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SOLAR ENERGY POLICY AND STRATEGY IN UZBEKISTAN

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Abstract
Solar energy, a renewable and pollution-free energy source, plays a significant role in the sustainable delivery of energy services. The main objective of this study is to examine solar energy, a renewable resource in Uzbekistan, and its potential, situation, future strategies, and policies. This study, which uses qualitative research methodology, made use of inductive procedures, a systematic approach, and a literature review. The study evaluates Uzbekistan's policy toward solar energy in light of potential solar energy sources, the current environment, and the country's long-term ambitions. Uzbekistan falls short in terms of producing electricity from renewable energy sources. The most important strategic goals for Uzbekistan's use of renewable and alternative energy sources have also been identified. Thus, the key objective has been set as having 25% of investments in renewable energy in the nation's total energy balance by 2030. According to the report, solar energy policies will benefit the nation's economy in the years to come because of Uzbekistan's geographic location and infrastructure system, which can provide solar energy to underdeveloped nations.
Keywords: Renewable Solar Energy, Solar Energy Potential, Solar Energy Strategy, Renewable Energy Policy.

Introduction

Decarbonizing the global energy system depends on increasing the amount of electricity generated by renewable sources. The combination of expanding low-cost renewable energy sources and the widespread usage of electricity for end-use applications in heating and transportation creates the most significant synergy of the global energy transformation. To achieve the energy transition at the needed pace and scale by 2050, the power industry must be almost entirely decarbonized. According to the REmap Case, renewable energy sources will account for 86% of global energy production by 2050 (IRENA, 2019a).

Uzbekistan has a strong domestic resource base that supports its well-developed energy infrastructure. The economic growth of Uzbekistan, which regained its independence in 1991, was greatly influenced by natural resources, particularly oil and gas. The relationship between

Uzbekistan's economic growth, the overall value of exports, and energy exports was evaluated as a result of the analysis based on data up until 1994–2018, but no causal association between the two was discovered. The country's export of energy products to foreign markets in the form of raw materials is cited as the primary cause of this (Huseynli, 2022).

The "Contract of the Century" deal, after Uzbekistan attained independence, is crucial in facilitating the access of energy resources to global markets. Additionally, Uzbekistan, which is likewise abundant in sustainable and energy-transferable renewable energy sources, implements energy regulations that will take advantage of this potential. Over the past 200 years, the expansion and development of the economy have been fueled by fossil fuels like coal and oil. However, according to Mikayilov et al. (2018), economic growth does not always rely on energy derived from fossil fuels.

To potentially replace fossil fuels, renewable energy sources have been intensively investigated (Bihari et al., 2021). Since renewable energy does not release harmful gases into the atmosphere or the local population, it is the most sustainable and long-lasting technology that will eventually replace fossil fuels. The following sources of renewable energy can provide electricity: solar, wind, hydro, biomass, geothermal, and tidal.

The sustainability of the globe relies on renewable energy. Forecasting the output of renewable energy has a big influence on the management and operation of power systems. To guarantee grid dependability and continuity as well as to lower the danger and expense of energy markets and systems, an accurate assessment of renewable energy output is essential (Alkhayat and Mehmood, 2021).

In recent years, renewable energy sources have been used to supply the need for electricity, particularly in remote locations that are not linked to the grid. According to Bihari et al. (2021), they also emphasize cost-cutting incentives and look at the viability of integrating hybrid renewable energy into the microgrid system. Li et al.'s study from 2021 looked at suitable novel solar energy investment options for both commercial and non-commercial users.

