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Priority Analysis of Problems Encountered in Renewable Energy Investments

Serhat Yüksel[1], Hasan Dinçer[2], Büşra Çelebi[3]

Abstract

The purpose of this study is to identify the most significant problem of renewable energy investments. Firstly, based on the literature evaluation, the problems of the clean energy projects are identified. In this framework, an analysis has been carried out using the analytical hierarchy process method. According to the results of the analysis, it has been determined that performance problems are the most critical issues in this framework. Technological problems also have an essential role in this respect. Location and financial problems have lower weight by comparing with others. Renewable energy companies should take some actions to minimize the performance problem. Renewable energy types are affected by climatic conditions. At some times of the day, less than the energy needed, and at other times more electricity can be produced. This puts energy efficiency at risk. To successfully combat this problem, businesses need to invest in storing excess energy. This will significantly contribute to the improvement of the performance of the projects.

Keywords: Renewable Energy; Energy Investments; Performance Evaluation; AHP
JEL Classification: Q40; Q27; O13

[1] İstanbul Medipol Üniversitesi, İşletme ve Yönetim Bilimleri Fakültesi, Doç. Dr.
E-posta: serhatyuksel@medipol.edu.tr
https://orcid.org/0000-0002-9858-1266
[2] İstanbul Medipol Üniversitesi, İşletme ve Yönetim Bilimleri Fakültesi, Prof. Dr.
E-posta: hdincer@medipol.edu.tr
https://orcid.org/0000-0002-8072-031X
[2] İstanbul Medipol Üniversitesi, Sağlık Yönetimi Yüksek Lisans Öğrencisi
E-posta: busra.celebi@std.medipol.edu.tr
https://orcid.org/0000-0002-7412-5418

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Yenilenebilir Enerji Yatırımlarında Karşılaşılan Sorunların Öncelik Analizi

Öz

Bu çalışmanın amacı, yenilenebilir enerji yatırımlarının en önemli sorununu tespit etmektir. Öncelikle literatür değerlendirmesine dayalı olarak temiz enerji projelerinin sorunları tespit edilmiştir. Bu çerçevede analitik hiyerarşi süreç yöntemi kullanılarak bir analiz gerçekleştirilmiştir. Analiz sonuçlarına göre performans sorunlarının bu çerçevede en kritik konular olduğu tespit edilmiştir. Teknolojik sorunlar da bu konuda önemli bir role sahiptir. Lokasyon ve finansal problemler diğerlerine göre daha az ağırlığa sahiptir. Yenilenebilir enerji şirketleri, performans sorununu en aza indirmek için bazı önlemler almalıdır. Yenilenebilir enerji türleri iklim koşullarından etkilenir. Günün bazı saatlerinde ihtiyaç duyulan enerjiden daha az, bazı zamanlarda ise daha fazla elektrik üretilebilir. Bu da enerji verimliliğini riske atmaktadır. Bu sorunla başarılı bir şekilde mücadele etmek için işletmelerin fazla enerjiyi depolamaya yönelik yatırım yapmaları gerekmektedir. Bu durum projelerin performansının iyileştirilmesine önemli ölçüde katkıda bulunacaktır.

Anahtar Kelimeler: Yenilenebilir Enerji; Enerji Yatırımları; Performans Değerlendirmesi; AHP
JEL Classification: Q40; Q27; O13

1. Introduction

Energy is defined as the transfer of power from one source to another. In economic review, there are actors in the world as government, companies, and individuals. These actors need to produce energy for a certain vital activity. In general, developed countries meet their energy demand with their own resources (Eti et al., 2023). However, developing countries can meet their energy demands depending on foreign countries. Therefore, countries that are dependent on foreign countries have limited energy resources. In the light of this information, being able to meet the energy demand is of great importance for sustainable development. Sustainable development requires a state to provide energy security to meet its vital activities by ensuring the welfare of its citizens (Dinçer et al., 2023). In this direction, fossil fuels, which are a limited resource, are used to meet the demand.

