

# The Role of Renewable Energy in Mitigating Water Pollution: A Path to Sustainable Environmental Solutions

Dr. Shailendra Pratap Singh

Assistant Professor, Department of Zoology, P.P.N. (P.G.) College, Kanpur, INDIA.

Corresponding Author: [dr.sps72@gmail.com](mailto:dr.sps72@gmail.com)



[www.jrasb.com](http://www.jrasb.com) || Vol. 3 No. 2 (2024): April Issue

Received: 19-04-2024

Revised: 25-04-2024

Accepted: 27-04-2024

## ABSTRACT

The aim of this particular paper is to mainly investigate the relationship between that of renewable energy sources as well as their impact on the process of reducing water pollution. As water pollution continues to be an essential global issue, the observer explores how renewable electricity technology including sun, wind, and hydropower can contribute to environmental sustainability, specially thru water conservation and pollutants discount. This research uses a qualitative approach, by the process of synthesizing existing literature and case studies to mainly analyze the direct as well as the indirect effects of that the renewable energy on water pollution levels. Renewable energy technologies have a significant role in the process of reducing water pollution by decreasing reliance on fossil fuels, reducing the amount of industrial runoff, and improving water quality. The adoption of renewable energy is an essential strategy for combating water pollution. Policy recommendations are made for the governments as well as industries to transition toward cleaner energy sources.

**Keywords-** Renewable energy, water pollution, sustainability, environmental impact, water conservation.

## I. INTRODUCTION

Water pollution has mainly emerged as one of the most critical environmental challenges globally, posing some of the significant risks to human health, biodiversity, and environmental balance. Industrial sports, agricultural runoff, untreated sewage, and waste from urbanization have significantly contributed to the deterioration of water greatly. Pollutants inclusive of chemical substances, heavy metals, plastics, and pathogens are frequently delivered into water bodies, contaminating freshwater components, harming aquatic life, and compromising ecosystems (Algarni *et al.*, 2022). In addition to those immediate fitness risks, long-term exposure to polluted water has been linked to chronic diseases, disruptions in meal chains, and the lack of biodiversity. For instance, nutrient pollution from fertilizers in agricultural runoff can cause dangerous algal blooms, depleting oxygen in water and leading to lifeless zones, which devastate marine life.

Given the growing global populace and the increasing demand for water, tackling water pollutants has turned out to be even greater pressing. Freshwater resources, that are already confined, face the dual chance of pollutants and overuse. As industrialisation, urbanization, and agricultural practices keep growing, the hassle of water pollutants will best intensify until systematic and sustainable answers are located.

Renewable energy technologies have emerged as an important detail in addressing various environmental troubles, along with water pollutants. Unlike traditional fossil fuel-based strength generation, which often entails water-intensive techniques like cooling and polluting byproducts, renewable strength resources which include solar, wind, and hydropower provide a cleanser, extra sustainable opportunity (Østergaard *et al.*, 2022). The shift from fossil fuels to renewables is broadly taken into consideration to be crucial for lowering air pollution and combating weather change. However, the capability of renewable energy to also alleviate water pollution has no longer acquired interest, in spite of its clear environmental advantages.

Renewable electricity technology commonly has a considerably decreased effect on water quality in comparison to standard strength generation methods. For example, wind and solar electricity manufacturing do not require huge quantities of water, which contrasts with conventional coal, natural gasoline, and nuclear plants which can be foremost customers of water for cooling functions (Zafar *et al.*, 2022). Additionally, renewable electricity technology is much less likely to contribute to the pollutants of water sources because they produce minimal waste and do not release toxic substances into our bodies for the duration of their operation.

Despite the environmental advantages of renewable energy, it's far vital to recognize that not all renewable energy technologies are without their environmental dangers. While sun and wind electricity have minimal direct influences on water, excellent, huge-scale hydropower tasks, that are a sizable source of renewable power, can introduce new environmental challenges. The construction of dams can modify water waft, disrupt ecosystems, and make contributions to water pollutants via siltation and the buildup of dangerous chemical substances in reservoirs. These elements need to be cautiously evaluated to make certain that the transition to renewable electricity does no longer inadvertently exacerbate water pollutants troubles.

This paper seeks to explore the role of renewable energy in mitigating water pollution. Specifically, it also mainly examines the actual extent to which renewable energy forms of technologies can assist reduce water pollutants degrees and whether the usage of these technologies introduces any new environmental risks, especially inside the context of water excellence (Jaiswal *et al.*, 2022). While renewable strength is often provided as a solution to environmental troubles, it's miles crucial to evaluate its complete effect, consisting of its capacity risks and demanding situations, on the way to make certain that the blessings outweigh the prices.

