ISSN No:-2456-2165

Current Challenges and Future Prospects of Renewable Energy: A Case Study in Bangladesh

Md. Yeamim Chowdhuri
Dept. of EEE, Rajshahi University of Engineering & Technology
Dhaka Bangladesh

Erona Khatun
Dept. of EEE, Prime University
Dhaka, Bangladesh

Md. Momin Hossain
Dept. of EEE, World University of Bangladesh
Dhaka, Bangladesh

Md Abdul Halim
Dept. of EEE, Prime University
Dhaka, Bangladesh

Abstract:- The purpose of this study was to examine the installed capacity of renewable energy in developing nations, with a particular focus on Bangladesh, which is the world leader in the development of renewable energy, to ascertain the factors that contribute to progress. The usage of renewable electricity in developing nations was then explored in light of recent legislation and policies governing those systems. The findings show that the private sector's reluctance to participate in such countries' continued growth of renewable energy is mostly a result of high costs and a long wait for capital to be returned. It was proposed in this study that governmental assistance and the assurance of the purchase of electricity produced could help to somewhat alleviate the issues. But there are many obstacles to the deployment of renewable energy, including technological, financial, and legal ones. Economic difficulties include expensive capital costs and ambiguous returns on investment, while technical difficulties include system optimization, control, and administration. In order to promote investment in hybrid renewable energy systems, regulations that support the usage of renewable energy sources, such as feed-in tariffs and net metering, must be put in place. The effective implementation of mixed renewable energy systems will depend on the creation of standards and laws that encourage the incorporation of renewable energy sources into the current energy infrastructure. Despite these obstacles, mixed renewable energy systems have bright future prospects and hold great promise for contributing significantly to the shift to a sustainable energy future.

Keywords:- *Renewable Energy, Challenges, Energy Sources, Solar, Wind, Bangladesh, Obstacle.*

I. INTRODUCTION

Multiple renewable energy sources and energy storage technologies are combined in hybrid renewable energy systems, which offer great potential for a sustainable energy future [1]. However, there are many obstacles, including technological, financial, and legal ones, that must be overcome before these devices can be deployed. Future study must concentrate on creating energy storage technologies that are affordable, optimizing system design and management, and enhancing energy forecasting models in order to completely achieve the promise of hybrid green energy systems. In addition, regulations that encourage the use of green energy sources and their integration into the current energy grid must be put into place. Despite these obstacles, mixed renewable energy systems have bright future prospects and hold great promise for contributing significantly to the shift to a sustainable energy future. The pressing need to switch from traditional energy sources to sustainable and renewable energy sources is what motivates the study of present difficulties and future possibilities of hybrid renewable energy. Multiple renewable energy sources and energy storage technologies combined in hybrid renewable energy systems have the potential to increase energy efficiency and dependability. However, there are many obstacles, including technological, financial, and legal ones, that must be overcome before these devices can be deployed. A sustainable energy future will only be possible if these issues are resolved and these systems' efficacy and usefulness are increased. This study seeks to add to the creation of successful strategies and policies for the successful implementation of mixed renewable energy systems by finding the current challenges and examining the future possibilities.

"Hybrid renewable energy systems: Current status and future prospects" by S. Kumar and S. Kaushik, published in Renewable and Sustainable Energy Reviews in 2016. This paper provides an overview of the current status of hybrid renewable energy systems and discusses the various challenges and future prospects of this technology. "Review of Hybrid Renewable Energy Systems" by M. Bhandari, N. Kumar, and R. Kumar, published in Renewable and Sustainable Energy Reviews in 2021. This paper reviews the recent advances in hybrid renewable energy systems and provides insights into their design, optimization, and control. "Hybrid renewable energy systems for sustainable power generation: A review" by A. Thakur and S. Raman, published in Renewable Energy in 2018. This paper presents a