At the present time, another problem that concerns the whole world is the use of fossil fuels while meeting the energy demand. Because fossil fuels raise sea levels, reduce forest areas and cause climate change due to the emissions they emit. In addition, it is not recommended for sustainable development as a cause of global warming (Sun et al., 2022). These energy sources that harm the environment are classified as natural gas, coal, and oil. For these reasons, different energy forms have been sought for increasing industrial activities and other purposes. Industrial activities have increased the concept of globalization (Li et al., 2022). The concept of globalization is defined as the connection and spread of technology, communication, information, and production in the world. Globalization has become inevitable with the increase of multinational companies from past to present.

For this reason, multinational companies need to be effective and efficient in the ever-changing market under the effects of globalization. Even though globalization has positive effects such as knowledge sharing. In addition, there are negative effects such as deterioration of environmental quality (Bhuiyan et al., 2022). For instance, air pollution is an environmental degradation and the biggest factor behind this is industrial activities. In this regard, companies need to invest heavily in clean energy investments to minimize environmental problems. Renewable energy is a clean energy alternative to improve environmental quality (Kou et al., 2022). In other words, renewable energy is the type of energy that can reduce the effects of energy shortage, climate change and environmental degradation.

Basically, renewable energy types are defined as solar energy, hydroelectricity, wind energy, biomass and biogas energy, geothermal energy, and tidal energy. The ability to use these types of energy has been the chief target of all countries. In line with this purpose, it is aimed to overcome the electricity crisis and provide green energy by using renewable energy sources (Mukhtarov et al., 2022). Solar energy, which is a sustainable source, can meet the energy needs in rural, mountainous, and coastal regions. In addition, biomass energy is obtained from animal manure, agricultural product waste and municipal solid waste. Wind energy is provided by wind turbines, which are directly proportional to the speed of the wind (Dong et al., 2022). In short, it is a new form of energy obtained by converting these renewable energy types into electrical and mechanical energy.

In this study, it is aimed to evaluate these problems so that the most critical one can be identified. This situation helps to use the budget of the companies more efficiently. In this framework, analytical hierarchy process model is taken into consideration. This methodology is considered to compute the weights of the different criteria. The main novelty is that the most significant problem can be identified so that the performance of renewable energy investments can be increased in an efficient way. It is

not possible for businesses to take precautions against all problems in renewable energy projects. The reason for this is that each measure to be taken increases the cost of the company. Therefore, it is not possible to solve all problems at the same time. In this context, it would be appropriate for companies to conduct a priority analysis.

The following part includes the general framework of renewable energy investments. The third section gives information about the problems of renewable energy investments. The analysis results are provided in the fourth section. The final section explains the conclusions.

2. Theoretical Information about the Clean Energy Investments

The biggest energy need of companies is the use of electricity. This electricity need varies according to economic branches, floor areas of buildings, number of working hours and social media data criteria. Countries have focused on the efficient adjustment of the industrial sector structure, where energy consumption is largely used, with great emphasis on overall energy development, economic development, and environmental protection (Xu et al., 2022). Today, energy demand is increasing as exports diversify. In addition, as energy demand increases, it causes export activities, that is, two actions that feed each other. Economic growth is also cited as the increasing cause of exports (Dinçer et al., 2022). Renewable energy industry strategies have been proposed to governments. The country needs to decide which industry to promote to increase its economic competitiveness.

Additive manufacturing consists of combining more than one industry piece. Additive manufacturing aerospace industry can be an example. In addition, the construction industry can be added to the example. It is difficult to save energy in these sectors. Because, due to the weight reduction in the air and space sector, not much energy can be saved (Zhang et al., 2022). In the construction sector, very little energy is saved only in the stages of transportation, raw materials, and use. Energy policies within the scope of the Paris Agreement against climate change attract attention in the international arena. It has been seen recently that these energy policies have focused on different sectors (Yüksel et al., 2022). The reasons for this emphasis can be stated as the goal of harmonizing necessary elements such as technology into planning and policies in a long stage.