The long-term goal of the EU Strategy for Central Asia is to establish a stable political, economic, and social environment along the EU's eastern frontier. The most populated nation in the region, Uzbekistan is also rich in hydrocarbon resources and contributes significantly to the EU's oil and natural gas supply. The resource, technical, economic, and market potential, ecology, and economic effectiveness of solar energy in Uzbekistan were all examined in a research These and other concerns about using renewable energy are covered in an essay by Rzayeva et al. (2021) that also assesses Uzbekistan's potential for using this kind of energy in the future. According to data from 2005 to 2015, a causal relationship between unemployment and renewable energy production, renewable energy production, and traditional energy production was discovered in Uzbekistan as a result of a study looking at the relationship between traditional energy production, renewable energy production, and unemployment rates (Huseynli and Huseynli, 2022).

In addition to all of these things, this study was conducted to address this vacuum in the literature because there isn't one on the potential, situation, and future plans for solar energy in Uzbekistan. Since solar energy is a renewable resource in Uzbekistan, the goal of this study is to examine its potential, present state, future strategies, and policies.

Literature Review

Conventional and Solar Energy. Energy is a crucial tool for ensuring that nations prosper economically and that people have access to wealth for decades to come. The world and the planets that orbit it are heated and powered mostly by the sun (Li et al., 2021). Among the available energy sources, solar energy is the most sustainable and unrenewable (Yüksel et al., 2019). Coal, petroleum, and nuclear power plants—the traditional sources of energy—damage natural life through radiation, carbon emissions, and chemical waste.

The term "solar energy" refers to the heating energy produced by the fusion of hydrogen and helium in the sun's core. Wherever the sun rises and sets, solar energy can be produced naturally, and getting there doesn't involve any more work (Li et al., 2021). Water, forest, or soil resources are not harmed by solar energy. It doesn't emit carbon dioxide and is eco-friendly (Qiu et al., 2020).

Photovoltaic (PV) systems can employ photon energy from light beams or the sun's heating potential in concentrated solar power (CSP) systems, according to Busse and Dinter (2016). The Leveled Cost of Energy (LCOE), which can be used to compare various systems, has its own advantages (Esram and Chapman, 2007). The production of photovoltaic energy is influenced by things like the choice of photovoltaic material and cloud cover. The sun gives the Earth enough energy in just 90 minutes to meet the world's energy needs for a whole year.

Even though solar energy is so abundant, it only accounts for a small portion of the global energy mix at the moment (Jäger-Waldau, 2020). However, acquiring renewable energy sources must be more challenging than obtaining energy from fossil fuels. However, in terms of sustainability, countries place a lot of significance on renewable energy sources. In this regard, solar energy is among the most purely natural and readily available types of renewable energy (Gielen et al., 2019). Solar energy, on the other hand, does not contribute to environmental and societal issues because it is safer and more sustainable.

Solar energy is used in concentrated solar power plants, solar thermal applications, solar photovoltaic (PV) plants, photoactive fuel cells, hydrogen fuels, and concentrated sun power (CSP) plants (Gonzalo et al., 2019; Wilberforce et al., 2019). Despite the fact that solar energy is free everywhere, it is initially quite expensive to invest in the infrastructure needed to make it accessible. Long-term profits could be generated from these investments, which have expenditure costs (Li et al., 2021).

Review of Renewable Solar Energy Literature

To meet its ongoing energy needs, the global economy is mostly dependent on fossil fuels, which are also the main source of greenhouse gas (GHG) emissions (Koengkan et al., 2018). According to the Green Energy Global Status Report, 26.2% of the electricity produced comes from renewable sources; of this, 15.8% is derived from hydropower, 5.5% from wind power, 2.4% from solar power, and 2.2% from biopower, while 0.4% comes from other energy sources (Kumar et al., 2020). However, this is quickly shifting as a result of global initiatives to combat climate change, increase energy access, and ensure supply security (Usman et al., 2020).

The body of research on solar energy is extensive. Some of these studies compare various criteria, including site selection, technical proficiency, customer satisfaction, risk, government policy, cost-benefit analysis, and skilled labor, to name a few.

