


Editorial

Energy Decision Making: Problems, Methods, and Tools—An Overview

Małgorzata Łatuszyńska *  and Kesra Nermend

Institute of Management, University of Szczecin, Cukrowa 8, 71-004 Szczecin, Poland; kesra.nermend@usz.edu.pl
* Correspondence: malgorzata.latuszynska@usz.edu.pl

Making decisions concerning the use of energy sources is a very difficult and complicated task. Such decisions are taken at various levels, ranging from individual to international. The individuals and households make energy decisions considering needs, costs, preferences, or social norms. At the national level, such decisions are made in accordance with formalised procedures resulting from legal conditions but are influenced by numerous and occasionally competing factors, including economic, social, environmental, and political issues. Market forces, taxes, regulations, and subsidies affect the prices of various forms of energy. Social and environmental costs are related to how various energy sources affect land, air, water, ecosystems, and people. The backdrop of energy decisions is created by political considerations brought about by governmental structure, political behaviour and political parties.

In short, energy decisions are part of a complex, multi-faceted process, which is reflected in the scientific articles included in the Special Issue entitled “Energy Decision Making: Problems, Methods, and Tools.” These articles cover a wide range of topics related to theoretical aspects of energy decision-making and problems arising in practice—at various levels.

Numerous articles [1–5] included for this Special Issue are studies that demonstrate the significance of consumer preferences and the factors influencing their behavior in the widely defined energy market.

Baruk [1] identifies the preferences of end consumers regarding the environment of cooperation with offerors and the benefits of cooperation. The findings of the study add to the understanding the consumer behaviour and making it simpler for offerors, including companies operating on the consumer energy market, to make effective decisions about encouraging recipients to cooperate in the process of developing a marketing offer. In another paper, Baruk [2] focuses on the importance of good relationships between offerors and final purchasers, as well as the significance of offerors’ perceptions in terms of listening to purchasers’ opinions and taking advantage of their willingness to cooperate for the specificities of the prosumeric activity.

The research by Rutkowska, Bartoszczuk and Singh [3,4] also address issues pertaining to end consumer behaviour. They focus on assessing the GREEN consumer values while taking renewable energy sources into account. One of their article presents the results of research conducted in Poland [3], while the other focuses on India [4]. Based on the existing green energy scenario in Poland, the first study concludes that consumers have a high degree of acceptability for renewable energy sources, which may contribute to sustainability and benefit policy makers in government, corporations, and end consumers. The second one demonstrates India’s progress in enhancing its capacity for renewable energy. Indian consumer values are very much aligned with eco sustainability, and the market is ready to consume renewable energy.

The consumer related issue is also included in the study by Stasiuk and Maison [5], which seeks to determine how well informed consumers are about the new labeling system, and what effect the new labels have (compared to the previous ones) on how consumers



Citation: Łatuszyńska, M.; Nermend, K. Energy Decision Making: Problems, Methods, and Tools—An Overview. *Energies* **2022**, *15*, 5545. <https://doi.org/10.3390/en15155545>

Received: 26 July 2022

Accepted: 28 July 2022

Published: 30 July 2022

Publisher’s Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

perceive household appliances and their decision-making. According to the findings of a survey done on a representative Polish sample from throughout the country, the majority of people do not identify the new energy classifications. Furthermore, compared to products with the prior labels, products with the new labels are perceived as being less energy efficient, demonstrating some confusion among consumers regarding the new energy efficiency labeling system.

Three other studies [6–8] draw attention to the importance of behavioral factors in making energy decisions. The first of these, according to Miłaszewicz [6] indicates that the traditional decarbonisation instruments related to choice architecture (nudges) may be improved by utilizing the potential of individual behavioural modifications. The aim of this study is to present nudges regarding the choice of a “green energy” supplier as one of the strategies for encouraging pro-environmental behavioral change and to analyse selected factors of acceptance of these instruments by the Polish society. The conclusions drawn from the research show that: (1) Poles’ support for the green nudges analysed is comparatively high, like in other European countries; (2) statistically significant differences in support for one of them are age and individual political party preferences.

Borawska, Borawski and Łatuszyńska [7] in turn, focus on the role of energy conservation communication campaigns for environmental sustainability through changing human behavior. In this study, they aim to present the possibility of applying cognitive neuroscience methods in conjunction with a questionnaire to experimentally check the effectiveness of the campaign message using the example of selected Polish electricity-saving communication campaigns. The key results of this study indicate that merging conscious and subconscious reactions to media messages allows us to gain new knowledge that can be used in the future to improve the campaign effectiveness.