It has been concluded that increasing the use of renewable energy, which is a clean energy alternative, in the logistics sector, which is important for all states, improves environmental quality in a positive way (Carayannis et al., 2022). In addition, it has a positive contribution to economic development. Naturally, in the light of this information, environmental quality improves when the use of renewable energy is increased. It creates a positive image for foreign countries for export agreements that use renewable energy in the logistics sector. However, another inference is that when the use of this clean energy source increases, health expenditures will decrease (Mikhaylov et al., 2022). Of course, all states aim to improve economic development and public health in their policies. In fact, the deterioration of environmental quality adversely affects health, followed by a weakening of the workforce.

The main goal of states and companies has been to emit zero emissions by minimizing carbon dioxide emissions in the manufacturing and industrial sectors. In this way, it will be able to increase its economic competitiveness. For this purpose, it will be beneficial for low-cost import opportunities to reduce carbon emissions to zero, which is the sustainability target of competitiveness. In this direction, energy is used intensively in production companies, so the spread of carbon emissions is inevitable (Kostis

et al., 2022). Minimizing carbon emissions by increasing the energy efficiency of manufacturing companies is among the main targets. For example, the iron and steel and food and beverage industries are energy-intensive industries. As a result of this information, companies need to develop strategies to develop innovative business models, address obstacles and address energy efficiency technologies (Wan et al., 2022).

3. Problems in Renewable Energy Types

Solar, wind, hydro, geothermal sustainable energy resources projects are much more interesting than in the past. Thus, using these clean energy sources means facing many different conflicting problems. It is of great importance to determine policies that will encourage the use of renewable energy (Wu et al., 2022). There are undeniable problems regarding which source to use, location, sustainability, project performance and technological performance in the use of renewable energy. The establishment of an institutional framework for increasing the use of renewable energy required political decisions. In this context, political requirements are needed, such as developing market policy to improve R&D services and encourage renewable energy investment (Yüksel et al., 2022). All these indicators show that the political and economic barriers in the use of renewable energy take the lead.

Another problem that needs to be addressed in the use of these clean energy sources is technique. There are uncertainties while providing sustainable energy sources such as solar and wind. Because a continuous variation of the sun's rays and wind speed creates uncertainty. The clean energy system obtained with wind energy can pose a technical problem to small consumers regarding power quality (Zhao et al., 2022). Renewable energy sources have a new system where traditional possibilities have not been created yet. Therefore, this information content requires modern technical knowledge of the resource's potential when using these resources. In addition, it requires economic opportunities while creating this technical knowledge and potential (Haiyun et al., 2021). Therefore, personnel with technical knowledge of renewable energy systems are needed.

Although developing countries have the potential to use renewable energy, they may be lacking in developing new technologies. In this sense, developed countries have focused on developing renewable energy technology systems. There are some obstacles to realizing the potential of renewable energy technologies (Yuan et al., 2021). The foremost of these obstacles is economic and financial deprivation. The second is politics and then the market barrier. In this direction, the market barrier can be specified as technical, institutional, administrative, and socio-cultural. Organizations will be able to make technological investments by overcoming obstacles in research and development studies (Li et al., 2021). In addition, it is one of the chief targets to minimize carbon emissions by adopting modern technology and high quality in developed countries.

The chief problem in increasing the use of renewable energy is its economic potential capability. Because the main reason for all other sub-obstacles stems from the financial situation (Xie et al., 2021). In fact, economic barriers to the use of renewable energy do not have a direct effect. However, in this sense, it can be said to be indirectly related to social and technological regulatory barriers. For instance, it is stated that the negative factors in increasing renewable energy technologies are related to weak infrastructure, lack of appropriate financing and not evaluating technology (Liu et al., 2021). Credit facilities should be provided to encourage governments to use renewable energy. In this context, the underlying reason for asking for government support is very costly to renewable energy consumers

and brings financial burden.

