TOWARDS SUSTAINABLE FUTURE: EXPLORING RENEWABLE ENERGY SOLUTIONS AND ENVIRONMENTAL IMPACTS

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Highlights

Towards Sustainable Future.

Abstract

The shift towards a low-carbon society relies on electrifying Renewable Energy Sources (RES). Energy projects have led to an increase in social divisiveness in certain countries. Hence, worldwide, governmental, and legislative entities - local, geographic, national, and global - exhibit significant apprehension over the environmental consequences and risk elements that shape the energy paradigms. Therefore, to mitigate and restrict the problems related to environmental insecurity, the globe must take prompt and efficient measures to safeguard the climate for a more promising future. It must actively seek alternate energy options while decreasing its reliance on petroleum-based energy sources. In light of this pressing matter, this research aims to showcase the capabilities of several RES, such as wind, solar, hydroelectric, and biomass. The research briefly summarizes energy-related issues and prospects, followed by a comparative analysis of RES and non-RES. A comprehensive overview of several Sustainable Energy Sources (SES), such as wind, solar, hydroelectricity, and biomass, is provided, accompanied by pertinent illustrations and statistical data on the global energy potential of each source. The paper addresses risk factors, offers closing observations, and presents future guidance in its final sections.

Keywords

renewable energy; sustainability; environmental impacts; sustainable development.

Overview of Renewable Energy Sources

Energy is essential for promoting economic and human progress and meeting the basic demands of daily life. In 2019, the global power production amounted to more than 26 terawatt-hours (TWh). The power was produced using various sources, primarily fossil fuels and nuclear and other Renewable Energy Sources (RES) such as biological, wind, hydroelectricity, and solar [1]. The primary contributor to worldwide greenhouse gas pollution is directly linked to the power manufacturing and consumption system. Greenhouse gases are widely recognized as the primary cause of climate change.

Many nations actively strive to diversify their energy production methods to facilitate a transition to cleaner energy sources. This transition entails a shift from generating energy from systems emitting a substantial quantity of greenhouse gases to those with little or no pollutants. The Paris Agreement, a consensus reached by more than 180 participating countries of the United Nations Framework Committee on Climatic Change, establishes a

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worldwide roadmap for transitioning to RES [2]. A primary goal is to decrease greenhouse gas releases by promoting the adoption of lower carbon sources to limit the average world temperature rise to less than 2°C compared to pre-industrial rates. According to the International Energy Agency (IEA), fossil fuels account for two-thirds of global power generation [3]. Therefore, to achieve the climatic targets by 2050, producing at least 80% of energy from lower carbon resources will be necessary.

Energy is essential for progress, and Sustainable Energy Systems (SES) are necessary for long-term and environmentally friendly growth [4]. Although certain countries have made significant progress in adopting RES, such as accomplishing double-digit proportions in power supply, several nations and industries, such as transportation, are still in the early stages of incorporating RES. The geographical location mainly determines the use of RES since it is customized to the RES that are locally accessible. Therefore, shifting towards RES necessitates evaluating available resources, implementing suitable methods, and establishing systems capable of effectively incorporating these sources to satisfy energy needs promptly.

The Renewable Energy Independent Energy Provider Purchasing Project has been praised for its ability to attract private sector participation in the RES industry [5]. The result is for a more thorough examination of RES as viable options for power production in the power mix. Advancing RES and energy-efficient technology is crucial in achieving a sustainable future.

The following sections are arranged: The section discusses the background of RES and non-RES. Section 3 discusses the potential of renewable energy resources and their impact on sustainability and the environment. Section 4 concludes the research with findings.

Background of the Studies

To what extent is RES exclusively devoted to the particularly advantageous energy source derived from fossil fuels? The demand for additional assets is heightened when populations grow at a rate above the median of 2%. The correlation between high quality of life and energy usage is evident since affluent developed nations, representing 25% of the global population, utilize 75% of the world's energy resources [6]. The issues about electricity and its use are not just limited to climate change but also include environmental contamination, acid precipitation, ozone depletion, habitat destruction, and nuclear discharges. To achieve a positive future in energy with minimal environmental consequences, it is imperative to solve these issues together. Abundant data indicates that human activities that harm the environment would have a detrimental influence on the future. Both oil firms and the general public have been increasingly focusing on specific issues related to the environment [7]. There is a growing consensus that customers are responsible for pollution and the associated expenses. In several nations throughout the last 10 to 20 years, the prices of these natural resources have increased to offset environmental costs partly. By the mid-21st century, it is expected that the world populace will double, and there is a high likelihood that economic development will persistently increase.