comprehensive review of the current status and future prospects of hybrid renewable energy systems, including their technical, economic, and environmental aspects. "Integration of renewable energy sources in hybrid power systems – Challenges and opportunities" by M. A. Mahmoud and A. A. El-Sakkary, published in Renewable and Sustainable Energy Reviews in 2021. This paper discusses the challenges and opportunities of integrating renewable energy sources in hybrid power systems, with a focus on their technical and economic aspects. "Optimization of hybrid renewable energy systems: A review" by S. Kumar and M. Kumar, published in Renewable and Sustainable Energy Reviews in 2018. This paper provides an overview of the optimization techniques used for hybrid renewable energy systems and discusses their advantages and limitations. "Design and Optimization of Hybrid Renewable Energy Systems: A Review" by R. Kumar and A. Kumar, published in Journal of Renewable and Sustainable Energy in 2018. This paper presents a review of the design and optimization techniques used for hybrid renewable energy systems, and discusses the challenges associated with integrating different renewable energy sources. "Techno-economic assessment of hybrid renewable energy systems: A review" by J. Garg and P. Sharma, published in Renewable and Sustainable Energy Reviews in 2017. This paper provides an overview of the techno-economic assessment of hybrid renewable energy systems, and discusses the factors that affect their economic viability. "A review of energy storage technologies for hybrid renewable energy systems" by M. A. Kashem and M. F. Hasan, published in Renewable and Sustainable Energy Reviews in 2020. This paper reviews the different energy storage technologies that can be used in hybrid renewable energy systems, and discusses their advantages and limitations. "Smart grid-enabled hybrid renewable energy systems: A review" by S. Kumar and S. Kaushik, published in Renewable and Sustainable Energy Reviews in 2018. This paper presents a review of smart grid-enabled hybrid renewable energy systems, and discusses their potential for improving the reliability and stability of power systems. "A review of optimization techniques for hybrid renewable energy systems" by R. Kumar and S. Singh, published in Renewable and Sustainable Energy Reviews in 2021. This paper provides a review of the optimization techniques used for hybrid renewable energy systems, and discusses their advantages and limitations.

A combination of factors including their capacity to boost the dependability and efficiency of renewable energy production, hybrid renewable energy systems mix two or more renewable energy sources to produce power. Hybrid renewable energy systems do, however, confront a number of difficulties, including fiscal, social, and technological ones. The expensive starting expenditure prices of hybrid renewable energy systems are one of their biggest obstacles. The initial costs associated with these technologies can prevent their adoption, especially in developing nations.

These devices can be expensive to implement, and emerging nations might not have the necessary equipment or resources. the coordination and administration of various energy sources. Multiple green energy sources must be integrated and managed by hybrid systems, which can be challenging and call for a high level of technological expertise. It is difficult to combine various energy sources effectively because they each have unique properties and equipment requirements. Because irregular renewable energy sources like solar and wind are needed to guarantee a consistent power supply, energy storage devices are necessary. Energy storage devices can be pricey, and the technology is still in its early stages, which creates problems with dependability and longevity. Hybrid green energy systems lack uniform technology and design. While these systems can be tailored to suit particular needs, this also means that technology and design are not standardized, which may cause technical problems and upkeep problems. In this paper we will discuss how to overcome from this problem.

II. RENEWABLE ENERGY SOURCES

The author first takes a quick look at capturing energy from ambient sources. Energy harvesting requires a variety of energy sources. In conclusion, designing and constructing an effective energy harvesting system requires a thorough understanding of the intended energy collecting source. There are many different energy sources available.

There are both large- and small-scale environmental energy sources among such ambient sources. Some of the ambient energy sources fall into the MACRO level range, while others fall into the MICRO level range [2]. Sources at the macro level, such as solar, wind, geothermal, hydroelectric, and nuclear sources, are amazing. Micro level sources are defined as vibration, mechanical strain, fluid, water, and human motion. Small scale electronics devices including sensor nodes, portable electronics, and medical equipment are better suited to be powered by micro scale energy sources. Energy harvesting is a technique for turning available energy sources into electricity without wasting any of them, and the energy produced can be stored for later use.

For small autonomous devices like wireless sensor networks, truly ambient sources, particularly high density sources, are essential for scavenging energy. Energy can be salvaged from a wide range of sources, such as solar energy, ocean waves, piezoelectricity, thermoelectricity, and mechanical vibrations. Some systems, for instance, transform random vibrations into useful electrical energy that wireless sensor nodes can employ for independent operation. Energy collecting sources should be chosen based on the application. In this section, a general review of various sources is covered in accordance with the characteristics of ambient sources [2]. Some renewable sources are shown in fig.1.

