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Editor Dr Milica Vlahović

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FOREWORD

The conditions created by the development of technologies in which modern man lives have led to a complex and paradoxical effect: that by removing obstacles on the way to a more comfortable, simpler, faster and more efficient life and way of working, man also generates numerous misfortunes, attracting dark clouds of threats to the survival of the planet and humanity. The question that concerns and affects all of us - all people, all living beings, systems in which life takes place, large and small, strong and weak - boils down to the problem of the negative impact of man on the environment; this issue invites us to an urgent solution by looking at the causes, proposing solutions, evaluating them, changing approaches and ways of thinking, as well as drawing correct conclusions. Simply put, by adapting nature to one's own needs, man threatens and damages it. That is why, with the joint efforts of all of us, individuals, organizations and states, it is necessary to take all possible measures to immediately prevent the negative effects that are ahead of us.

The importance of renewable sources of electricity, which this international conference focuses on, is noticeable from two angles: the first - it is certain that fossil fuels as a resource will disappear and it is necessary to find alternative sources, the second - the use of renewable energy sources by its essence implies "clean" technology that significantly contributes to reducing CO₂ emissions and thus mitigating climate change and reducing pollution, while encouraging social and economic development in all spheres of life.

The 11th International Conference on Renewable Electrical Power Sources is organized by the Society for Renewable Electrical Power Sources (DOIEE) at SMEITS, with co-organizers: The Institute of Architecture and Urban & Spatial Planning of Serbia (IAUS) and the Chamber of Commerce and Industry of Serbia, with the support of the Ministry of Science, Technological Development and Innovation of the Republic of Serbia.

The registered participants designed their papers according to the given conference topics:

- Energy sources and energy storage;*
- Energy efficiency in the context of use of renewable energy sources (RES);*
- Environment, sustainability and policy;*
- Applications and services.*

Eminent authors - scientists, teachers, experts in this field from fifteen different countries: Algeria, Belgium, Bosnia and Herzegovina, China, Croatia, Greece, Hungary, India, Portugal, Saudi Arabia, Serbia, Slovenia, Spain, the United Arab Emirates, and Ukraine, contributed to the conference through sixty-nine papers that were reviewed by the Scientific Committee of the Conference, and after the review process were accepted for presentation at the conference and for publication in the proceedings.

At the end of this short message and at the beginning of the proceedings I believe that it can be proudly said that scientists, researchers, policy makers and industry experts gathered in one place, in order to exchange experiences and knowledge with the aim of promoting scientific and professional ideas and results of research, technology improvement for the use of RES, promoting the rational use of electricity, affirming and proposing inventive solutions in the field of sustainable sources of electricity.

*Belgrade,
November 2023*

Milica Vlahović

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PRIMERI PRIMENE VIŠEKTERIJUMSKOG ODLUČIVANJA U OBLASTI OBNOVLJIVIH IZVORA ENERGIJE

EXAMPLES OF THE APPLICATION OF MULTI-CRITERIA DECISION-MAKING IN THE FIELD OF RENEWABLE ENERGY SOURCES

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Apstract

Obnovljivi izvori energije su svoju primenu imali jos od samih početaka ljudske civilizacije i to za različite namene kao što su: prevoz tereta, pogon mlinova za mlevenje žitarica, itd. ali se sa njihovom upotrebom u proizvodnji električne energije počelo u drugoj polovini 19. veka. Međutim, pravi značaj obnovljivi izvori energije dobijaju u drugoj polovini 20. veka a posebno u zadnjih nekoliko decenija. U ovom periodu su se intenzivirala i istraživanja u ovoj oblasti, toliko da je broj radova od samo nekoliko hiljada početkom 2000-tih došao na oko 30.000 u 2022. godini. Uporedo sa intenziviranjem istraživanja, krenula je i upotreba višekriterijumskog odlučivanja u ovoj oblasti.

Broj radova u kojima se za rešavanje različitih problema vezanih za istraživanja u oblasti obnovljivih izvora energije i njihovu praktičnu primenu koriste metode višekriterijumskog odlučivanja iz godine u godinu raste. U ovom radu će biti prikazani samo neki od primera primene različitih metoda višekriterijumskog odlučivanja u ovoj oblasti.