The demand for global energy is forecasted to double by 2050, while essential oil production is anticipated to expand by 1.5 to 3 times [8]. The issue will inevitably exacerbate energy-related ecological problems, such as acid precipitation, degradation of stratospheric ozone, and worldwide climate change. One proposed solution to the unavoidable scarcity of power is to use RES and technologies further. This cause is bolstered by an intense passion that results in unwarranted and improbable assertions. Infrastructure feasibility will be assessed based on practicality, performance, application, environmental impact, lack of supplies, and public acceptability. All power sources provide a consistent supply of energy. The fluctuation in sea levels, known as tidal fluctuation, is primarily driven by the gravitational forces exerted by the moon and sun and the geothermal activity resulting from a significant decrease in the Earth's temperature [9]. Various potential energy providers exist, but their underlying principle remains unknown.

Considerable research investment is allocated to the project to identify a viable engineering solution. The scientific understanding of the process is very straightforward, whereas the engineering aspect presents more difficulties. Regarding earlier assertions, it is essential to note that energy is a crucial aspect to be discussed in environmentally friendly conversations. Several notions of sustainability were proposed, including growth that satisfies current needs without compromising the well-being of future populations. Multiple factors will lead to

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long-term and environmentally responsible expansion [10]. One of the most important aspects is the requirement for a complete SES. A reliable energy supply is commonly acknowledged as a necessary but insufficient condition for community progress. Adequate progress within a system necessitates the ample accessibility of energy resources that are both freely and readily available, are cost-effective in the long run, and can be utilized for all essential reasons without causing negative social consequences. It requires the practical and effective utilization of RES. The connection between RES and environmental stability becomes apparent.

Renewable Energy Potential

Wind and Wave Power Resource Availability

Due to limitations imposed by terrain and neighbor concerns, wind resources on land are becoming more constrained. Efforts are being focused on offshore initiatives to meet the substantial rise in RES demand projected in different scenarios. The wind resources in this area are generally favorable due to the geography. Wave power generation also has promise in offshore areas.

Aydoğan et al. examine the possibilities of harnessing wave and wind energy in the Black Sea [11]. The findings indicate suitable locations for installing wind-wave integrated power generation systems along the Romanian coastline and the eastern part of Ukraine. These systems have the potential to be a significant contributor to the long-term development of the electrical grid. Both studies address the same subject: wind energy in the Black Sea area. However, they aim to provide projections for the following thirty years instead of examining past events.

Using 17 years of reanalysis information, Li et al. evaluate the possibilities for harnessing wave and wind energy at 10 locations in the Atlantic Ocean, spanning from Portugal to Russia in Europe [12]. They study ten locations off the coastline of the Americas. The most promising potential for energy resources is identified in Ireland and Tierra del Fuego. Wave energy technologies have much lower capacity ratios in comparison to wind turbines. It is determined that the coastal region of the Black Sea has dependable wind and wave supplies that will be used to construct SES in the future.

Ifaei et al. conducted a financial evaluation of RES to determine the most efficient and sustainable approach for developing power systems in Korea's micro-grid, off-grid, and on-grid scenarios [13]. The ability to use RES, such as wind and solar sources, was determined using weather information from 28 locations throughout Korea. In addition, a fuel cell and diesel engine generation were chosen as the primary power source, while a battery storage device was added to optimize energy administration. The findings indicate that integrating various energy sources is efficiently used to enhance the sustainability of the electrical grid.

Sandesh et al. examine the short-term advancements in wave power possibilities based on two distinct greenhouse gas emission paths: the Intergovernmental Committee on Climate Change's Regional Concentration Pathways (RCP) 4.5 and 8.5 [14]. Under route 4.5, the Black Sea experiences a rise in wave power ranging from 5 to 16% due to increased wind speeds. However, under pathway 8.5, the rise is twice as significant. In addition, the average values were computed for every interval, and a linear regression analysis was conducted on the dataset. There were no meaningful patterns observed.