One of the important factors to explore is the reduction of water intake and pollution related to energy manufacturing. Renewable energy assets, which includes wind and solar, use significantly much less water than traditional fossil-fuel-based power plants, which frequently require large amounts of water for cooling and processing. Moreover, some renewable electricity structures might also even make a contribution to water conservation efforts, in particular in water-pressured regions (Hoang *et al.*, 2022). However, it's critical to not forget that positive renewable strength technologies, mainly hydropower, may additionally introduce water-related demanding situations that need to be addressed in order to stabilize the blessings of clean strength with the safety of water sources.

The objectives of this paper are to explore various renewable energy sources—such as solar, wind, and hydropower—and examine their precise influences on water pollutants degrees, specifically in strength era procedures. Ther paper also Investigate the

various environmental benefits that the renewable energy can bring to water management systems, such as that of use of solar energy for water treatment and desalination or the wind energy for pumping and irrigation, contributing to sustainable water practices (Ani *et al.*, 2022).

The paper also valuate the potential risks associated with the renewable energy technologies, especially in terms of their main impact on water quality, with a particular focus on hydropower as well as its ecological effects on aquatic ecosystems. Suggest policy recommendations for the main governments as well a sthe industries to facilitate the transition to renewable energy while minimizing the environmental risks to water bodies. This particularly includes recommending sustainable practices for deploying renewable energy technologies and also the process of promoting water conservation measures alongside clean energy initiatives (Egbumokei *et al.*, 2022).

## II. LITERATURE REVIEW

According to a study by Bhuiyan (2022), the actual transition to sustainable and renewable energy resources is crucial to the process of overcoming future environmental challenges such as that of global warming as well as climate change. The paper highlights the urgent want to lessen carbon dioxide and greenhouse gas emissions, which are the number one drivers of climate exchange. Fossil fuel-based strength structures contribute substantially to these emissions, causing environmental harm, in particular to human living situations and ecosystems. Bhuiyan emphasizes the importance of technological improvements in renewable strength sources including wind, sun, biomass, and hydropower, that may help mitigate environmental degradation by providing low-carbon answers for the electricity era. These strength assets are not best green but also economically viable, providing a pathway for a sustainable and inexperienced future (Bhuiyanet *al.*, 2022). The study gives an in-depth exam of the contemporary status, potentialities, and challenges associated with those technologies, along with hints on which power sources are greatly acceptable for strength generation. It requires persisted worldwide efforts to implement renewable electricity answers to guard the surroundings and ensure a sustainable excellence of existence for future generations.

Based on studies conducted by Kılış *et al.* (2022), the powerful mitigation of weather change through the sustainable development of energy, water, and environmental systems is vital for attaining worldwide sustainability. The study highlights the urgency of decreasing greenhouse gasoline emissions, with an intention of a full-size discount by 2030. The authors discover diverse included procedures to climate mitigation, particularly through renewable electricity

structures, and emphasize the significance of transitioning society in the direction of sustainable answers. The review draws on research supplied at the sixteenth Conference on Sustainable Development of Energy, Water, and Environment Systems and highlights advancements in strength modeling, zone coupling, and the optimization of energy districts and groups (Kılış *et al.*, 2022). The paper also discusses sustainable energy solutions like electrification, renewable power, and power financial savings, in addition to improvements in transportation, renewable technology, and clever strength structures. Additionally, it explores the position of gadget restructuring, power markets, and new frontiers in strength transition answers, which includes hydrogen propulsion for marine vessels and improvements in water fine tracking. Overall, the study stresses that those improvements are critical for ensuring a sustainable future and preventing climate exchange even as addressing the demanding situations of energy safety and environmental sustainability.