Ključne reči: višekriterijumsko odlučivanje; obnovljivi izvori energije; istraživanje; ciljevi održivog razvoja;

Abstract

Renewable energy sources have been used since the very beginning of human civilization for various purposes such as: transportation of cargo, operation of grain mills, etc. but their use in the production of electricity began in the second half of the 19th century. However, renewable energy sources gained real importance in the second half of the 20th century, and especially in the last few decades. During this period, research in this area intensified, so much so that the number of papers from only a few thousand in the early 2000s came to around 30,000 in 2022. Along with the intensification of research, the use of multi-criteria decision-making in this area also started. The number of papers in which multi-criteria decision-making methods are used to solve various problems related to research in the field of renewable energy sources and their practical application is growing year by year. In this paper, only some examples of the application of various methods of multi-criteria decision-making in this area will be presented.

Keywords: multi-criteria decision making; renewable energy sources; research; sustainable development goals;

1 Introduction

The idea of using renewable energy has been present for centuries. For example in ancient times humans have been using renewable energy in various forms, i.e. wind power for sailing ships and windmills for grinding grains. The renewable energy sources were the main sources of energy

until 19th century, when the increasing use of fossil fuels began with the rise of the industrial revolution. However, during this time, scientists like Augustin Mouchot, John Ericsson, Alessandro Battaglia and William Adams started exploring solar power as an alternative energy source [1]. Also, the first hydroelectric power plant was launched in 1881 in Appleton (Wisconsin, USA) [2].

In the early 20th century, hydroelectric power became more prevalent. Large-scale hydropower projects were developed, such as the Hoover Dam in the United States [3], utilizing the energy from flowing water to generate electricity. The 1970s marked a turning point in the modern renewable energy movement. The oil crisis and growing environmental concerns led to increased attention to alternative energy sources. This period saw the emergence of significant research and development in solar, wind, and geothermal energy. Between 1980s and 1990s governments and organizations worldwide started to promote renewable energy, driven by concerns about climate change and the desire for energy independence. Policies and incentives were introduced to support the growth of renewable energy industries.

The 21st century has seen a rapid expansion of renewable energy technologies. Solar and wind power have become more economically viable and widely adopted. The advancement of technology, coupled with decreasing costs, has made renewable energy increasingly competitive with fossil fuels.

Today, the use of renewable energy sources such as solar, wind, hydro, and geothermal power continues to grow as countries strive to reduce greenhouse gas emissions, combat climate change, and transition towards a more sustainable and clean energy future.

2 Research in the area of renewable energy

Affordable and clean energy is one of the Sustainable Development Goals (SDG) set by the United Nations [4]. In order to accomplish this goal and provide the world with affordable and clean energy a lot of research needs to be undertaken, since today's sources of energy are either "dirty" like fossil fuels and nuclear energy or expensive like energy from renewable energy sources. According to this, more and more researchers from all over the world are trying to find new, cleaner and more affordable sources of energy or new technologies for using the existing ones that will be in accordance with the SDG.

The increase in awareness about the use of renewable energy, i.e. its increasingly intensive use, also caused the publication of a significant number of articles in scientific and professional journals, which is illustrated in Figure 1.

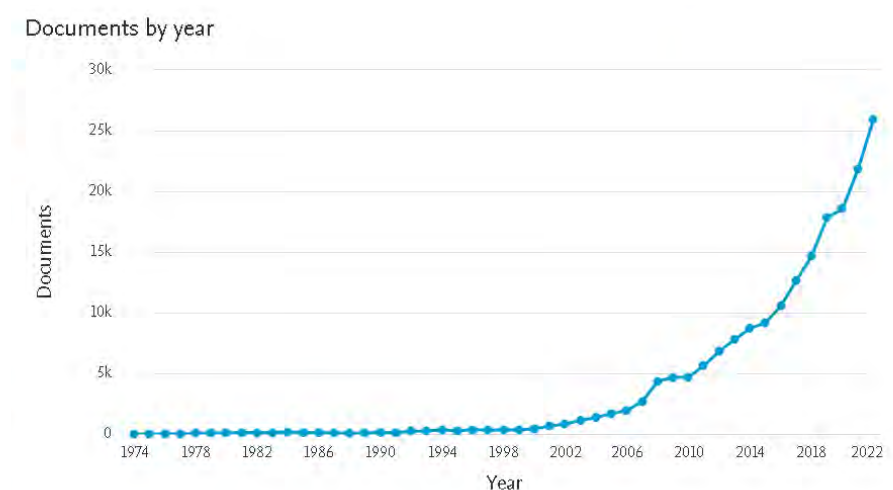


Figure 1. Number of articles published in scientific and professional journals over the years (Source: Scopus)

According to the Scopus data base the first article containing the key word "Renewable energy" was published in 1974, but the real breakthrough came in the 2000s leading to over 25,000 articles published in 2022 (Figure 1).

Renewable energy sources have been studied from different aspects and from different subject areas. An overview of published works by different subject areas is shown in Figure 2.