Özel et al. conducted a study on implementing wave energy converters in Eregli, a coastal region on the western shore of the Black Sea in Turkey [15]. The aim was to enhance the dependability and sustainability of a power system primarily dependent on local resources. The findings indicate that wave energy generation is more appropriate, particularly in the first stages, for coastal conversions in Eregli. The research region has geological characteristics make it well-suited for implementing alternating water column and tapering channel technologies. The approval of Wave Energy's appropriateness for SES has been confirmed.

Wind Power Technology

Fuglestvedt et al. examine the short-term advancements in wave power possibilities based on two distinct greenhouse gas emission paths: the Intergovernmental Committee on Climate Change's RCP 4.5 and 8.5 [16]. Under route 4.5, the Black Sea experiences a rise in wave energy ranging from 5 to 16% due to increased wind speeds. Under pathway 8.5, the rise is twice as significant. In addition, the average values were computed for

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Solar Electricity

Medghalchi et al. utilized the energy systems simulation framework to examine a configuration including a solar system and power storage using an electrolyzer, a reservoir for hydrogen, and a fuel cell [18]. The findings indicate that substantial high-pressure storage is necessary. The efficiency of the technology could be improved and would need to be reduced by 75% to be comparable with grid power.

Baz et al. studied the shift from fossil fuels to a solar PV combination [19]. They evaluated its technological and economic aspects to promote the growth of an SES in the Philippines. According to their findings, the price of electricity in off-grid regions, where it relies entirely on fossil fuels, is exorbitant. Latest deployments have shown that hybrid structures that utilize RES are cost-effective alternatives to current power plants. The findings indicate that islands in the Philippines provide substantial economic opportunities for transitioning from diesel to solar PV-battery-diesel hybridization technologies. This transition offers a mean savings of 20% in levelized costs, which is very important for achieving the sustainable growth objectives of the local population.

Lizana et al. examine the potential of integrating photovoltaic arrays with small-scale biological Rankine cycle structures and determine that this approach is economically viable [20]. The findings validate the use of these systems for small-scale residential uses, especially in cold temperature conditions. The inner rate of return exceeds 15%, and the payback period is short, at 3.1 years.

Zeng et al. studied a ground-source thermal pumping plant powered by solar energy to evaluate its effects on the electrical grid [21]. An index is introduced to quantify the impact of a structure on the power grid. This index is calculated by summing the inflow and the outflow of the building and dividing it by the building's energy consumption. In terms of the primary source of energy and emissions, the technical solution shows favorable results relative to traditional options. Using batteries increases household energy use while reducing the strain on the power system.

Recent research has shown that solar energy is harnessed to provide environmentally friendly RES via photovoltaic panels, solar concentrators, and Stirling engines. Solar power on electrical grids enhances voltage excellence, and the evaluation of RES demonstrates its viability in multiple energy sources from both a sustainable and economic standpoint.

Solar Heating/Cooling

Alahmer et al. are primarily interested in solar fields utilized in district cooling systems [22]. They examine the system's performance when integrated with a borehole thermal reservoir. The simulation includes evacuated tube structures and flat panels paired with photovoltaic panels for collecting sunlight. All pairings exhibit favorable ecological and financial advantages compared to conventional fossil options, resulting in decreased CO_2 emissions at prices ranging from 0.12 to 0.97 V/t.

Khandelwal et al. model the performance of solar thermal power plants integrated with a storage system that undergoes charging and discharging via heat transfer [23]. O'Neil et al. conducted experimental investigations on evacuation tube solar absorbers combined with heat storage for residential setups [24]. Their trials in Mediterranean circumstances demonstrate an effectiveness of 62%, the ratio between the solar input and the

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resultant amount of warm water from the collection system. After accounting for losses incurred during the conversion of solar irradiance to hot water consumption, the effectiveness decreases to 51.6%.

RES to power construction heating is crucial due to the significant energy requirement of the warming sector in electrical systems [25]. Solar energy is extensively utilized for enhancing heating systems in individual constructions, incorporating traditional district warming plants, offering power for solar desalination systems, integrating with digestion and adsorption freezers, and supplying heat for solar-powered dryers utilized to dry crop drying.