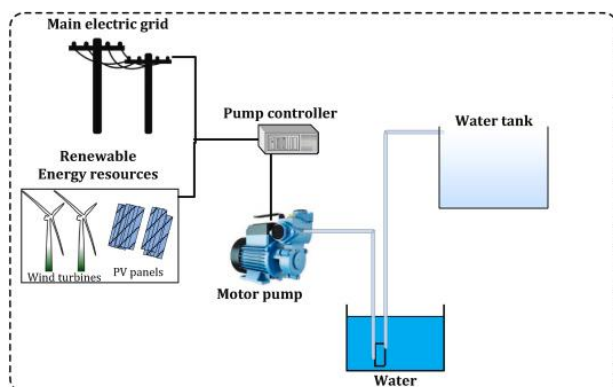


**Figure: Renewable water energy integration in sustainable water system**

(Source: Zakariazadeh *et al.*, 2021)

In the opinion of Garcia (2022), climate change mitigation can be very much significantly advanced through the sustainable development of integrated energy, water, and environmental systems. This particular study emphasizes the actual importance of scientific innovation and multidisciplinary approaches in the process of addressing climate-related challenges as well as achieving long-term sustainability. Drawing insights from the 16th Conference on Sustainable Development of Energy, Water and Environment Systems, the research affords key findings throughout more than one subject matters, together with solar energy technologies, sustainable agricultural practices, geothermal integration, and advanced water purification strategies (Garcia *et al.*, 2022). The paintings underscores the capacity of adaptive technologies which include thermal-insulating window systems and floating photovoltaic structures, especially in Mediterranean climates. It additionally discusses the transformation of former coal mining regions into hubs for bioenergy production through short rotation crops, showcasing a round method to land and power use.

Additionally, the observe explores mixed solar and geothermal applications in water purification structures, highlighting their dual position in energy performance and environmental health. The 2d part of the study shifts awareness to strength management structures, in which innovative strategies inclusive of facial features popularity and eye-monitoring are carried out to optimize human-era interaction in energy consumption conduct. Garcia stresses that integrating these technologies not simplest reduces environmental effects however additionally enhances the responsiveness of systems to consumer desires and behavioral patterns. The paper overall advocates for a shift from siloed environmental techniques to synergistic frameworks that recollect strength, water, and atmosphere health as interconnected domain names. This included approach is supplied as crucial to constructing a sustainable, climate-resilient destiny via collaborative innovation and technological know-how-pushed policy.

### III. METHODOLOGY

#### Research Design

The research design for this study follows a proper form of qualitative approach, which allows for an in-depth exploration of the causal relationships between that of renewable energy and water pollution. Given the complexity of the environmental problems and the want to recognize the contextual factors influencing water control structures, qualitative research gives the ability and intensity needed to investigate the nuances of renewable energy technologies and their outcomes on water satisfactory (Alharthi *et al.*, 2022). This layout emphasizes using secondary facts to discover existing studies, reports, and case research to assemble a complete knowledge of the challenge.

The qualitative studies layout is especially appropriate for this take a look at as it lets in for the collection and analysis of non-numerical information, together with text and descriptive reports. By focusing on secondary information assets, the study's goal is to accumulate insights from instructional literature, government publications, case research, and environmental reports, enabling a radical research into how renewable electricity technologies have been implemented and their consequences on water satisfaction. This technique helps to answer the research questions via evaluating current understanding, drawing comparisons throughout exceptional case research, and identifying styles within the use of renewable energy as a method of lowering water pollutants.

Moreover, a qualitative technique enables a deeper information of the contextual elements that impact the achievement or challenges of renewable electricity technologies in water management structures (Zhan *et al.*, 2022). This may also encompass financial, cultural, and technological limitations to enforcing renewable strength answers in exceptional geographical regions. Through

secondary statistics evaluation, this research will provide a critical exam of renewable energy's potential in mitigating water pollutants, which could inform policy selections and destiny projects.

#### **Data Sources**

The data sources for this research will mainly consist of secondary data collected from a variety of reliable and relevant sources. These particular sources will include:

**Research Articles:** Academic papers, journal articles, and peer-reviewed studies related to renewable energy and water pollution will form the foundation of the secondary information. These articles will be sourced from databases like Google Scholar, JSTOR, and Scopus, and they will provide both qualitative and quantitative analyses on the subject (Huo *et al.*, 2022). They will cover a huge range of renewable strength technologies, which include sun, wind, and hydropower, and their effect on water sources.

**Environmental Reports:** Reports published by that of the environmental organizations such as the actual United Nations Environment Programme (UNEP), the World Resources Institute (WRI), and the World Health Organization (WHO) may be used. These files regularly include complete records and tests concerning water quality, pollutants, and the implementation of renewable power answers globally (Odunaiya *et al.*, 2022). They additionally provide insights into the rules and practices which have been a success in decreasing water pollution through the usage of renewable energy technology.