The capacity of newly commissioned solar power plants was 127 GW, and the total installed capacity of solar power plants worldwide was 714 GW (24.3%) in 2020, according to a report by the International Renewable Energy Agency (IRENA, 2019a). Thus, the world's largest market for renewable energy sources, China, installed 49 GW of solar power plants in 2020, while the United States added 15 GW. China (255 GW), the United States (75 GW), Japan (68 GW), Germany (53 GW), and India (39 GW) are the top five nations in the world for solar capacity. The International Renewable Energy Agency's "Future of Solar Photovoltaic" report (IRENA, 2019a) estimates that the 480 GW of solar electricity generated globally in 2018 will expand to almost 8000 GW by 2050. is anticipated to rise.

The study underlines that a quarter of the world's electricity demand will be met by solar energy by 2050 as new markets are created all over the world. Additionally, the Report projects that by 2050, Asia will account for more than 50% of all solar energy capacity installed worldwide.

The use of environmentally friendly alternative (renewable) energy sources such as solar and wind energy, small HPPs, thermal waters, and biomass energy is common in developed countries due to the gradual depletion of conventional energy sources and the significant environmental harm they cause when used. The USA, Canada, Germany, Finland, Norway, Denmark, Spain, Japan, and China are leaders in this field. Statistics show that 13.5 percent of the total energy produced in developed countries comes from renewable energy sources, including hydropower facilities. According to Jäger-Waldau (2020), China is currently the world's largest consumer of solar energy, followed by the USA, Japan, and Germany. However, Australia tops the list of countries that consume the most solar energy per person, followed by Germany, Japan, and Spain (Dale, 2019).

In their cost-benefit study of solar energy investments, Yang et al. (2018) discovered that the payback period exceeds 13 years. In this respect, Plank and Doblinger (2018) looked at the German renewable energy market to investigate the effect of public funds on corporate innovation.

According to Avezova et al. (2019), who examined the situation of Uzbekistan, highly competent professionals must be trained and retrained in order for the sector of renewable energy, particularly solar energy, to advance. Customers are one of the most crucial aspects of investments in renewable energy, according to Dinçer and Yüksel's 2019 study, which assessed worldwide investment possibilities in the context of renewable energy.

Research Methodology

Purpose of the Study. The main purpose of this study is to examine the potential, state-of-play, upcoming plans and policies for solar energy from renewable resources in Uzbekistan.

Analysis method**.** An important part of the sustainable delivery of energy services is played by solar energy, which is an unrenewable and pollution-free energy source. Studies on the subjects of physics, economics, politics, pollution, and their intersection have been done. It's crucial to translate resource potential into strategy. only by taking into account land use,

topography, distance to consumer locations, and related aspects can these strategic decisions be made (Leibowitz et al., 2019).

This study is a piece of qualitative research. That is, a literature review, a systematic methodology, and inductive approaches were employed within the parameters of the study. The project is structured as follows:

1. First step: A review of the global and Uzbekistani literature on solar energy.
2. Second step: The potential for solar energy in Uzbekistan was assessed.
3. Third step: The current energy and solar energy situation in Uzbekistan was examined.
4. Fourth step: Plans for Uzbekistan's use of renewable solar energy were evaluated.
5. Fifth step: Using all of this information, a critical analysis of the prospective, existing, and future strategic solar energy policies of Uzbekistan was made.

Analysis And Results

Analysis Of The Use Of Solar Energy Sources In Uzbekistan's Potential**.** The natural climatic conditions of Uzbekistan provide numerous chances to boost solar energy production of electricity and heat. In many parts of Uzbekistan, expanding solar energy use can help with the country's energy woes. The Photovoltaic Program (FVP) has recently seen widespread implementation in several developed nations. The installation of these kinds of energy systems in the area may be significantly aided by Uzbekistan's participation in this program. Figure 1 depicts the pattern that reflects the number of sunny hours in Uzbekistan throughout the year.