Roumpedakis et al. present the ZEOSOL project, which aims to provide a scientifically grounded description of photovoltaic cooling system elements and formulate strategies for developing solar cooling structures [26]. The findings validate the sizing methodology used to calculate power savings over a year, which vary from 35 to 89% when comparing Riyadh to Berlin.

Tan et al. examined the function of excellent heat energy storage in incorporating RES and lowering peak loads [27]. They stressed that utilizing RES in established sustainable structures is a potential alternative. Nevertheless, using cooling thermal power storage might significantly impact the control of high-demand periods and address the issue of intermittent power generation from RES. The findings indicated that the cooling and associated compression loads are heavily influenced by the ambient conditions, leading to reduced load coefficients and the use of machinery that is too large.

Calautit et al. examine the potential of windcatchers integrated with heat pipes as alternate solutions for cooling and improving indoor air quality [28]. By doing models and experiments, they discovered that the system can decrease temperatures by as much as 10 degrees Celsius in summertime.

Sun et al. similarly examine the possibilities of cooling and heating buildings, although they focus specifically on ventilated sun spaces [29]. Balconies provide the greenhouse impact by trapping heat during the winter season. However, they are left open during the summer to reduce this localized climate change.

Relationship

Every year, information on all observable parameters necessary for the prospective creation of this empirical evaluation is gathered from each nation in the World Bank dataset. Most of the effect uses a predetermined set of observable characteristics at the level of empirical measurement. In the case of complex and difficult-to-measure topics such as logistical performance, financial growth, and environmental deterioration, it's increasingly essential to create underlying concepts utilizing various observable indicators. It devised a collection of hidden variables with several occurrences. As a result, Structural Equation Modeling (SEM) was chosen as the optimal analytical approach [30]. The minimal sample size required for SEM analysis is 100. This research combined information from seven years, resulting in 541 assessments, excluding any records with missing values. Figure 1 shows the relationship between RES and environmental impacts.

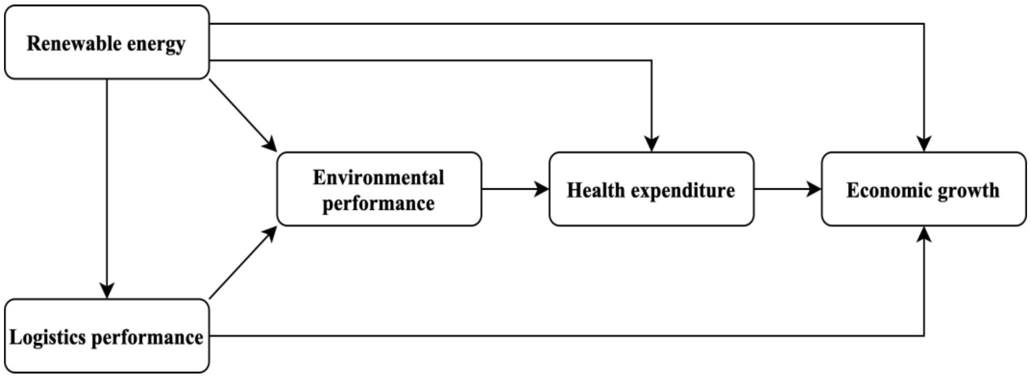

Fig. 1. Relationship between RES and environmental impacts

RES construction consists of a single observable variable, representing using RES in a nation's logistical and economic processes. The statistics on RES are derived from the proportion of the overall final energy consumption in each respective country. General health expenditures are determined by a single observable variable, encompassing the healthcare items and services used to assist patients, such as those with asthma, lung malignancies, and illnesses caused by outdoor pollution. Studies have shown a rise in pollution-related diseases in developing countries, primarily due to the combustion of coal and fossil fuels. It was cautioned that emerging nations must establish policies to safeguard their socio-environmental stability.

The logistics efficiency framework has primarily four metrics. The logistics performance gauge measures the proficiency and excellence of logistics services. The user refers to three components of the logistical performance index: the ease of organizing inexpensive deliveries, the quality of the trading and transport-related facilities, and the effectiveness of the border-clearing procedure. Prior academics used index information to quantify logistics efficiency in Asian and European countries.