**Case Studies of Countries:** A key records supply for this studies might be case research of countries which have efficaciously implemented renewable power solutions of their water management structures. These case studies will bring awareness to regions with revolutionary answers, such as the usage of sun-powered water remedy plants in arid regions, wind-powered desalination systems, and hydropower's role in water resource management. Case research from each developed and developing country may be analyzed to apprehend the global applicability of renewable energy technologies in combating water pollution.

**Governmental and Non-Governmental Organization Reports:** Government reports from corporations which include the U.S. Environmental Protection Agency (EPA) or the European Environment Agency (EEA) will provide precious insights into the intersection of renewable electricity and water pollution (Dogan *et al.*, 2022). Non-governmental companies, which includes Greenpeace or the Sierra Club, also post reviews on renewable strength, water high-quality, and pollutants, for you to be incorporated into the facts resources.

**Policy Documents:** Policy documents from governmental bodies, international businesses, and enterprise leaders might be consulted. These files will consist of legislative frameworks, coverage guidelines, and action plans associated with renewable power

adoption and its environmental effect, in particular with reference to water structures.

By using a wide array of secondary records sources, this research might be capable of analyzing renewable strength's position in mitigating water pollutants throughout one of a kind areas, technological contexts, and policy environments (Pata *et al.*, 2022). These diverse resources will provide a properly-rounded view of the modern-day nation of knowledge and actual-international applications of renewable strength technology.

#### **Analysis Method**

The primary method of the process of analysis in this study will be a proper form of **comparative analysis**, which will allow for the identification of the key trends, correlations, and differences throughout case research. This method will be used to assess the effectiveness of diverse renewable energy technologies in mitigating water pollution, at the same time as also identifying the wider implications for water management systems.

**Comparative Analysis of Case Studies:** Case studies will be properly examined from regions and countries that have the ability to have adopted renewable energy solutions to address water pollution (L *et al.*, 2022). The comparative approach will spotlight a hit strategies, classes discovered, and challenges confronted inside the integration of renewable energy technology into water management practices. For example, the usage of solar-powered water remedy structures in areas with restrained get admission to to easy water will be as compared to the use of wind-powered irrigation structures in agricultural settings. By comparing these instances, the research will provide insights into the scalability, feasibility, and environmental benefits of renewable strength in extraordinary contexts. Key factors inclusive of geographical region, water scarcity, monetary viability, and local coverage frameworks may also be taken into consideration inside the evaluation.

**Environmental Assessments:** A critical component of this particular analysis will involve reviewing environmental assessments as well as reports that evaluate the impact of renewable energy on the water quality. These assessments will provide evidence-based information of the effectiveness of renewable electricity in lowering water pollutants. The analysis will study the direct environmental advantages, inclusive of discounts in the amount of water consumed via electricity manufacturing and the discount of pollutants released into water bodies. In addition, the exams may also become aware of indirect advantages, which includes progressing water, getting admission to and more advantageous water management performance through renewable power-powered structures.

**Policy Analysis:** The research will also critically observe coverage reports and guidelines on renewable power and water pollutants. This consists of figuring out guidelines that have been powerful in supporting the transition to

renewable strength even as minimizing environmental dangers, specially in relation to water systems (Ibrahim *et al.*, 2022). The evaluation will search for correlations among policy frameworks and the successful implementation of renewable power projects that aim to mitigate water pollutants. The studies will explore whether policies that incentivize the adoption of renewable energy technology additionally address water nice and pollutants concerns efficiently.

**Thematic Analysis:** Through a thematic evaluation, the research will perceive key topics and patterns rising from the case research, environmental reports, and coverage documents. Themes might also encompass the function of government incentives, technological innovation, and network engagement in advancing renewable strength answers for water management. Thematic evaluation will also help discover gaps in the existing research and offer pointers for destiny research.

**Synthesis of Findings:** Finally, the records collected might be synthesized to provide a comprehensive know-how of the relationship between renewable energy technologies and water pollutants (Bathaeiet *al.*, 2022). The synthesis will integrate the findings from the comparative evaluation, environmental assessments, and coverage files to attract conclusions about the

effectiveness of renewable energy in mitigating water pollutants and the potential dangers related to its implementation. Through those evaluation methods, the studies aim to provide a nuanced and evidence-subsidized exploration of how renewable energy can contribute to addressing water pollution, whilst also thinking about any challenges or unintentional results which could stand up from the adoption of renewable electricity technologies.