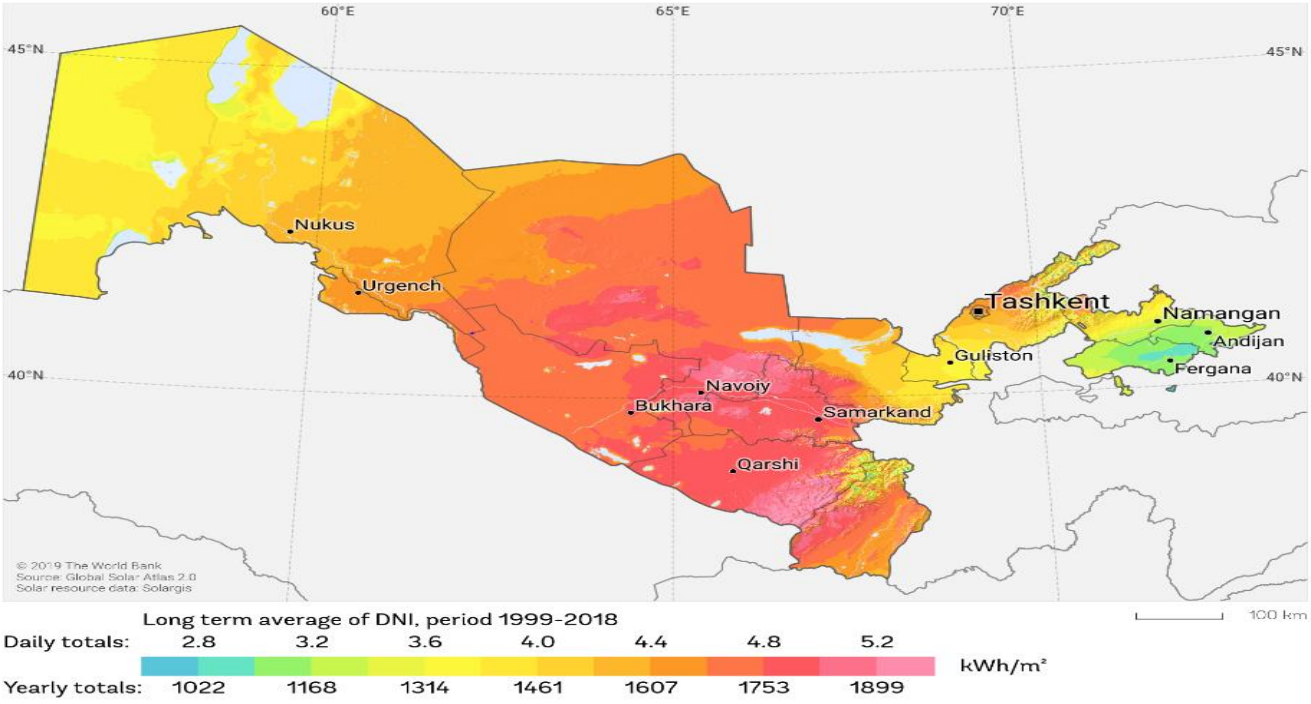

Figure 1: Number of sunny hours in Uzbekistan in a year (in hours).

Source: Source: Global Solar Atlas 2.0, Solar resource data: Solargis.com

It should be mentioned that the natural climate and geographic location of the nation affect how effective solar power facilities are. As can be seen, Uzbekistan has more sunlight

falling on its land than other nations, which can be considered one of the effective conditions for drawing investments in the use of solar energy.

IRENA (2019b) also evaluated the potential of renewable energy sources in Uzbekistan. As a result, the technical potential of solar energy in Uzbekistan is estimated at 7,411 PJ, which is about four times the nation's current primary energy consumption. The gross potential of solar energy in the country is 2,134 x 103 PJ. With the aid of contemporary technology, it is conceivable to use solar energy in Uzbekistan in place of traditional carbon-based energy sources (Gulaliyev et al., 2020).