The logistics effectiveness information is derived from empirical polling information systematically gathered by the World Bank. The Logistics Performance Indicator is assessed at the national or regional level by soliciting input from local businesses about the efficiency and user-friendliness of the transportation system in their respective countries. The Likert scale information goes from 1 to 5, with 1 indicating poor logistical performance and 5 indicating excellent logistical performance.

Sustainability and Environmental Impacts

The traditional energy paradigm must be revised to address these significant political and social issues. The circumstances have necessitated a fundamental change in the energy policy framework. There needs to be more supply assurance and environmental adaptation in the strategy to fulfill the energy demand.

Balcioglu et al. examine the ecological stability of three biomass-for-power methods: combustion, gas extraction, and anaerobic digestion, using a life-cycle analysis approach [31]. The investigations primarily review paddy and coconut leftovers' burning and gasification processes for biogas generation. It does not include an in-depth comparison among various applications of biomass assets. Among these options, using manure for biogas production is considered the most favorable approach across several effect categories in Life Cycle Assessment (LCA). Many impact subcategories indicate that manure used for biogas production has negative effects. This results from the adverse environmental consequences of leaving animal waste on the ground.

Taherahmadi et al. introduced a viable power system and simulated electricity demand and supply issues in Ebino, Japan [32]. An analysis was conducted to determine the most significant capacity of SES that can be supplied to the town and the power demand. The results showed that the city's power consumption is around 162 GWh/year, and the annual carbon dioxide released from electricity generation is 84,570 tons. Various scenarios, including varying proportions of RES, are suggested and simulated. The findings indicate that the city had significant potential for augmenting the proportion of RES. The stock can rise from 10 to 54.2% between 2010 and 2020, positioning it as one of Japan's most RES settlements.

Richa et al. examine the ecological viability of biomass utilization, emphasizing releasing tiny particles resulting from burning beech lumber [33]. Upon analyzing the quantity of small particles released in controlled laboratory settings, the researchers discovered emissions within $2e^{9}$%. They observed a declining pattern in emissions as the level of oxygen was raised. They highlight the significant health expenses associated with air pollution, emphasizing the need to include them in optimizing plant architecture. From a broader systems viewpoint, prior research has also suggested that biomass should be allocated for uses when no substitutes are available.

Rani et al. conducted a study on providing heaters and power for SES and self-sufficiency in small towns in the Spanish city of Uruena [34]. The study focused on using bioenergy and other locally accessible sources of energy. The design of a new district heating system was evaluated, which included a photovoltaic array, a biomass facility using hay as an SES for continuous supply, and a petroleum-based boiler for high-demand periods. These components were integrated with a hot water storage vessel. The findings show that the expense of implementing extensive power storage is contingent upon the specific use of the apparatus and often necessitates substantial initial financial outlay.

Malozyomov et al. explore an autonomous power supply system fueled by RES to establish an SES [35]. It is emphasized that achieving sustainable economic growth necessitates using RES logically and deliberately. The project aims to create an autonomous power supply system using a combination of energy sources. The fundamental system comprises a backup power source, a primary power source, an energy-storing device, a second power source, a weather administrator, and stations. The suggested system is designed to address energy deficiencies in the neighborhood network autonomously.

Adekanbi et al. devised a technique for incorporating wind power using clever electric water heating [36]. The study is centered on the depletion of fossil fuel supplies and the need to decrease the production of greenhouse gases across a wide array of potential scenarios for future electrical systems. The findings are contrasted to determine which control approach shown has the most significant potential for achieving system residual price savings, energy efficiency, and successful incorporation of wind energy, hence steering the system toward sustainability.

Prata et al. examine the environmental services provided to the human race from a review standpoint [37]. Most studies in the energy ecological services domain focus on hydropower and its associated concerns, such as the reliance on the preservation of forests, soil loss, and the effects on rivers. The key results highlight the potential for enhancing the strategy to expand RES in future planning. The findings suggest that implementing RES infrastructure planning has favorable prospects for improving the environmental service by increasing its application to the first phases.

