through performance analysis of green dielectrics for sustainable electric discharge machining," *Mater. Manuf. Process.*, vol. 31, no. 4, pp. 541–549, 2016.
- [5] R. Ozaki, "Adopting sustainable innovation: what makes consumers sign up to green electricity?," *Bus. Strateg. Environ.*, vol. 20, no. 1, pp. 1–17, 2011.
- [6] A. Hast, S. Syri, J. Jokiniemi, M. Huuskonen, and S. Cross, "Review of green electricity products in the United Kingdom, Germany and Finland," *Renew. Sustain. Energy Rev.*, vol. 42, pp. 1370–1384, 2015.
- [7] Abedallah Z. Abualkishik, Rasha Almajed, Triangular Neutrosophic Multi-Criteria Decision Making AHP Method for Solar Power Site Selection, *International Journal of Advances in Applied Computational Intelligence*, Vol. 2 , No. 2 , (2022) : 08-15 (Doi : <https://doi.org/10.54216/IJAACI.020201>)
- [8] S. Faizi, W. Sařabun, T. Rashid, J. Wątróbski, and S. Zafar, "Group decision-making for hesitant fuzzy sets based on characteristic objects method," *Symmetry (Basel)*, vol. 9, no. 8, p. 136, 2017.
- [9] M. Wu, R. Chen, and J. Fan, "Application of evidence reasoning algorithm and QUALIFLEX with single-valued neutrosophic set for MCDM," *J. Intell. Fuzzy Syst.*, no. Preprint, pp. 1–16, 2022.
- [10] C. Tian, J. J. Peng, Z. Q. Zhang, M. Goh, and J. Q. Wang, "A multi-criteria decision-making method based on single-valued neutrosophic partitioned Heronian mean operator," *Mathematics*, vol. 8, no. 7, p. 1189, 2020.
- [11] S. Broumi *et al.*, "Interval valued pentapartitioned neutrosophic graphs with an application to MCDM," *Oper. Res. Eng. Sci. Theory Appl.*, vol. 5, no. 3, pp. 68–91, 2022.
- [12] Ş. Özlü and F. Karaaslan, "Hybrid similarity measures of single-valued neutrosophic type-2 fuzzy sets and their application to MCDM based on TOPSIS," *Soft Comput.*, vol. 26, no. 9, pp. 4059–4080, 2022.
- [13] S. Dey and G. C. Ray, "Properties of Redefined Neutrosophic Composite Relation," *Neutrosophic Syst. with Appl.*, vol. 7, pp. 1–12, 2023.
- [14] J. Ye, S. Du, and R. Yong, "Multi-criteria decision-making model using trigonometric aggregation operators of single-valued neutrosophic credibility numbers," *Inf. Sci. (Ny)*, p. 118968, 2023.
- [15] T. R. Ayodele, A. S. O. Ogunjuyigbe, O. D. Ajayi, A. A. Yusuff, and T. C. Moselethe, "Willingness to pay for green electricity derived from renewable energy sources in Nigeria," *Renew. Sustain. Energy Rev.*, vol. 148, p. 111279, 2021.
- [16] K. Arkesteijn and L. Oerlemans, "The early adoption of green power by Dutch households: An empirical exploration of factors influencing the early adoption of green electricity for domestic purposes," *Energy Policy*, vol. 33, no. 2, pp. 183–196, 2005.
- [17] D. P. Strik, H. V. M. Hamelers, J. F. H. Snel, and C. J. N. Buisman, "Green electricity production with living plants and bacteria in a fuel cell," *Int. J. Energy Res.*, vol. 32, no. 9, pp. 870–876, 2008.

- [18] Y. Huang *et al.*, “Graphene oxide assemblies for sustainable clean-water harvesting and green-electricity generation,” *Accounts Mater. Res.*, vol. 2, no. 2, pp. 97–107, 2021.
- [19] S.-H. Yoo and S.-Y. Kwak, “Willingness to pay for green electricity in Korea: A contingent valuation study,” *Energy Policy*, vol. 37, no. 12, pp. 5408–5416, 2009.
- [20] L. Gan, G. S. Eskeland, and H. H. Kolshus, “Green electricity market development: Lessons from Europe and the US,” *Energy Policy*, vol. 35, no. 1, pp. 144–155, 2007.
- [21] O. Parniakov, F. J. Barba, N. Grimi, N. Lebovka, and E. Vorobiev, “Extraction assisted by pulsed electric energy as a potential tool for green and sustainable recovery of nutritionally valuable compounds from mango peels,” *Food Chem.*, vol. 192, pp. 842–848, 2016.
- [22] K. Yoo *et al.*, “Optimized renewable and sustainable electricity generation systems for Ulleungdo Island in South Korea,” *Sustainability*, vol. 6, no. 11, pp. 7883–7893, 2014.
- [23] S. Salmela and V. Varho, “Consumers in the green electricity market in Finland,” *Energy Policy*, vol. 34, no. 18, pp. 3669–3683, 2006.
- [24] A. Munshi and W. Sampath, “CdTe photovoltaics for sustainable electricity generation,” *J. Electron. Mater.*, vol. 45, pp. 4612–4619, 2016.
- [25] B. Ridhosari and A. Rahman, “Carbon footprint assessment at Universitas Pertamina from the scope of electricity, transportation, and waste generation: toward a green campus and promotion of environmental sustainability,” *J. Clean. Prod.*, vol. 246, p. 119172, 2020.
- [26] W. M. Lafferty, *Promoting sustainable electricity in Europe: challenging the path dependence of dominant energy systems*. Edward Elgar Publishing, 2009.
- [27] I. H. Rowlands, D. Scott, and P. Parker, “Consumers and green electricity: profiling potential purchasers,” *Bus. Strateg. Environ.*, vol. 12, no. 1, pp. 36–48, 2003.
- [28] F. Mattern, T. Staake, and M. Weiss, “ICT for green: how computers can help us to conserve energy,” in *Proceedings of the 1st international conference on energy-efficient computing and networking*, 2010, pp. 1–10.
- [29] A. Piegat and W. Sałabun, “Comparative analysis of MCDM methods for assessing the severity of chronic liver disease,” in *Artificial Intelligence and Soft Computing: 14th International Conference, ICAISC 2015, Zakopane, Poland, June 14-18, 2015, Proceedings, Part I 14*, Springer, 2015, pp. 228–238.
- [30] M. Ali, Z. Hussain, and M.-S. Yang, “Hausdorff distance and similarity measures for single-valued neutrosophic sets with application in multi-criteria decision making,” *Electronics*, vol. 12, no. 1, p. 201, 2022.
- [31] S. Ashraf, S. Abdullah, F. Smarandache, and N. ul Amin, “Logarithmic hybrid aggregation operators based on single valued neutrosophic sets and their applications in decision support systems,” *Symmetry (Basel)*, vol. 11, no. 3, p. 364, 2019.