ISSN No:-2456-2165

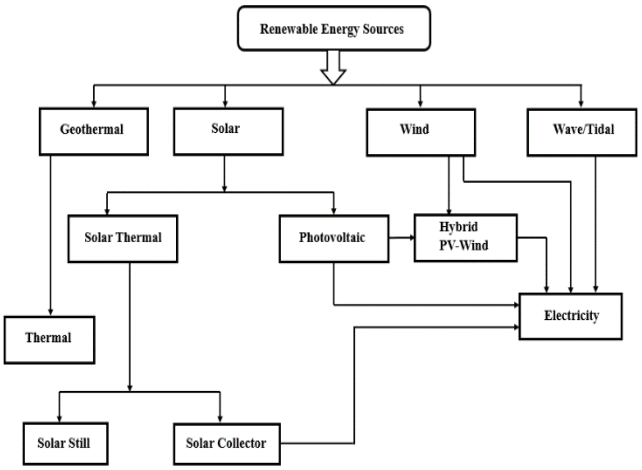

FIG 1: RENEWABLE ENERGY SOURCES.

III. ASSESSMENT OF RESOURCE POTENTIAL

Starting with the location selection procedure, there are several stages involved in hybrid green energy systems. In order to do this, it is necessary to pinpoint regions that have a high potential for green energy sources, such as those with powerful wind patterns, abundant sunlight, or substantial hydroelectric potential [4]. It is also necessary to take into account the supply of property, infrastructure, and transmission capability. Systems that use hybrid renewable energy blend two or more green energy sources to produce electricity. These systems have the potential to deliver dependable and affordable energy while reducing their negative effects on the ecosystem. When determining the resource potential of mixed green energy, keep the following points in mind:

➢ *Availability And Accessibility Of Renewable Energy Sources*

The abundance and usability of different renewable energy sources, such as sun, wind, geothermal, biomass, and hydropower, determine the economic potential of hybrid renewable energy [5]. Location, temperature, and other variables will affect which combination of energy sources is best.

➢ *Technological Developments*

To realize the maximum promise of hybrid green energy sources, technological developments are essential [6]. This covers advancements in energy storage systems, smart grid technology, and energy output optimization management systems.

➢ *Integration And Improvement Of The System*

To fully utilize the potential of hybrid systems, various green energy sources must be effectively integrated and optimized [7]. In order to develop a balanced and effective system that can satisfy energy demands while lowering expenses, various energy sources must be combined.

➢ *Financial Stability*

A crucial element to take into account is the fiscal feasibility of hybrid green energy systems. For hybrid systems to be widely adopted, their energy production costs must be comparable with those of conventional fossil fuels [8].

➢ *Environmental Impact*

By lowering greenhouse gas pollution and limiting environmental harm, hybrid renewable energy sources can benefit the ecosystem. However, it is still necessary to evaluate how the system will affect the ecosystem and to take action to lessen any unfavorable impacts.

➢ *Policy Backing*

Government and regulatory backing for hybrid renewable energy systems is crucial for their growth and uptake. Hybrid renewable energy can be supported by incentives like tax credits, feed-in tariffs, and renewable portfolio requirements to help it become more commercially feasible.

Table 1: Renewable energy sources with their advantages and disadvantages

Renewable Energy Source	Advantages	Disadvantages
Solar	Low running expenses, no emissions, and widespread availability.	Sporadic, reliant on weather, and affected by land use.[9]
Wind	Low running expenses, no emissions, and widespread availability.	Intermittent, effects of land use, and possible effects on animals.[10]
Biomass	Broadly accessible fuel that can be used for transit, electricity, and heating.	Broadly accessible fuel that can be used for transit, electricity, and heating.[11]
Geothermal	No emissions, great reliability, and the capacity to produce heat and energy simultaneously.	Low supply and expensive initial expenses.[12]
Wave	No emissions, steady source of electricity.	Low technology growth and expensive initial expenses.[13]
Vibration/ Kinetic	Numerous uses, possibly affordable.	Limited technological advancement and dependability issues.[14]

ISSN No:-2456-2165

IV. METHODOLOGY OF HYBRID RENEWABLE ENERGY GENERATION

To identify the potential of each renewable energy source, a resource evaluation is the first step in the production of hybrid renewable energy. Studying variables like wind speed, solar radiation, and water movement is part of this research. The information gathered at this point is used to guide the system building process. The system design stage entails picking the right parts, like wind turbines, solar panels, and water turbines, as well as sizing the system to supply the required amount of energy. For the system to produce the most electricity and cost-effectively, its parts must effectively cooperate.

After choosing the system parts, the next stage is to combine them into a functional system. To make sure the system's parts function properly, power devices like inverters and processors are used. Systems for generating mixed green energy must also include energy storage. Even when green energy sources are not accessible, energy storage technologies like batteries, pumped hydro storage, and compressed air energy storage help to maintain a constant flow of power. Hybrid renewable energy production systems must also have effective control and tracking mechanisms. These systems watch system performance and make changes as necessary using sensors, software, and communication networks.