Khan et al. conduct comprehensive socioeconomic and financial assessments of the conversion of district cooling systems from bioenergy to heat exchangers [38]. They use the Danish island of Samsø as a specific example for their research. Danish region heating businesses are financially incentivized to transition from small-scale Combined Heat and Power (CHP) to biomass boiler-based region heating manufacturing. However, heat pumps are a more suitable option for the energy system as they effectively incorporate variable power sources and allow biomass to be used for applications that require stored energy. The study has been utilized in several local heating and CHP study assessments and has acted as a crucial tool for designing CHP plants in Denmark and Germany.

Conclusion and Discussions

The rapid and uncontrolled expansion of urbanization and industrialization and the population increase in developing nations present a substantial danger to ecological health and human well-being. Scientists, technicians, elected officials, and politicians in several countries are actively addressing the significant issue of environmental contamination. The influence of public opinion on environmental concerns, such as deforestation and global warming, is apparent on social media platforms. The worldwide progress of environmental science and technology has profoundly impacted the restoration of various chemicals and polluted regions and the development of sophisticated wastewater treatment plants and remediation methods to prevent contamination and conserve assets.

The significance of RES is well recognized for its role in safeguarding the environment. Energy serves as the interchangeable currency for technology. The whole framework of human civilization would collapse without power; the consequences of a 24-hour decrease in electricity supply to a metropolis demonstrate our heavy dependence on this valuable energy source. Utilizing RES and technology is essential to achieving sustainable development. RES provides three crucial functions.

1. RES requires a much lower environmental effect than conventional energy sources to protect the environment and fulfill energy requirements. However, they can't achieve zero environmental impact. The move to RES offers several practical choices that result in a much greener power system than just tightening standard energy management.

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2. Unlike fossil fuel and uranium sources, RES are inexhaustible. They can provide a reliable and enduring energy source when utilized safely and appropriately. The availability of fossil fuel and uranium is restricted due to their scarcity and constrained by the processes of extraction and use.
3. It advocates decentralizing the RES and implementing regional remedies that are relatively autonomous from the national power grid. This approach enhances the system's adaptability and improves the economic provision of power for distant and isolated areas. Hence, several viable technology alternatives for harnessing RES to meet major urban areas' energy demands exist.

References

[1] A. Rahman, O. Farrok, M.M. Haque, Environmental impact of renewable energy source based electrical power plants: Solar, wind, hydroelectric, biomass, geothermal, tidal, ocean, and osmotic, Renewable and Sustainable Energy Reviews, 161 (2022).

[2] S.T. Zaman, The Energy Transition Under the Paris Agreement: Assessing the Existing Normative Directions, Environs: Env't L. & Pol'y J., 46, 201, 2022.

[3] T. Kober, H.W. Schiffer, M. Densing, E. Panos, Global energy perspectives to 2060–WEC's World Energy Scenarios, Energy Strategy Reviews, 31 (2020). https://doi.org/10.1016/j.esr.2020.100523

[4] G.L. Kyriakopoulos, Should low-carbon energy technologies be envisaged in the context of sustainable energy systems?, In Low carbon energy technologies in sustainable energy systems, (2021) 357-389.

[5] G. Chebotareva, W. Strielkowski, D. Streimikiene, Risk assessment in renewable energy projects: A case of Russia, Journal of Cleaner Production, 269 (2020). https://doi.org/10.1016/j.jclepro.2020.122110.

[6] I. Khan, F. Hou, H.P. Le, The impact of natural resources, energy consumption, and population growth on environmental quality: Fresh evidence from the United States of America, Science of the Total Environment, 754 (2021). https://doi.org/10.1016/j.scitotenv.2020.142222

[7] R.J. Brulle, M. Aronczyk, J. Carmichael, Corporate promotion and climate change: an analysis of key variables affecting advertising spending by major oil corporations 1986–2015, Climatic Change, 159 (2020) 87-101.

[8] T. Ahmad, D. Zhang, A critical review of comparative global historical energy consumption and future demand: The story told so far, Energy Reports, 6 (2020) 1973-1991.