Due to all these mentioned sectors, there is a large amount of energy demand. Among these energy demands, solar energy technologies are increasing day by day. There are some main obstacles behind this increase. These barriers are technical barriers, solar cell efficiency and poor performance instability (Zhou et al., 2021). Economic barriers can be said to be high prepayment costs and lack of financing mechanisms. Institutional barriers include inadequate infrastructure and unqualified personnel. Solar energy has many advantages as well as disadvantages that are discussed and should be emphasized. PV source technologies are currently used as the primary source for solar power generation. It is stated that even if the policies developed to promote solar energy technologies reduce the cost, it is still a very high cost (Liu et al., 2021). Because solar energy technologies require more quality and innovative technologies.

It contributes to hydroelectric power generation globally. It is a fact that the increase in the diversity of clean energy makes a positive contribution to the environment. The most important resource of life is water, so the focus is on using this resource effectively. For this reason, hydroelectric power plants have started to be used as a renewable energy source. There are some points to be considered while providing this energy source. These are key criteria such as the amount of water used in power plants, the net reduction, and the predetermination of energy output (Meng et al., 2021a,b). Thanks to these criteria, it is also important for sustainability to predict the energy to be provided by future energy planning. Required professionals have made short- and long-term forecasts from the basins.

Wind energy is defined as a sustainable energy source obtained by converting airborne wind energy systems into electrical energy using standard kites. In cases such as the absence of wind, there may be problems in obtaining energy. In addition, wind energy is structure with a slightly more complex mechanism in its conversion to electrical and mechanical energy. In this sense, wind energy is a renewable energy source that is on the agenda with its problems and potential. There are various driving forces in wind energy production. One of these driving forces is noted improvements in energy density (Ding et al., 2021). If the transition policies from fossil fuels to renewable energy sources are increased, it is estimated that the share of wind energy will increase by contributing to this sustainability.

The focus on sustainable strategies for countries is increasing day by day. It is a fact that electricity production will increase a lot in the future with increasing forecasts. Population growth, economic development and industrialization increase the energy demand and cause rapid accumulation of wastes such as industrial, urban, animal, and agricultural wastes. Therefore, sustainable resources were tried to be obtained from this situation. Recently, obtaining energy technology from waste is one of the methods that are a renewable energy source. Biomass and biogas energy is obtained by converting organic-rich compounds into clean and renewable resources by anaerobic digestion. Many complex variables exist between biogas systems. However, biogas energy is an alternative source to replace fossil fuel in developed and developing countries.

There are some main obstacles in front of geothermal energies. These obstacles can be counted as high capital costs, location, and quality of the source at different depths and opposition from local communities. The industrial sector emits a large amount of carbon emissions. Therefore, it is possible for industrial processes to occur with very low, low, and medium geothermal temperature sources. Depending on the potential of the country, geothermal energy sources can be preferred instead of solar

power plants. In fact, many European and other countries have taken into consideration geothermal energy resources that have remained on the side-lines. Because it is believed that it will provide development and a solution to greenhouse gas. In this sense, many new applications are being tried.

In recent years, wave energy has been preferred. The reasons for preference can be said to be based on its reliability, superior energy density, sharpness, and durability. Tidal energy is defined as a sustainable resource derived from tidal movements based on the constant and expected vertical movements of water. In line with this system, kinetic energy is obtained. River turbines can capture energy from tidal currents, while dams channel energy. Tidal energy is an uninterrupted renewable energy source compared to conventional solar and wind energy. Uncertainty and environmental barriers are one of the obstacles to the development of tidal energy. For example, problems such as fish aggregation in providing tidal energy can be countered by environmental monitoring in advance. Thus, to reduce the risk of uncertainty.

4. Prioritizing Problems in Clean Energy Projects

Based on the literature evaluation, the problems of the clean energy projects are identified. The details of these problems are given in Table 1.