Analysis of the current situation on the use of Solar energy sources in Uzbekistan

In Uzbekistan, which experiences 270–300 sunny days per year on average, solar energy accounts for up to 99 percent of the country's entire renewable energy potential. The largest solar energy production potential, with over 19 billion tonnes of oil equivalent (TOE), is in Karakalpakstan. With 129 million TOE, the Andijan region in the country's mountainous far east has the least solar energy potential.

In Uzbekistan, research and development on solar energy began in the 1980s, but nothing has been accomplished thus far. The Uzbek provinces of Karakalpakstan, Navoi, Bukhara, and Surkhandarya, which are rich in solar energy potential, are primarily desert and have limited populations, offering opportunities for the development of alternative energy. A joint venture to produce photovoltaic panels with a 100 MW capacity has been established by Uzbekenergo and the Chinese business Suntech Power. Uzbekenergo is constructing a 100 MW photovoltaic power plant in the Samarkand region with financing of US$110 million from the Asian Development Bank. By 2019, the plant must be built.

Directions of strategic development of solar energy sources in Uzbekistan

Relevant laws and normative legal actions have been adopted in Uzbekistan to advance the field of renewable energy and strengthen the institutional and legislative environment in this area. The fieldwork has continued in recent years, and in 2020, the Republic of Uzbekistan's law "On the use of renewable energy sources in the production of electricity," which specifically aids in the advancement of renewable energy, was enacted.

The strategic plans for the future show Uzbekistan's approach to using renewable energy sources. The utilization of renewable energy sources and the expansion of the application of "green" technology are being given increased emphasis in the current and future periods in accordance with the country's socio-economic development priorities. As part of this field's work, camera studies were carried out all across the nation with the goal of locating and ranking viable locations for renewable energy sources. According to the President of the Republic of Uzbekistan's decree from 2020, national priorities are particularly significant in the direction of carrying out the duties. Additionally, a number of projects are being worked on to analyze the potential for Uzbekistan to create power from renewable energy sources as well as the procedures and measures that need to be done to harness this potential. In order to identify and prioritize places with the potential for renewable energy sources, 8 areas have been chosen. The proper steps are already being taken to conduct pilot programs in the three areas that were chosen. Compared to wind energy, projects are planned to be implemented in the regions over the following years to utilize the country's vast solar energy potential, make use

of land unsuitable for agriculture, and distribute electricity generation capacity among renewable energy sources. The effort to use an auction to fund investments in prioritized and carefully chosen renewable energy sources in high-potential regions continues. Currently, the European Bank for Reconstruction and Development (EBRD) and Uzbekistan are working together on the project "Support for holding renewable energy auctions in Uzbekistan." The development of the auction rules, the list of auction requirements, the electricity purchase agreement, the requirements for participation in the auction (RFQ), and the format of the offer for auction (RFP) will all be done within the framework of the project (Ministry of Energy of the Republic of Uzbekistan, 2022a).

The application of solar energy systems for subartesian wells, small, powerful mobile solar and battery energy systems, combined solar and heat pump energy systems for greenhouses, and energy systems for the thermal use of biomass energy in buildings have all been proposed as pilot project ideas within the framework of the project. An implementation strategy, stakeholders, and technical and economic analysis of the aforementioned pilot project concepts were all prepared to assist the growth of decentralized renewable energy.

Contracts with the Saudi Arabian and United Arab Emirates businesses were inked as part of renewable energy initiatives. According to the agreements, 122-megawatt wind power plant construction projects with a power firm and 122-megawatt solar power plant building projects with the company will be carried out. Both projects will receive 400 million dollars in foreign investment.

In terms of producing electricity from renewable energy sources, Uzbekistan lags behind a little. Along with all of this, the most crucial strategic objectives for Uzbekistan's utilization of renewable and alternative energy sources have been established. The primary objective is to reach 25% renewable energy investment in the nation's total energy balance by 2030 (Ministry of Energy of the Republic of Uzbekistan, 2020).