The durability and dependability of the hybrid green energy system, ongoing operation and upkeep are necessary. To maintain the system's efficiency and extend its lifespan, routine checks, maintenance, and repairs are required. The production of hybrid green energy requires a sophisticated methodology that includes meticulous resource analysis, system design and integration, energy storage, management and monitoring, and ongoing upkeep. This approach can be used to develop a dependable, long-lasting supply of energy that lowers greenhouse gas emissions and aids in the fight against climate change.

V. COMPARISON OF ENERGY HARVESTING SOURCES

According to the description of all ambient sources, each source possesses some advantages and disadvantages. For example, using mechanical vibrations of different frequencies a good amount of power can be scavenged in mW range compared to constant frequency. Solar energy in an outdoor situation has the highest power density with hundreds of mW of power output, but is only available in the daytime. Wind can generate power in mW range using high temporal variations of wind. RF energy is available continuously (day and night). RF energy in the AM band has the longest energy harvesting distance among all RF energy sources without the limitation of line-of-sight propagation conditions. A table of various ambient sources with their efficiency, characteristics, output power and applications which is shown in table 2.

Table 2: Scavenged output power and efficiency of various ambient sources with their applications

Energy Source	Characteristic	Efficiency	Scavenged Power	Applications
Solar (Outdoors)	Inexhaustible, Clean with high absorption layer and sun tracker	6%-35% [15]	1350mW	Handheld Electronic Devices such as AC & DC Load
Solar (Indoors)	Inexhaustible, Clean with internal lighting	3%-7% [16]	621µW	Small scale electronics devices
Wind	High temporal variations	7%-20% [17]	0.77mW-439mW	National electrical grids and providing electricity to rural residences or grid-isolated locations.
Mechanical (vibration from machine)	Nonlinear frequency	20%-40%	200µW-40mW	Handheld Electronic Devices or Remote Wireless Actuators bearable electronics devices
Mechanical (vibration from human motion)	Linear and Non-linear frequency	10%-30%	0.84mW-4.13mW	Small scale electronics devices
Radio Frequency GSM 900	Longest wavelengths with smallest frequency	5%-15% [18]	1mW	Remote Wireless Sensors
Optical Light	Luminescent solar concentrator	6%-10%	100mW/cm2	Handheld Electronic Devices

ISSN No:-2456-2165

VI. CHALLENGES

➢ *Technological Challenges*

Various sustainable energy sources, such as solar, wind, and hydropower power, as well as energy storage technologies, like batteries or pumped hydro, are frequently used in hybrid systems [19]. Due to variations in each source's voltage, frequency, and output characteristics, it can be difficult to combine and maximize these various technologies so that they coexist harmoniously. The sporadic and unpredictable nature of green energy sources. For instance, weather-related energy sources like solar and wind can generate electricity sporadically. The electricity infrastructure may become unstable as a result, making it challenging to satisfy demand during peak hours. Hybrid systems must incorporate energy storage technologies to both store surplus energy during periods of high production and release it during periods of low production in order to overcome this problem. Energy storage is frequently needed in hybrid renewable energy systems to guarantee a steady flow of electricity, particularly during times when the output from the renewable sources is minimal. To maximize the storage and discharge of energy, new technologies and methods must be developed because energy storage can be costly and physically difficult.

➢ *Financial Challenges*

The expensive original outlay needed to develop and implement hybrid green energy systems. These systems frequently call for a sizable quantity of infrastructure, such as energy storage facilities, wind generators, and solar panels, all of which can be costly to place and keep [20]. Adoption may be hampered by this, particularly in developing nations or in groups with scant financial means. Hybrid renewable energy system funding methods can be difficult to understand, particularly in the absence of a mature market for these products. To support the implementation of these systems and guarantee that they are available to a broad variety of stakeholders, creative financing methods, such as green bonds or crowdsourcing, may be required.

➢ *Environmental Challenges*

Although renewable energy sources have the potential to lower greenhouse gas pollution and lessen climate change, they also present a number of environmental difficulties that must be resolved if they are to be sustainable and provide long-term advantages [22]. The environmental effect of the materials used in the building of hybrid renewable energy systems is one of their environmental problems. A lot of the raw materials needed for solar cells, wind generators, and energy storage devices are removed using harmful environmental practices. These materials' production and removal may harm the ecosystem by polluting the environment and destroying habitats. Wind Turbine and solar panel installations can harm local environments and habitats while wind mills have been linked to bird and bat deaths. Installations for green energy can be carefully planned and managed to reduce these effects and safeguard delicate environments.