In the last of this group paper, Kluczek, Żegleń, and Matušíková [8] apply a behavioral approach with multi-criteria decision making (MDCA) methods to assist decision making about energy efficient investment in order to help practitioners choose and implement 4.0 technologies that will contribute to energy sustainability. This paper offers a new perspective on energy sustainability analysis with a prospective theory and is also one of several articles contained in the discussed Special Issue, which present the possibilities of using multi-criteria methods to support the decision-making process in the selection of energy sources, technologies, location of energy generating devices or also their parameters. The studies [9–12] also belong to this group. Additionally, Piwowarski, Borawski and Nermend raise a more general issue in the article [13] regarding the effectiveness of selected multicriteria methods (TOPSIS, VIKOR, VMCM) in terms of computational robustness to outlier objects and show that the best method in this respect is (VMCM), which is then applied to study the level of development of renewable energy sources in European countries. The subsequent mentioned articles are mainly focused on issues of practical problems.

In the article [9], Lipka and Szwed analyse the problem of choosing one of the purportedly clean coal technologies to be used in conditions of transformation of the power sector. Apart from the technology recommendation, the research came to the conclusion that the proposed method may be applied to decision-making in the field of power generation technology management.

In study [10] Vagiona investigates the prioritisation and ranking problem of the appropriate locations at which to deploy solar photovoltaic (PV) farms with the island of Rhodes (Greece) being used as an example. Vagiona uses and compares four different multicriteria methods: AHP, TOPSIS, VIKOR, and PROMETHEE II.

The next two articles by Siwiec and Pacana [11,12] also deal with photovoltaic panels. The purpose of the first one is to suggest the preferred model of photovoltaic panels considering customers’ expectations (satisfaction of concrete customer in combination with the cost of purchase). The second one aims to offer a model to predict the quality of photovoltaic panels considering the expectations of the customers. The developed models can be used by any entity for any photovoltaic panel and according to individual tailored criteria for the customer.

The research by Fijałkowska, Waksmundzka, and Chmiel [14] continues the discussion of photovoltaic panels. The aim of this study is to evaluate the effectiveness of photovoltaic panels on the shelters of public transport bus/tram stops with the use of 3D Spatial Analysis. The proposed methodology for calculating the solar potential and shading may be a valuable addition to the existing solutions for scheduling installation power and the location of individual panels.

The assessment of the effectiveness of projects related to energy-producing devices is also undertaken in the study by Barber et al. [15]. In this work, a new approach to the decision-making process related to Wind Resource Assessment is developed, which allows the best compromise between skill and costs for a given wind energy project is developed, with a focus on complex terrain. Work has already begun on developing a reliable automated decision-making tool in this area.

Another study aims to propose a decision support tool. Biresselioglu and Demir [16] present a decision support tool for the energy policymakers and energy providers to facilitate an analytical decision-making framework where the key drivers, motivators, and barriers are taken into account. A decision support system is designed in the format of a decision tree algorithm.

The next group of four articles, although concerning different issues, focuses on indicating the possibility of taking actions aimed at achieving sustainable development by reducing energy consumption [17,18], increasing the energy efficiency of devices [19], or optimizing the energy system for organization facilities [20].

Orłowski, Cofta, and Orłowski provide a rule-based model for increasing the energy efficiency of the digital transformation processes in Smart Cities in their work [17]. The approach presented in the article is based on three key aspects: rule-based description of the state of digital transformation processes enabling their energy assessment, introducing energy maturity capsules to describe the state of these processes and application of measures based on project negentropy increments for maturity capsules.

Szaruga and Załoga [18] identify ineffective airports (taking into account energy consumption, airplane traffic, and passenger movement) and assess the spatial autocorrelation between national airports, which shows whether airports cooperate or compete with each other. The study was conducted on 12 airports. Based on the map-graph of connections, airports have been identified to which part of airplane traffic service can be transferred.

Kriaučiūnas et al. [19] focus on the study of impact of simulated biogas compositions (CH_4 and CO_2) on vibration, sound pressure and performance of a spark ignition engine in the context of ensuring environmental friendliness and reducing air pollution. The results of the study reveal which vibration of the engine correlates with combustion intensity, which is directly related to the main measure of engine energy efficiency—break thermal efficiency.

The work of Gorbach and Thomsen [20] assesses the benefits of using two-stage stochastic programming in the context of energy system optimization, with uncertain CO_2 prices and energy carrier cost as two important but uncertain input parameters. The academic literature has not analysed this aspect so far, and this work closes the knowledge gap with its analysis. Various future study paths can be furthered in light of this work.