Discussion And Conclusion

Location choice is arguably the most crucial aspect of solar energy expenditures. Even if there is sunlight everywhere, factors like solar radiation, daily sundial, availability of electricity grids, and distance to local centres are particularly important when choosing a site (Apostolopoulos and Liargovas, 2016). In this regard, Aktas and Kabak (2019) used the analytical hierarchy process (AHP) and order preference methodology as the optimal solution methods based on fuzzy logic to investigate the best location for solar energy investments. Future initiatives can be influenced by the potential of Uzbekistan's sunny regions and the existing utilization of some of these potentials.

The increasing need for energy resources has given the interdependence that exists on a global basis now even more significance. Conflicts may arise as a result of the interdependence between nations' different approaches to gaining access to energy resources (Tutar et al., 2022).

The issues of energy scarcity from conventional sources are being addressed through the use of photovoltaic solar energy, a renewable energy source (Sampaio, 2017). The solar energy potential of Uzbekistan presents excellent opportunity for such ventures.

Studies have been done to determine how the adoption of solar photovoltaic (PV) technology will affect society and the economy (Khan, 2020). Income status, education level,

solar usage time, and customer satisfaction were among the characteristics that affected the purchase of solar energy, according to Yadav et al. (2019). The cost-benefit analysis of the proposed investment is one of the key factors in solar energy projects. The return on the investment and the profit to be made are the deciding elements in the investment because the initial capital expenditure is fairly expensive (Strantzali and Aravossis, 2016). With the correct approaches, this crucial issue should be resolved in a way that does not interfere with uninterrupted energy use. The first step toward self-improvement and major accomplishments will be getting Uzbekistan's energy products ready for export (Huseynli, 2022a). The debate over solar energy is a complicated one that takes into account numerous economic, social, and environmental factors. As a result, it is challenging to pinpoint a single particular strategy for solar investment (Li et al., 2021).

Anake and Wang (2015) claim that battery storage technology is a more established technology that is more dependable and widely available. Additionally, nations can stop relying on outside resources and start producing their own energy (Zhou et al., 2020). As a result, solar energy investments significantly reduce the nation's current account deficit (Li et al., 2021).

With the correct investments, Uzbekistan's solar energy potential will eventually enhance the country's energy exports. As is common knowledge, the oil and natural gas-rich nation of Uzbekistan exports these resources. The importance of Uzbekistan to Europe's energy security is well understood on a global scale. The significance of energy policy in economic growth will also be strengthened by identifying the potential of renewable energy sources as a strategic goal within the context of sustainability conditions. In terms of the nation's economic and energy policies, Uzbekistan's key goal, which is to have a 25% share of renewable energy in the country's entire energy balance by 2030, is particularly significant. Based on all of this, it can be concluded that solar energy policies will benefit the nation's economy in the years to come because of Uzbekistan's geographic location and its ability to provide infrastructure to developing nations.

List of used literature

1. Aktas, A., Kabak, M. (2019), A hybrid hesitant fuzzy decision-making approach for evaluating solar power plant location sites. Arabian Journal for Science and Engineering, 44(8), 7235-7247.

2. Anake, M., Wang, M. (2016), Energy storage technologies and real life applications-a state of the art review. Applied Energy, 179(1), 350-377.

3. Apostolopoulos, N., Liargovas, P. (2016), Regional parameters and solar energy enterprises: Purposive sampling and group AHP approach. International Journal of Energy Sector Management, 10(1), 19-37.

4. Avezova, N.R., Vokhidov, A.U., Farmonov, A.A., Dalmuradova, N.N. (2019), Renewable energy: Challenges and solutions. Applied Solar Energy, 55(2), 149-152.

5. Dale, S. (2019), BP Statistical Review of World Energy. London, United Kingdom: BP Plc. p14-16. Available from: https://www. imemo.ru/files/File/ru/events/2021/BP-2021.pdf [Last accessed on 2022 Jul 07].