[9] I.D. Haigh, M.D. Pickering, J.M. Green, B.K. Arbic, A. Arns, S. Dangendorf, P.L. Woodworth, The tides they are a-Changin': A comprehensive review of past and future nonastronomical changes in tides, their driving mechanisms, and future implications, Reviews of Geophysics, 58 (1) (2020). https://doi.org/10.1029/2018RG000636

[10] X. Li, F. Wang, M. Al-Razgan, E.M. Awwad, S.Z. Abduvaxitovna, Z. Li, J. Li, Race to environmental sustainability: Can structural change, economic expansion and natural resource consumption effect environmental sustainability?, A novel dynamic ARDL simulations approach, Resources Policy, 86 (2023). https://doi.org/10.1016/j.resourpol.2023.104044

[11] B. Aydoğan, T. Görmüş, B. Ayat, T. Çarpar, Analysis of potential changes in the Black Sea wave power for the 21st century, Renewable Energy, 169 (2021) 512-526.

[12] M. Li, H. Luo, S. Zhou, G.M.S. Kumar, X. Guo, T.C. Law, S. Cao, State-of-the-art review of the flexibility and feasibility of emerging offshore and coastal ocean energy technologies in East and Southeast Asia, Renewable and Sustainable Energy Reviews, 162 (2022). https://doi.org/10.1016/j.rser.2022.112404

[13] P. Ifaei, A.S.T. Charmchi, J. Loy-Benitez, R.J. Yang, C. Yoo, A data-driven analytical roadmap to a sustainable 2030 in South Korea based on optimal renewable microgrids, Renewable and Sustainable Energy Reviews, 167 (2022). https://doi.org/10.1016/j.rser.2022.112752.

[14] U.K. Sandesh, S. Rao, Manu, A Review of Computational Studies on Indian Coast Considering Climate Change Effects, River and Coastal Engineering: Hydraulics, Water Resources and Coastal Engineering, (2022) 123-134.

[15] Ö. Özel, D. Dondurur, I. Klaucke, Seismic and geoacoustic evidence for subsurface fluid flow and seepage offshore Akçakoca, Southwestern Black Sea, Turkey, Geo-Marine Letters, 42 (4) (2022) 17. https://doi.org/10.1007/s00367-022-00740-z

[16] J. Fuglestvedt, M.T. Lund, S. Kallbekken, B.H. Samset, D.S. Lee, A “greenhouse gas balance” for aviation in line with the Paris Agreement, Wiley Interdisciplinary Reviews: Climate Change, 14 (5) (2023). https://doi.org/10.1002/wcc.839.

[17] S. Foteinis, Wave energy converters in low energy seas: Current state and opportunities, Renewable and Sustainable Energy Reviews, 162 (2022). https://doi.org/10.1016/j.rser.2022.112448