Documents by subject area

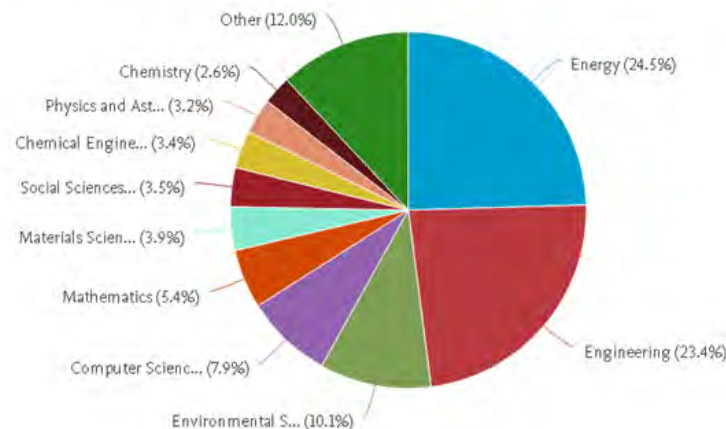


Figure 2. Overview of the number of published articles by different subject areas (Source: Scopus)

The number of published articles related to renewable energy sources varies significantly across countries, as illustrated in Figure 3.

Documents by country or territory

Compare the document counts for up to 15 countries/territories.

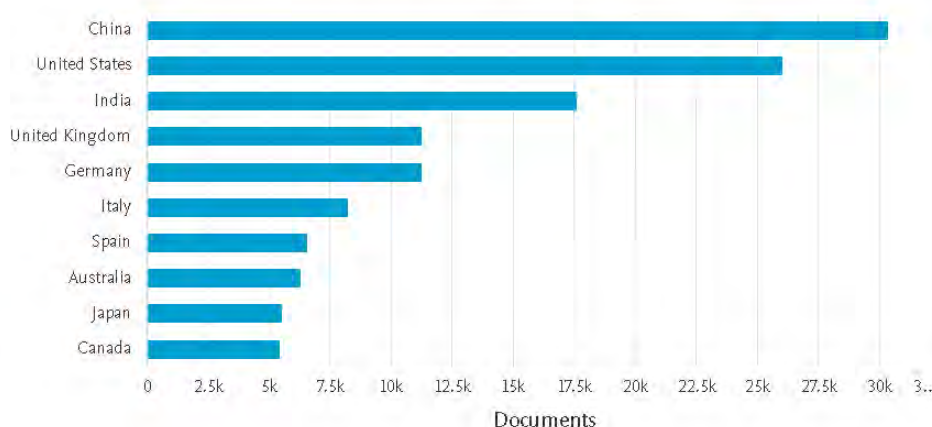


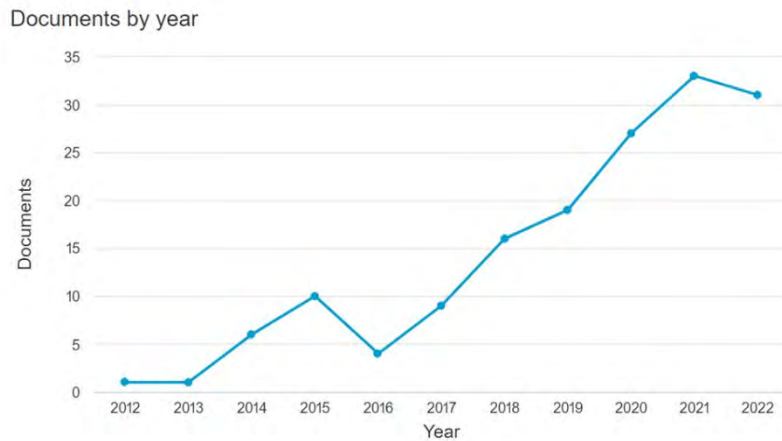
Figure 3. Number of articles published by countries (Source: Scopus)

From Figure 3, it can be seen that China, the USA, and India are at the top among the countries where the application of renewable energy sources is intensively considered.