6. Gielen, D., Boshell, F., Saygin, D., Bazilian, M.D., Wagner, N., Gorini, R. (2019), The role of renewable energy in the global energy transformation. Energy Strategy Reviews, 24, 38-50

7. International Renewable Energy Agency. (2019b), Bərpaolunan Enerji Mənbələrindən İstifadəyə Hazırlığın Qiymətləndirilməsi: Azərbaycan Respublikasında. Abu Dhabi: International Renewable Energy Agency. Available from: https://www.irena.org/-

/media/files/irena/agency/publication/2019/dec/irena_rra_azerbaijan_2019_AZ.PDF [Last accessed on 2022 Jun 27]

8. Khan, I. (2020), Impacts of energy decentralization viewed through the lens of the energy cultures framework: Solar home systems in the developing economies. Renewable and Sustainable Energy Reviews, 119, 109576
9. Plank, J., Doblinger, C. (2018), The firm-level innovation impact of public R&D funding: Evidence from the German renewable energy sector. Energy Policy, 113, 430-438.
10. Qiu, D., Dinçer, H., Yüksel, S., Ubay, G.G. (2020), Multi-faceted analysis of systematic risk-based wind energy investment decisions in E7 economies using modified hybrid modeling with IT2 fuzzy sets. Energies, 13(6), 1423.
11. Sampaio, P.G.V., González, M.O.A. (2017), Photovoltaic solar energy: Conceptual framework. Renewable and Sustainable Energy Reviews, 74, 590-601
12. Sharma, P., Kolhe, M.L. (2017), Review of sustainable solar hydrogen production using photon fuel on artificial leaf. International Journal of Hydrogen Energy, 42(36), 22704-22712.
13. Tutar, H., Sarkhanov, T., Guliyeva, N. (2022), Eastern Mediterranean area in energy security of the European union: From sea border issues to economic conflicts of interest. International Journal of Energy Economics and Policy, 12(1), 332-341
14. Usman, O., Akadiri, S.S., Adeshola, I. (2020), Role of renewable energy and globalization on ecological footprint in the USA: implications for environmental sustainability. Environmental Science and Pollution Research, 27(24), 30681-30693
15. Wilberforce, T., Baroutaji, A., El Hassan, Z., Thompson, J., Soudan, B., Olabi, A.G. (2019), Prospects and challenges of concentrated solar photovoltaics and enhanced geothermal energy technologies. Science of the Total Environment, 659, 851-861.
16. Xia, T., Ji, Q., Zhang, D., Han, J. (2019), Asymmetric and extreme influence of energy price changes on renewable energy stock performance. Journal of Cleaner Production, 241, 118338.
17. Yadav, P., Davies, P.J., Sarkodie, S.A. (2019), The prospects of decentralised solar energy home systems in rural communities: User experience, determinants, and impact of free solar power on the energy poverty cycle. Energy Strategy Reviews, 26, 100424
18. Yang, S., Zhu, X., Guo, W. (2018), Cost-benefit analysis for the concentrated solar power in China. Journal of Electrical and Computer Engineering, 2018, 1-11.
19. Yüksel, S., Dinçer, H., Meral, Y. (2019), Financial analysis of international energy trade: A strategic outlook for EU-15. Energies, 12(3), 431
20. Zhou, P., Zhou, P., Yüksel, S., Dinçer, H., Uluer, G.S. (2019), Balanced scorecard-based evaluation of sustainable energy investment projects with IT2 fuzzy hybrid decision making approach. Energies, 13(1), 82.
21. https://iea.blob.core.windows.net/assets/926d5a58-efa0-41a8-97cceec86c4d17b0/IEA-06_Uzbekistan-V4_WEB.pdf
22. https://www.iea.org/reports/solar-energy-policy-in-uzbekistan-a-roadmap/a-solar-energy-roadmap-for-uzbekistan-by-2030
23. https://www.oecd.org/countries/uzbekistan/solar-energy-policy-in-uzbekistan-d7cc3daf-en.htm
24. https://minenergy.uz