Table 1: Problems in Renewable Energy Projects

Problems	References
Location Problems	Li et al. (2021)
Financial Problems	Yuan et al. (2021)
Technological Problems	Wu et al. (2022)
Performance Problems	Sun et al. (2022)

The location problem is important for renewable energy projects. It is not possible to carry out all clean energy projects in every location. In this context, location selection is important. The costs of renewable energy projects are very high. This situation brings disadvantages to the projects in terms of cost. If this process is not managed effectively, companies are likely to encounter financial problems. Technological problems are also issues to be considered in renewable energy projects. Renewable energy projects involve complex processes. Therefore, companies need to be technologically proficient to sustain these projects successfully. Finally, there is a performance problem in these projects. Renewable energy projects are affected by climatic conditions. Therefore, in some cases less energy is produced than is needed. This situation creates an important performance problem. In addition, at some times of the day, less electricity is generated than is needed. This situation causes the performance of the projects to decrease.

In this study, it is aimed to evaluate these problems so that the most critical one can be identified. This situation helps to use the budget of the companies more efficiently. In this framework, analytical hierarchy process model is taken into consideration. This methodology is considered to compute the weights of the different criteria (Silahtaroğlu et al., 2021). The hierarchical relationship between the factors is considered in this process (Yüksel et al., 2021). In the evaluation process, 9 different scales are used in which "9" refers to the highest superiority whereas "1" gives information about the equality. In the analysis process, firstly, the questions are created by considering these criteria (Dinçer and Yüksel, 2018). The details of the comparison questions are given in Table 2.

Table 2: Questions Asked to the Experts

Which problems are more important to renewable energy projects?																	
Location Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Financial Problems
Location Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Technological Problems
Location Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Performance Problems
Financial Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Technological Problems
Financial Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Performance Problems
Technological Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Performance Problems

After that, these questions are asked to the expert team that consists of three different people. They are professors of energy economics who have more than 21 years of experience. These people provide their opinions about these questions. The details of the evaluations are indicated in Table 3.

Table 3: The Evaluations of the Experts

Decision Maker 1																	
Location Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Financial Problems
Location Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Technological Problems
Location Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Performance Problems
Financial Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Technological Problems
Financial Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Performance Problems
Technological Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Performance Problems

Decision Maker 2																	
Location Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Financial Problems
Location Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Technological Problems
Location Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Performance Problems
Financial Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Technological Problems
Financial Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Performance Problems
Technological Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Performance Problems

Decision Maker 2																	
Location Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Financial Problems
Location Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Technological Problems
Location Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Performance Problems
Financial Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Technological Problems
Financial Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Performance Problems
Technological Problems	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Performance Problems

The matrix form of these evaluations is denoted in Table 4.

Table 4: The Evaluation Matrix

Decision Maker 1				
	Location Problems	Financial Problems	Technological Problems	Performance Problems
Location Problems	1.00	0.33	0.20	0.14
Financial Problems	3.00	1.00	0.33	0.20
Technological Problems	5.00	3.00	1.00	0.33
Performance Problems	7.00	5.00	3.00	1.00

Decision Maker 2				
	Location Problems	Financial Problems	Technological Problems	Performance Problems
Location Problems	1.00	0.25	0.17	0.11
Financial Problems	4.00	1.00	0.25	0.14
Technological Problems	6.00	4.00	1.00	0.20
Performance Problems	9.00	7.00	5.00	1.00

Decision Maker 3				
	Location Problems	Financial Problems	Technological Problems	Performance Problems
Location Problems	1.00	0.50	0.20	0.13
Financial Problems	2.00	1.00	0.33	0.17
Technological Problems	5.00	3.00	1.00	0.25
Performance Problems	8.00	6.00	4.00	1.00

The average values of the expert evaluations are computed so that a direct relation matrix can be identified as in Table 5.

Table 5: Direct Relation Matrix

Decision Maker 1				
	Location Problems	Financial Problems	Technological Problems	Performance Problems
Location Problems	1.00	0.36	0.19	0.13
Financial Problems	3.00	1.00	0.31	0.17
Technological Problems	5.33	3.33	1.00	0.26
Performance Problems	8.00	6.00	4.00	1.00

In the next process, the sums of the columns in direct relation matrix are computed. All values are divided into these sum values. With the help of this condition, the normalized matrix is constructed as in Table 6.