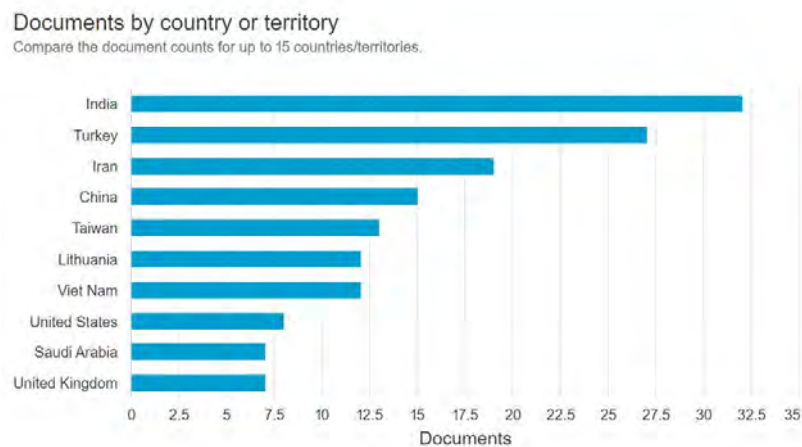
3 Multiple criteria decision making and renewable energy

The multiple criteria decision making (MCDM) is a part of operational research which is being developed very intensively and which has so far been used to solve numerous problems from different fields.

The number of articles related to the application of MCDM methods in the field of renewable energy is shown in Figure 4, while the number of articles by country is shown in Figure 5.



*Figure 4. Number of articles by year
(Source: Scopus)*



*Figure 5. Number of articles by country
(Source: Scopus)*

From Figure 4, it can be seen that the number of articles per year is increasing, and from Figure 5, it can be seen that India, Turkey and Iran are among the countries where MCDM methods are used the most in the field of renewable energy.

In the continuation of the paper, some examples of the application of MCDM in the field of renewable energy sources are given. Lee and Chang (2018) used MCDM methods for ranking renewable energy sources in Taiwan [5], while Alizadeh et al. (2020) used MCDM methods for improving renewable energy policy planning [6]. Colak and Kaya (2017) [7] and Nigim et al. (2004) [8] applied MCDM method for prioritizing renewable energy sources. A comprehensive overview of the application of MCDM methods for sustainable renewable energy development can be found in Kumar et al. (2017) [9]. Ramezanzade et al. (2021) implemented a new hybrid fuzzy MCDM model in which VIKOR (Vise Kriterijumska Optimizacija I Kompromisno Resenje), distance from average solution, and additive ratio assessment methods were used for ranking renewable energy projects [10]. Lak Kamari et al. (2020) gave an overview of applications of MCDM methods in renewable energy development [11]. Similar to that, Siksnelyte-Butkiene et al (2020) also did a review of MCDM applications for the assessment of renewable energy technologies in a household [12], as well as Shao et al. (2020) whose review was on MCDM applications for renewable energy site selection [13].

Comparative analysis of hybrid renewable energy systems based on concentrating solar and biomass technologies for Faro-Poli, Cameroon was investigated by Biboum et al. (2023) where they compared three hybrid renewable energy systems (HRES) alternatives by Analytic Hierarchy Pro-

cess combined with the Technique for Order Preference by Similarity to Ideal Solution (AHP-TOPSIS) method [14]. Wang et al. (2022) combined the spherical fuzzy analytical hierarchy process (SF-AHP) and weighted aggregated sum product assessment (WASPAS) for offshore wind power station (OWPS) site selection [15]. Ijadi Maghsoodi et al. (2018) proposed a hybrid Multiple Attribute Decision Making (MADM) approach based on the Step-Wise Weight Assessment Ratio Analysis (SWARA) approach with a hierarchical arrangement combined with the Multi-Objective Optimization on the basis of Ratio Analysis plus the full MULTIplicative form (MULTIMOORA) for renewable energy technology selection [16]. Karaşan and Kahraman (2020) did a selection of the most appropriate renewable energy alternatives by using a novel interval-valued neutrosophic ELECTRE I method [17].

4 Conclusion

The necessity of using renewable energy sources was recognized at the very beginning of the industrial revolution, in the second half of the 19th century, when the first scientists began researching the application of wind and solar energy for the production of electricity. The use of renewable energy sources for the production of electricity, but also as a substitute for fossil fuels, has become an imperative of modern civilization in order to reduce environmental pollution and preserve natural resources, which was also recognized by the United Nations adding affordable and clean energy as one of the sustainable development goals.

Research in the field of renewable energy sources began in the 1970s, but experienced its expansion in the early 2000s, when the number of published works according to the Scopus database increased from several hundred (thousands) per year to almost 30,000 thousand in 2022. With the increase in the importance of renewable energy and research in this area, arose the need to apply MCDM, another area of science that has experienced a great rise in recent years, for solving various selection and decision making problems in the field of renewable energy sources.

As it was shown in this paper, MCDM methods found their applications for selection of the best renewable energy technologies for certain area or for implementing in households, for renewable energy power plant site selection, for ranking renewable energy projects, for improving renewable energy policy planning, etc. These are only some of the examples for MCDM can be used in this area and help decision makers when dealing with different problems and solutions. However, the list of MCDM applications is much larger and certainly there are still many possibilities for their implementation in renewable energy area.