➢ *Socio-Political Challenges*

The laws, rules, and societal norms that influence the energy industry and the larger socioeconomic setting in which green energy is used [23] . The influence of special interests in the conventional energy industry is a sociopolitical issue. In order to advance their own interests, fossil fuel corporations and other energy incumbents may oppose the implementation of green energy systems through legislative lobbying or direct action. This may hinder the installation of green energy technologies and impede the shift to a more sustainable energy future. It is challenging for renewable energy systems to contend on an even playing field in many nations because the regulatory climate is still geared toward promoting fossil fuels and other non-renewable energy sources. These obstacles can be overcome with the aid of policies that encourage the use of renewable energy, such as feed-in prices and renewable portfolio requirements.

VII. DISCUSSION

Like many other nations, Bangladesh is having a difficult time meeting its rising energy needs while also lowering its ecological impact. The nation has set lofty goals for the use of renewable energy, aiming to produce 10% of its power from these sources by 2021 and 40% by 2041. Bangladesh is looking into the viability of mixed renewable energy systems that combine solar, wind, and other green sources to meet these goals. In Bangladesh, the absence of a helpful policy and legislative climate is one of the present obstacles to the implementation of mixed renewable energy systems. There aren't many incentives or policies in place to support the implementation of green energy systems, and the legislative structure as it stands is oriented toward conventional fossil fuel sources. In terms of prices and expenditure, this has made it challenging for green energy initiatives to compete with fossil fuel-based energy production. Financing options for green energy initiatives are scarce. Due to perceived risks or a lack of familiarity with the technology, banks and other financial organizations may be reluctant to engage in green energy initiatives. Due to this, there is currently a funding gap that needs to be closed in order to hasten the adoption of hybrid green energy systems. Bangladesh's dearth of technological know-how and facilities can also present difficulties. The nation must improve its infrastructure and technological capabilities in order to successfully develop, implement, and manage mixed renewable energy systems. This necessitates spending on educational initiatives, research and development, and expanding the local green energy equipment supply chain. The introduction of hybrid green energy systems in Bangladesh also has bright possibilities. The nation's environment is ideal for producing green energy, and there are plenty of solar and wind resources available. International groups and financiers are also becoming more interested in and supportive, which may help close the funding gap and support the growth of green energy initiatives.

VIII. CONCLUSION AND FUTURE WORK

Renewable energy systems have the potential to significantly reduce greenhouse gas emissions while supplying a sustainable and dependable source of energy to satisfy the increasing demand. However, there are a number of obstacles to the implementation of these systems, including ones related to technology, money, the environment, socio politics, and regulations. Given the rising demand for renewable energy sources, the falling cost of renewable energy technologies, and the expanding knowledge and support for the use of renewable energy sources, the future prospects for mixed renewable energy systems appear bright in Bangladesh. However, lawmakers, financiers, researchers, and other stakeholders will need to work together to solve the present issues in Bangladesh. There are many mixed renewable energy systems, and it is anticipated that renewable energy will contribute more and more to fulfilling the world's energy needs. The efficacy and dependability of hybrid renewable energy systems can be further improved by developments in energy storage technologies, smart grid architectures, and renewable energy predictions. Make sure that everyone has access to a safe and fair energy future by tackling the issues and capitalizing on the opportunities.