[18] Z. Medghalchi, O. Taylan, A novel hybrid optimization framework for sizing renewable energy systems integrated with energy storage systems with solar photovoltaics, wind, battery and electrolyzer-fuel cell, Energy Conversion and Management, 294 (2023). https://doi.org/10.1016/j.enconman.2023.117594.
[19] K. Baz, D. Xu, H. Ali, U. Khan, J. Cheng, K. Abbas, I. Ali, Nexus of minerals-technology complexity and fossil fuels with carbon dioxide emission: Emerging Asian economies based on product complexity index, Journal of Cleaner Production, 373 (2022). https://doi.org/10.1016/j.jclepro.2022.133703.
[20] J. Lizana, C. Bordin, T. Rajabloo, Integration of solar latent heat storage towards optimal small-scale combined heat and power generation by Organic Rankine Cycle, Journal of Energy Storage, 29 (2020). https://doi.org/10.1016/j.est.2020.101367.
[21] R. Zeng, X. Zhang, Y. Deng, H. Li, G. Zhang, Optimization and performance comparison of combined cooling, heating and power/ground source heat pump/photovoltaic/solar thermal system under different load ratio for two operation strategies, Energy Conversion and Management, 208 (2020). https://doi.org/10.1016/j.enconman.2020.112579.
[22] A. Alahmer, S. Ajib, Solar cooling technologies: State of art and perspectives, Energy Conversion and Management, 214 (2020). https://doi.org/10.1016/j.enconman.2020.112896
[23] N. Khandelwal, M. Sharma, O. Singh, A.K. Shukla, Comparative evaluation of Integrated Solar combined cycle plant with cascade thermal storage system for different heat transfer fluids, Journal of Cleaner Production, 353 (2022). https://doi.org/10.1016/j.jclepro.2022.131519
[24] T.J. O'Neil, S. Sobhansarbandi, Thermal performance investigation of energy storage based U-pipe evacuated tube solar collector: An experimental study, Sustainable Energy Technologies and Assessments, 52 (2022). https://doi.org/10.1016/j.seta.2022.102146
[25] S. Bellocchi, M. Manno, M. Noussan, M.G. Prina, M. Vellini, Electrification of transport and residential heating sectors in support of renewable penetration: Scenarios for the Italian energy system, Energy, 196 (2020). https://doi.org/10.1016/j.energy.2020.117062
[26] T.C. Roumpedakis, G. Kallis, D. Magiri-Skouloudi, D. Grimekis, S. Karellas, Life cycle analysis of ZEOSOL solar cooling and heating system, Renewable Energy, 154 (2020) 82-98.
[27] K.M. Tan, T.S. Babu, V.K. Ramachandaramurthy, P. Kasinathan, S.G. Solanki, S.K. Raveendran, Empowering smart grid: A comprehensive review of energy storage technology and application with renewable energy integration, Journal of Energy Storage, 39 (2021). https://doi.org/10.1016/j.est.2021.102591
[28] J.K. Calautit, D. O'Connor, P.W. Tien, S. Wei, C.A.J. Pantua, B. Hughes, Development of a natural ventilation windcatcher with passive heat recovery wheel for mild-cold climates: CFD and experimental analysis, Renewable Energy, 160 (2020) 465-482.
[29] K. Sun, W. Zhang, Z. Zeng, R. Levinson, M. Wei, T. Hong, Passive cooling designs to improve heat resilience of homes in underserved and vulnerable communities, Energy and Buildings, 252 (2021). https://doi.org/10.1016/j.enbuild.2021.111383
[30] M.F. Zhang, J.F. Dawson, R.B. Kline, Evaluating the use of covariance-based structural equation modelling with reflective measurement in organizational and management research: A review and recommendations for best practice, British Journal of Management, 32 (2) (2021) 257-272.
[31] G. Balcioglu, H.K. Jeswani, A. Azapagic, Evaluating the environmental and economic sustainability of energy from anaerobic digestion of different feedstocks in Turkey, Sustainable Production and Consumption, 32 (2022) 924-941.
[32] J. Taherahmadi, Y. Noorollahi, M. Panahi, Toward comprehensive zero energy building definitions: a literature review and recommendations, International Journal of Sustainable Energy, 40 (2) (2021) 120-148.
[33] L. Richa, B. Colin, A. Pétrissans, J. Wolfgram, C. Wallace, R.L. Quirino, M. Pétrissans, Catalytic torrefaction effect on waste wood boards for sustainable biochar production and environmental remediation, Environmental Pollution, 341 (2024). https://doi.org/10.1016/j.envpol.2023.122911.
[34] S. Rani, R.K. Mishra, M. Usman, A. Kataria, P. Kumar, P. Bhambri, A.K. Mishra, Amalgamation of advanced technologies for sustainable development of smart city environment: A review, IEEE Access, 9 (2021) 150060-150087.
[35] B.V. Malozyomov, N.V. Martyushev, E.V. Voitovich, R.V. Kononenko, V.Y. Konyukhov, V. Tynchenko, Y.A. Tynchenko, Designing the Optimal Configuration of a Small Power System for Autonomous Power Supply of Weather Station Equipment, Energies, 16 (13) (2023). https://doi.org/10.3390/en16135046
[36] M.L. Adekanbi, Optimization and digitization of wind farms using internet of things: A review, International Journal of Energy Research, 45 (11) (2021) 15832-15838.

[37] J.C. Prata, J.P. Da Costa, I. Lopes, A.L. Andrady, A.C. Duarte, T. Rocha-Santos, A One Health perspective of the impacts of microplastics on animal, human and environmental health, Science of the Total Environment, 777 (2021). https://doi.org/10.1016/j.scitotenv.2021.146094
[38] S.A. Khan, S.G. Al-Ghamdi, Renewable and integrated renewable energy systems for buildings and their environmental and socio-economic sustainability assessment, In Energy Systems Evaluation (Volume 1) Sustainability Assessment, Cham: Springer International Publishing, (2021) 127-144.