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6 References

- [1] **García, I. L., Álvarez, J. L., Blanco, D.** Performance model for parabolic trough solar thermal power plants with thermal storage: Comparison to operating plant data, *Solar Energy, Volume* 85 (2011), issue 10, pp. 2443-2460.
- [2] **Steller, J.** Hydropower and its development, *Acta Energetica, Volume* 3 (2013), issue 16, pp.7–20.
- [3] **Rogers, J.D.** Hoover Dam: Scientific studies, name controversy, tourist attraction, and contributions to engineering. *Proceedings Hoover Dam 75th Anniversary History Symposium*, Las Vegas, NV, USA, 21–22 October 2010; pp. 216–248.
- [4] United Nations, *Transforming our world: The 2030 Agenda for Sustainable Development A/RES/70/1*, New York, USA, 2015.

<https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf>

- [5] **Lee, H. C., Chang, C. T.** Comparative analysis of MCDM methods for ranking renewable energy sources in Taiwan. *Renewable and sustainable energy reviews*, Volume 92 (2018), pp. 883-896.
- [6] **Alizadeh, R., Soltanisehat, L., Lund, P. D., Zamanisabzi, H.** Improving renewable energy policy planning and decision-making through a hybrid MCDM method. *Energy Policy*, Volume 137 (2020), 111174.
- [7] **Colak, M., Kaya, İ.** Prioritization of renewable energy alternatives by using an integrated fuzzy MCDM model: A real case application for Turkey. *Renewable and sustainable energy reviews*, Volume 80, (2017), pp. 840-853.
- [8] **Nigim, K., Munier, N., Green, J.** Pre-feasibility MCDM tools to aid communities in prioritizing local viable renewable energy sources. *Renewable energy*, Volume 29 (2004), issue 11, pp. 1775-1791.
- [9] **Kumar, A., Sah, B., Singh, A. R., Deng, Y., He, X., Kumar, P., Bansal, R. C.** A review of multi criteria decision making (MCDM) towards sustainable renewable energy development. *Renewable and Sustainable Energy Reviews*, Volume 69 (2017), pp. 596-609.
- [10] **Ramezanzade, M., Karimi, H., Almutairi, K., Xuan, H.A., Saebi, J., Mostafaeipour, A., Techato, K.** Implementing MCDM Techniques for Ranking Renewable Energy Projects under Fuzzy Environment: A Case Study. *Sustainability*, Volume 13, (2021), 12858.
- [11] **Lak Kamari, M., Isvand, H., Alhuyi Nazari, M.,** Applications of multi-Criteria Decision-Making (MCDM) Methods in Renewable Energy Development: A Review, *Renewable Energy Research and Applications*, Volume 1 (2020) issue 1, pp. 47-54.
- [12] **Siksnyte-Butkiene, I., Zavadskas, E.K., Streimikiene, D.** Multi-Criteria Decision-Making (MCDM) for the Assessment of Renewable Energy Technologies in a Household: A Review. *Energies*, Volume 13 (2020), 1164.
- [13] **Shao, M., Han, Z., Sun, J., Xiao, C., Zhang, S., Zhao, Y.** A review of multi-criteria decision making applications for renewable energy site selection, *Renewable Energy*, Volume 157 (2020), pp. 377-403.
- [14] **Biboum, A. C., Yilanci, A., Mouangue, R.** Comparative analysis of hybrid renewable energy systems based on concentrating solar and biomass technologies for Faro-Poli, Cameroon, *Environmental Progress & Sustainable Energy*, Volume 4 (2023), 13933.
- [15] **Wang, C.N., Nguyen, N.A.T., Dang, T.T.** Offshore wind power station (OWPS) site selection using a two-stage MCDM-based spherical fuzzy set approach, *Scientific Reports*, Volume 12 (2022), 4260.
- [16] **Ijadi Maghsoodi, A., Ijadi Maghsoodi, A., Mosavi, A., Rabczuk, T., Zavadskas, E.K.** Renewable Energy Technology Selection Problem Using Integrated H-SWARA-MULTIMOORA Approach, *Sustainability*, Volume 10 (2018), 4481.
- [17] **Karaşan, A., Kahraman, C.** Selection of the Most Appropriate Renewable Energy Alternatives by Using a Novel Interval-Valued Neutrosophic ELECTRE I Method, *Informatica*, Volume 31 (2020), issue 2, pp. 225–248.