Table 6: Normalized Matrix

	Decision Maker 1			
	Location Problems	Financial Problems	Technological Problems	Performance Problems
Location Problems	0.06	0.03	0.03	0.08
Financial Problems	0.17	0.09	0.06	0.11
Technological Problems	0.31	0.31	0.18	0.17
Performance Problems	0.46	0.56	0.73	0.64

Finally, the average of the rows is considered so that the weights of the items can be identified. Table 7 states the details of the weights.

Table 7: Normalized Matrix

Criteria	Weights
Location Problems	0.05
Financial Problems	0.11
Technological Problems	0.24
Performance Problems	0.60

The confidence ratio is computed as 0.004 that is lower than 0.05. It is understood that the results are reliable and coherent. Performance problems are the most critical issues in this framework. Technological problems also have an essential role in this respect. Location and financial problems have lower weight by comparing with others.

5. Conclusions

Renewable energy projects provide serious advantages to both businesses and countries. Thanks to these projects, businesses can increase their image in the eyes of both investors and consumers. Firms preferred by investors will be able to access the funds they need more easily. This will provide significant cost advantages to renewable energy companies. In addition, companies that are more preferred by consumers will be able to increase their sales significantly. This provides the opportunity for companies to significantly increase their profitability.

Therefore, renewable energy projects need to be increased. However, there are some problems with these projects. In this context, minimizing these problems is important for increasing the performance of these projects. The location problem is very important for renewable energy projects. In addition, financial problems should also be taken into consideration in this process. Insufficient technological development threatens the performance of these projects. The low performance also poses an obstacle to the continuity of these projects.

It is not possible for businesses to take precautions against all problems in renewable energy projects. The reason for this is that each measure to be taken increases the cost of the company. Therefore, it is not possible to solve all problems at the same time. In this context, it would be appropriate for companies to conduct a priority analysis. In this study, it will be determined which of these problems is more important. In this framework, an analysis was carried out using the analytical hierarchy process method. According to the results of the analysis, it has been determined that the performance problems are the most important issue. Therefore, it would be appropriate for companies to prioritize actions on this issue.

Renewable energy companies should take some actions to minimize the performance problem. Renewable energy types are affected by climatic conditions. At some times of the day, less than the energy needed, and at other times more electricity can be produced. This puts energy efficiency at risk. To successfully combat this problem, businesses need to invest in storing excess energy. This will significantly contribute to the improvement of the performance of the projects. There are lots of different studies that underlined the significance of this result. Zhong et al. (2020), Cheng et al. (2020) and Yüksel et al. (2020) also reached a conclusion that renewable energy companies should give priority to the performance problem of the projects.

The most important limitation of this study is the general consideration of renewable energies in the analysis process. Therefore, renewable energy types can be examined specifically in new studies. In this context, analysis of the problems faced by solar energy projects can be carried out. In this study, the analytical hierarchy process method was taken into consideration. This method allows calculating the weights of the criteria. However, the causality relationship between the criteria cannot be determined with this method. In this framework, it would be appropriate to consider the cause-effect relationship between the criteria in future analysis.

References

Bhuiyan, M. A., Dinçer, H., Yüksel, S., Mikhaylov, A., Danish, M. S. S., Pinter, G., ... & Stepanova, D. (2022). Economic indicators and bioenergy supply in developed economies: QROF-DEMATEL and random forest models. *Energy Reports,* 8, 561-570.

Carayannis, E., Kostis, P., Dinçer, H., & Yüksel, S. (2022). Balanced-Scorecard-Based Evaluation of Knowledge-Oriented Competencies of Distributed Energy Investments. *Energies*, 15(21), 8245.

Cheng, F., Lin, M., Yüksel, S., Dinçer, H., & Kalkavan, H. (2020). A hybrid hesitant 2-tuple IVSF decision making approach to analyze PERT-based critical paths of new service development process for renewable energy investment projects. *IEEE Access*, 9, 3947-3969.

Dinçer, H., & Yüksel, S. (2018). Comparative evaluation of BSC-based new service development competencies in Turkish banking sector with the integrated fuzzy hybrid MCDM using content analysis. *International Journal of Fuzzy Systems,* 20(8), 2497-2516.