REFERENCES

[1]. Tang, L., Yang, Y., & Soh, C. K. (2013). Broadband vibration energy harvesting techniques. Advances in energy harvesting methods, 17-61.
[2]. Abrol, S., & Chhabra, D. (2017). Harvesting piezoelectricity using different structures by utilizing fluid flow interactions. International Journal of R & D in Engineering, Science and Management, 5(7), 24-36.].
[3]. Cao, S., & Li, J. (2017). A survey on ambient energy sources and harvesting methods for structural health monitoring applications. Advances in Mechanical Engineering, 9(4), 1687814017696210. solar cells using SCAPS simulation program. Superlattices and Microstructures, 82, 248-261.
[4]. Holechek, J. L., Geli, H. M., Sawalhah, M. N., & Valdez, R. (2022). A global assessment: can renewable energy replace fossil fuels by 2050?. Sustainability, 14(8), 4792.
[5]. Khan, S. A. R., Godil, D. I., Yu, Z., Abbas, F., & Shamim, M. A. (2022). Adoption of renewable energy sources, low-carbon initiatives, and advanced logistical infrastructure—an step toward integrated global progress. Sustainable Development, 30(1), 275-288.
[6]. Suki, N. M., Suki, N. M., Sharif, A., Afshan, S., & Jermsittiparsert, K. (2022). The role of technology innovation and renewable energy in reducing environmental degradation in Malaysia: A step towards sustainable environment. Renewable Energy, 182, 245-253.
[7]. Chen, Y., Xu, J., Wang, J., Lund, P. D., & Wang, D. (2022). Configuration optimization and selection of a photovoltaic-gas integrated energy system considering renewable energy penetration in power grid. Energy Conversion and Management, 254, 115260.
[8]. Qi, X., Wang, J., Królczyk, G., Gardoni, P., & Li, Z. (2022). Sustainability analysis of a hybrid renewable power system with battery storage for islands application. Journal of Energy Storage, 50, 104682.
[9]. Kumar, V., & Kaushik, A. K. (2022). Solar rooftop adoption among Indian households: a structural equation modeling analysis. Journal of Social Marketing, (ahead-of-print).
[10]. Roga, S., Bardhan, S., Kumar, Y., & Dubey, S. K. (2022). Recent technology and challenges of wind energy generation: A review. Sustainable Energy Technologies and Assessments, 52, 102239.
[11]. Wu, Y., Ghalkhani, M., Afshar, E. A., Karimi, F., Xia, C., Van Le, Q., & Vasseghian, Y. (2022). Recent progress in Biomass-derived nanoelectrocatalysts for the sustainable energy development. Fuel, 323, 124349.
[12]. Milousi, M., Pappas, A., Vouros, A. P., Mihalakakou, G., Souliotis, M., & Papaefthimiou, S. (2022). Evaluating the Technical and Environmental Capabilities of Geothermal Systems through Life Cycle Assessment. Energies, 15(15), 5673.
[13]. Song, Y., Liu, P., Zhou, R., Zhu, R., & Kong, J. (2022). SiBNCx ceramics derived from single source polymeric precursor with controllable carbon structures for highly efficient electromagnetic wave absorption at high temperature. Carbon, 188, 12-24.
[14]. Halim, M. A., Hossain, M. M., & Nahar, M. J. (2022). Development of a Nonlinear Harvesting Mechanism from Wide Band Vibrations. International Journal of Robotics and Control Systems, 2(3), 467-476.
[15]. Hamzat, A. K., Omisanya, M. I., Sahin, A. Z., Oyetunji, O. R., & Olaitan, N. A. (2022). Application of nanofluid in solar energy harvesting devices: A comprehensive review. Energy Conversion and Management, 266, 115790.
[16]. Khan, R., Kumar, R., & Ma, Z. (2022). Experimental investigations on the performance characteristics of plastic surfaces for developing low flow falling film liquid desiccant regenerators. Solar Energy, 236, 356-368.
[17]. Cao, Y., Taslimi, M. S., Dastjerdi, S. M., Ahmadi, P., & Ashjaee, M. (2022). Design, dynamic simulation, and optimal size selection of a hybrid solar/wind and battery-based system for off-grid energy supply. Renewable Energy, 187, 1082-1099.
[18]. Mansour, M., Mansour, I., & Zekry, A. (2022). A reconfigurable class-F radio frequency voltage doubler from 650 MHz to 900 MHz for energy harvesting applications. Alexandria Engineering Journal, 61(10), 8277-8287.
[19]. Salah, S. I., Eltaweel, M., & Abeykoon, C. (2022). Towards a sustainable energy future for Egypt: A systematic review of renewable energy sources, technologies, challenges, and recommendations. Cleaner Engineering and Technology, 100497.
[20]. Akadiri, S. S., & Adebayo, T. S. (2022). Asymmetric nexus among financial globalization, non-renewable energy, renewable energy use, economic growth, and carbon emissions: impact on environmental sustainability targets in India. Environmental Science and Pollution Research, 29(11), 16311-16323.

[21]. Zhang, L., Xu, M., Chen, H., Li, Y., & Chen, S. (2022). Globalization, green economy and environmental challenges: state of the art review for practical implications. Frontiers in Environmental Science, 10, 199.
[22]. Al-Shetwi, A. Q. (2022). Sustainable development of renewable energy integrated power sector: Trends, environmental impacts, and recent challenges. Science of The Total Environment, 153645.
[23]. Al-Shetwi, A. Q. (2022). Sustainable development of renewable energy integrated power sector: Trends, environmental impacts, and recent challenges. Science of The Total Environment, 153645.