The energy sector and energy decisions are influenced by many factors—including legal conditions, current events (e.g., COVID-19 pandemic), and economic cycles. Articles [21–24] are related to these issues. The article [25] addresses this issue, which is no less significant than the influence of the energy sector and the direction of its growth on other important economic sectors, such as agriculture.

The main objective of the study by Słotwiński [21] is a theoretical analysis of the legal solutions in force in Poland that allow building energy self-sufficiency in municipalities and their adequacy to the current economic, technological, and political conditions. The scientific discussion focuses on research problems related to the impact of the national regulations on the gradual assumption of control by municipalities over the generation and distribution of electricity regarding energy produced in renewable energy sources

installations and the independence of municipalities from the national energy management and supply system.

The study by Tomczak [22] aims to select indicators that consistently (stable over time) shows the differences between the values in individual sectors before and during COVID-19. The research covered six sectors: manufacturing, construction, retail and wholesale trade, transportation and warehousing, and energy (biomass electric power generation, wind electric power generation, fossil fuel electric power generation, hydroelectric power generation, and solar electric power generation). The sample covered companies listed on the Warsaw Stock Exchange, the Prague Stock Exchange, the Bratislava Stock Exchange, or the Budapest Stock Exchange.

The study by Bieszk-Stolorz and Markowicz [23] examines what is the probability and intensity of a decrease in the prices of shares of energy and fuel companies listed on the Warsaw Stock Exchange (Poland) was during the first wave of the COVID-19 pandemic. The analysis shows that the probability and intensity of price decline of energy and fuel companies in the initial period was the same as that of other companies. The differences became apparent only after 50 days from the established maximum of their value. The risk of price decline in energy and fuel companies increased significantly. This situation was related both to a temporary reduction in demand for energy and fuels, pandemic restrictions introduced in individual countries and the behaviour of stock market investors.

Szaruga et al. presents in their research [24], the synchronisation of economic cycles of GDP and crude oil and oil products cargo volumes in major Polish seaports. Crude oil and oil products cargo volumes are a specific barometer that predicts the next economic cycle, especially as they are primary sources of energy production. According to the study results, the cyclical components of the cargo traffic and GDP are affected by the leakage of other short-term cycles. However, based on the cross-correlation, it is proved that changes in crude oil and oil products cargo volumes preceded changes in GDP by 1–3 quarters, which may be valuable information for decision-makers and economic development planners.

Buko, Duda, and Makowski [25] using the example of Poland identify the causes and level of agricultural dependence on fossil fuels, and energy threats to agriculture and energy source alternative to fossil fuels. The results of their deliberations indicate that Poland is not a country that has irretrievably lost its ability to restore its food self-sufficiency in the event of loss of access to external sources of fossil fuels.

Problems raised in the Special Issue do not exhaust the subject of Energy Decision Making. Yet, in the opinion of the editors, it shows well the diversity of areas, problems, methods, techniques and domains concerning this subject.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Baruk, A.I. The Preferences of Active Final Purchasers Regarding the Environment of Cooperation with Offerors and Benefits Achieved Thanks to Such Cooperation. *Energies* **2021**, *14*, 4631. [[CrossRef](#)]
2. Baruk, A.I. Relationships between Final Purchasers and Offerors in the Context of Their Perception by Final Purchasers. *Energies* **2021**, *14*, 3271. [[CrossRef](#)]
3. Bartoszczuk, P.; Singh, U.; Rutkowska, M. An Empirical Analysis of Renewable Energy Contributions Considering Green Consumer Values—A Case Study of Poland. *Energies* **2022**, *15*, 1027. [[CrossRef](#)]
4. Rutkowska, M.; Bartoszczuk, P.; Singh, U. Management of Green Consumer Values in Renewable Energy Sources and Eco Innovation in India. *Energies* **2021**, *14*, 7061. [[CrossRef](#)]
5. Stasiuk, K.; Maison, D. The Influence of New and Old Energy Labels on Consumer Judgements and Decisions about Household Appliances. *Energies* **2022**, *15*, 1260. [[CrossRef](#)]
6. Miłaszewicz, D. Survey Results on Using Nudges for Choice of Green-Energy Supplier. *Energies* **2022**, *15*, 2679. [[CrossRef](#)]
7. Borawska, A.; Borawski, M.; Łatuszyńska, M. Effectiveness of Electricity-Saving Communication Campaigns: Neurophysiological Approach. *Energies* **2022**, *15*, 1263. [[CrossRef](#)]
8. Kluczek, A.; Żegleń, P.; Matušíková, D. The Use of Prospect Theory for Energy Sustainable Industry 4.0. *Energies* **2021**, *14*, 7694. [[CrossRef](#)]