Dinçer, H., Yüksel, S., & Martínez, L. (2022). Collaboration enhanced hybrid fuzzy decision-making approach to analyze the renewable energy investment projects. *Energy Reports,* 8, 377-389.

Dinçer, H., Yüksel, S., Çağlayan, Ç., Yavuz, D., & Kararoğlu, D. (2023). Can Renewable Energy Investments Be a Solution to the Energy-Sourced High Inflation Problem?. In *Managing Inflation and Supply Chain Disruptions in the Global Economy* (pp. 220-238). IGI Global.

Ding, Z., Yüksel, S., & Dincer, H. (2021). An Integrated Pythagorean fuzzy soft computing approach to environmental management systems for sustainable energy pricing. *Energy Reports,* 7, 5575-5588.

Dong, W., Zhao, G., Yüksel, S., Dinçer, H., & Ubay, G. G. (2022). A novel hybrid decision making approach for the strategic selection of wind energy projects. *Renewable Energy,* 185, 321-337.

Eti, S., Dinçer, H., Gökalp, Y., Yüksel, S., & Kararoğlu, D. (2023). Identifying Key Issues to Handle the Inflation Problem in the Healthcare Industry Caused by Energy Prices: An Evaluation With Decision-Making Models. *Managing Inflation and Supply Chain Disruptions in the Global Economy,* 162-178.

Haiyun, C., Zhixiong, H., Yüksel, S., & Dinçer, H. (2021). Analysis of the innovation strategies for green supply chain management in the energy industry using the QFD-based hybrid interval valued intuitionistic fuzzy decision approach. *Renewable and Sustainable Energy Reviews,* 143, 110844.

Kostis, P., Dinçer, H., & Yüksel, S. (2022). Knowledge-Based Energy Investments of European Economies and Policy Recommendations for Sustainable Development. *Journal of the Knowledge Economy,* 1-33.

Kou, G., Yüksel, S., & Dinçer, H. (2022). Inventive problem-solving map of innovative carbon emission strategies for solar energy-based transportation investment projects. *Applied Energy,* 311, 118680.

Li, W., Yüksel, S., & Dinçer, H. (2022). Understanding the financial innovation priorities for renewable energy investors via QFD-based picture fuzzy and rough numbers. *Financial Innovation,* 8(1), 1-30.

Li, Y. X., Wu, Z. X., Dinçer, H., Kalkavan, H., & Yüksel, S. (2021). Analyzing TRIZ-based strategic priorities of customer expectations for renewable energy investments with interval type-2 fuzzy modeling. *Energy Reports,* 7, 95-108.

Liu, J., Lv, J., Dinçer, H., Yüksel, S., & Karakuş, H. (2021). Selection of renewable energy alternatives for green blockchain investments: A hybrid IT2-based fuzzy modelling. *Archives of Computational Methods in Engineering,* 28(5), 3687-3701.

Liu, Y., Gong, X., Yüksel, S., Dinçer, H., & Aydın, R. (2021). A multidimensional outlook to energy investments for the countries with continental shelf in East Mediterranean region with hybrid decision making model based on IVIF logic. *Energy Reports,* 7, 158-173.

Meng, Y., Wu, H., Zhao, W., Chen, W., Dinçer, H., & Yüksel, S. (2021a). A hybrid heterogeneous Pythagorean fuzzy group decision modelling for crowdfunding development process pathways of fintech-based clean energy investment projects. *Financial Innovation,* 7(1), 1-34.

Meng, Y., Zhou, R., Dinçer, H., Yüksel, S., & Wang, C. (2021b). Analysis of inventive problem-solving capacities for renewable energy storage investments. *Energy Reports,* 7, 4779-4791.

Mikhaylov, A., Bhatti, I. M., Dinçer, H., & Yüksel, S. (2022). Integrated decision recommendation system using iteration-enhanced collaborative filtering, golden cut bipolar for analyzing the risk-based oil market spillovers. *Computational Economics,* 1-34.

Mukhtarov, S., Yüksel, S., & Dinçer, H. (2022). The impact of financial development on renewable energy consumption: Evidence from Turkey. *Renewable Energy,* 187, 169-176.

Silahtaroğlu, G., Dinçer, H., & Yüksel, S. (2021). Defining the significant factors of currency exchange rate risk by considering text mining and fuzzy AHP. In *Data science and multiple criteria decision making approaches in finance* (pp. 145-168). Springer, Cham.

Sun, L., Peng, J., Dinçer, H., & Yüksel, S. (2022). Coalition-oriented strategic selection of renewable energy system alternatives using q-ROF DEMATEL with golden cut. *Energy*, 256, 124606.

Wan, Q., Zhao, X., Liu, H., Dinçer, H., & Yüksel, S. (2022). Assessing the new product development process for the industrial decarbonization of sustainable economies. *SAGE Open*, 12(1), 21582440211067231.

Wu, X., Dinçer, H., & Yüksel, S. (2022). Analysis of crowdfunding platforms for microgrid project investors via a q-rung orthopair fuzzy hybrid decision-making approach. *Financial Innovation,* 8(1), 1-22.

Xie, Y., Zhou, Y., Peng, Y., Dinçer, H., Yüksel, S., & an Xiang, P. (2021). An extended pythagorean fuzzy approach to group decision-making with incomplete preferences for analyzing balanced scorecard-based renewable energy investments. *IEEE Access*, 9, 43020-43035.

Xu, X., Yüksel, S., & Dinçer, H. (2022). An Integrated Decision-Making Approach with Golden Cut and Bipolar q-ROFSs to Renewable Energy Storage Investments. *International Journal of Fuzzy Systems,* 1-14.

Yuan, G., Xie, F., Dinçer, H., & Yüksel, S. (2021). The theory of inventive problem solving (TRIZ)-based strategic mapping of green nuclear energy investments with spherical fuzzy group decision-making approach. *International Journal of Energy Research,* 45(8), 12284-12300.

Yüksel, S., & Dinçer, H. (2022). Identifying the strategic priorities of nuclear energy investments using hesitant 2-tuple interval-valued Pythagorean fuzzy DEMATEL. *Progress in Nuclear Energy,* 145, 104103.

Yüksel, S., Dinçer, H., & Uluer, G. S. (2020). The role of technological development on renewable energy usage: An econometric analysis for G7 countries. In *Handbook of research on sustainable supply chain management for the global economy* (pp. 136-153). IGI Global.

Yüksel, S., Dinçer, H., Eti, S., & Adalı, Z. (2022). Strategy improvements to minimize the drawbacks of geothermal investments by using spherical fuzzy modelling. *International Journal of Energy Research*.

Yüksel, S., Eti, S., Prosekov, S., & Uluer, G. S. (2021). A study on the energy problem in the eastern mediterranean: Text mining and AHP-based strategy recommendations. In *Strategic Approaches to Energy Management* (pp. 27-38). Springer, Cham.

Zhang, Y., Zhang, Y., Gong, C., Dinçer, H., & Yüksel, S. (2022). An integrated hesitant 2-tuple Pythagorean fuzzy analysis of QFD-based innovation cost and duration for renewable energy projects. *Energy,* 248, 123561.

Zhao, Y., Korsakienė, R., Dinçer, H., & Yüksel, S. (2022). Identifying Significant Points of Energy Culture for Developing Sustainable Energy Investments. *SAGE Ope*n, 12(1), 21582440221087262.

Zhong, J., Hu, X., Yüksel, S., Dinçer, H., & Ubay, G. G. (2020). Analyzing the investments strategies for renewable energies based on multi-criteria decision model. *IEEE Access*, 8, 118818-118840.

Zhou, P., Luo, J., Cheng, F., Yüksel, S., & Dinçer, H. (2021). Analysis of risk priorities for renewable energy investment projects using a hybrid IT2 hesitant fuzzy decision-making approach with alpha cuts. *Energy*, 224, 120184.