9. Lipka, W.; Szwed, C. Multi-Attribute Rating Method for Selecting a Clean Coal Energy Generation Technology. *Energies* **2021**, *14*, 7228. [[CrossRef](#)]
10. Vagiona, D.G. Comparative Multicriteria Analysis Methods for Ranking Sites for Solar Farm Deployment: A Case Study in Greece. *Energies* **2021**, *14*, 8371. [[CrossRef](#)]
11. Siwiec, D.; Pacana, A. Model of Choice Photovoltaic Panels Considering Customers' Expectations. *Energies* **2021**, *14*, 5977. [[CrossRef](#)]
12. Pacana, A.; Siwiec, D. Model to Predict Quality of Photovoltaic Panels Considering Customers' Expectations. *Energies* **2022**, *15*, 1101. [[CrossRef](#)]
13. Piwowarski, M.; Borawski, M.; Nermend, K. The Problem of Non-Typical Objects in the Multidimensional Comparative Analysis of the Level of Renewable Energy Development. *Energies* **2021**, *14*, 5803. [[CrossRef](#)]
14. Fijałkowska, A.; Waksmundzka, K.; Chmiel, J. Assessment of the Effectiveness of Photovoltaic Panels at Public Transport Stops: 3D Spatial Analysis as a Tool to Strengthen Decision Making. *Energies* **2022**, *15*, 1230. [[CrossRef](#)]
15. Barber, S.; Schubiger, A.; Koller, S.; Egli, D.; Radi, A.; Rumpf, A.; Knaus, H. A New Decision Process for Choosing the Wind Resource Assessment Workflow with the Best Compromise between Accuracy and Costs for a Given Project in Complex Terrain. *Energies* **2022**, *15*, 1110. [[CrossRef](#)]
16. Biresselioglu, M.E.; Demir, M.H. Constructing a Decision Tree for Energy Policy Domain Based on Real-Life Data. *Energies* **2022**, *15*, 2420. [[CrossRef](#)]
17. Orłowski, C.; Cofta, P.; Orłowski, A. The Rule-Based Model of Negentropy for Increasing the Energy Efficiency of the City's Digital Transformation Processes into a Smart City. *Energies* **2022**, *15*, 1436. [[CrossRef](#)]
18. Szaruga, E.; Załoga, E. Sustainable Development Programming of Airports by Identification of Non-Efficient Units. *Energies* **2022**, *15*, 932. [[CrossRef](#)]
19. Kriauciūnas, D.; Žvirblis, T.; Kilikevičienė, K.; Kilikevičius, A.; Matijošius, J.; Rimkus, A.; Vainorius, D. Impact of Simulated Biogas Compositions (CH₄ and CO₂) on Vibration, Sound Pressure and Performance of a Spark Ignition Engine. *Energies* **2021**, *14*, 7037. [[CrossRef](#)]
20. Gorbach, O.G.; Thomsen, J. Comparing the Energy System of a Facility with Uncertainty about Future Internal Carbon Prices and Energy Carrier Costs Using Deterministic Optimisation and Two-Stage Stochastic Programming. *Energies* **2022**, *15*, 3836. [[CrossRef](#)]
21. Słotwiński, S. Building Energy Self-Sufficiency of Municipalities on the Basis of National Legal Conditions in the Theoretical Perspective of the Polish Legal Experiences. *Energies* **2022**, *15*, 3000. [[CrossRef](#)]
22. Tomczak, S.K. Ratio Selection between Six Sectors in the Visegrad Group Using Parametric and Nonparametric ANOVA. *Energies* **2021**, *14*, 7120. [[CrossRef](#)]
23. Bieszk-Stolorz, B.; Markowicz, I. Decline in Share Prices of Energy and Fuel Companies on the Warsaw Stock Exchange as a Reaction to the COVID-19 Pandemic. *Energies* **2021**, *14*, 5412. [[CrossRef](#)]
24. Szaruga, E.; Kłos-Adamkiewicz, Z.; Gozdek, A.; Załoga, E. Linkages between Energy Delivery and Economic Growth from the Point of View of Sustainable Development and Seaports. *Energies* **2021**, *14*, 4255. [[CrossRef](#)]
25. Buko, J.; Duda, J.; Makowski, A. Food Production Security in Times of a Long-Term Energy Shortage Crisis: The Example of Poland. *Energies* **2021**, *14*, 4725. [[CrossRef](#)]