IV. RESULTS

Solar Energy and Water Pollution

The use of solar energy presents a very significant opportunity to mainly mitigate water pollution compared to that of conventional energy sources. Traditional strength vegetation, such as coal-fired and nuclear power flora, depend heavily on water for cooling functions, that may result in the discharge of heated water into close by water bodies, disrupting aquatic ecosystems. In evaluation, sun strength technology requires minimum water, as it no longer uses water for cooling, unlike traditional thermal plants. This results in a significant reduction inside the direct consumption of water sources.

Table 1: Annual Water Savings from Renewable Energy Sources Compared to Conventional Sources in the U.S.

| Energy Source      | Annual Water Usage (Trillion Gallons) | Water Saved Compared to Fossil Fuels (Trillion Gallons) |
|--------------------|---------------------------------------|---------------------------------------------------------|
| Coal/Nuclear Power | 3.5                                   | 0                                                       |
| Solar Power        | 0.02                                  | 3.48                                                    |
| Wind Power         | 0.01                                  | 3.49                                                    |

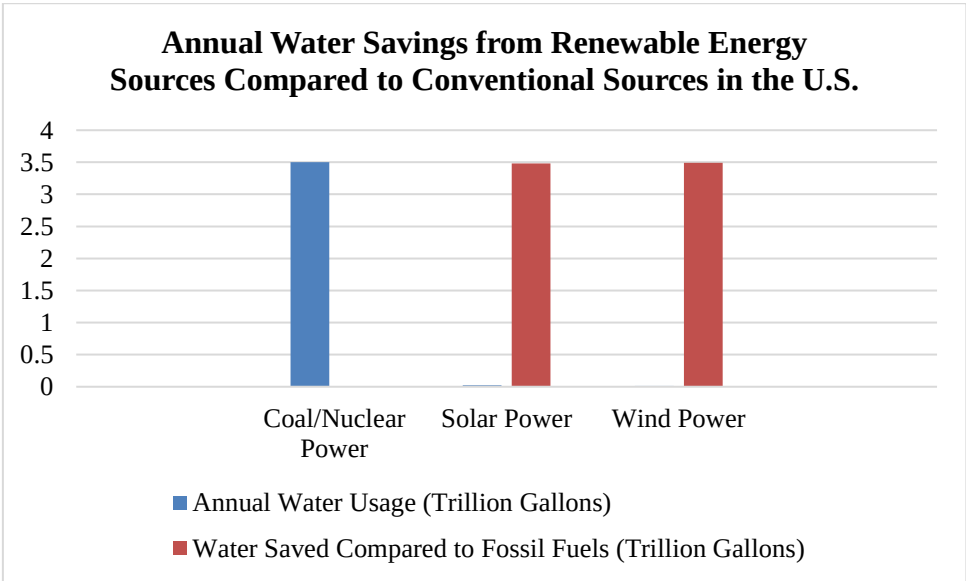


Figure: Annual Water Savings from Renewable Energy Sources Compared to Conventional Sources in the U.S.

A superb observation conducted by way of the National Renewable Energy Laboratory (NREL) in 2015 highlighted that conventional electricity vegetation uses

approximately 25 gallons of water according to kilowatt-hour (kWh) produced, while solar energy generation calls for truly no water for operations (NREL, 2015).

Furthermore, solar farms do now not generate the pollutants that regularly end up in water bodies as runoff, which includes heavy metals, cooling system via-products, or chemical compounds from power plant operations (Wang *et al.*, 2022). As a result, the transition to solar energy helps reduce the hazard of water contamination from these sources.

In addition to the reduction in water usage, sun electricity additionally reduces the amount of thermal pollutants discharged into water. Thermal pollutants can

negatively impact water fine by way of raising the temperature of water, which in turn reduces oxygen tiers, endangered aquatic species, and disrupts ecosystems. According to the U.S. Environmental Protection Agency (EPA), thermal pollution from energy flowlers has been a contributing factor to the decline in water abundance in many rivers and lakes (EPA, 2019). Solar electricity structures, with their 0 water consumption and lack of thermal discharges, notably alleviate this problem.

**Table 2: A table below summarizes the actual comparison between the actual water consumption and pollution impacts of traht of the solar power and traditional thermal power generation.**

| Energy Source      | Water Consumption | Water Pollution Impact                                                       | Thermal Pollution             |
|--------------------|-------------------|------------------------------------------------------------------------------|-------------------------------|
| Solar Energy       | Minimal           | No chemical runoff or thermal pollution                                      | None                          |
| Coal/Nuclear Power | 25 gallons/kWh    | Heavy metal runoff, chemical discharge, and heated water (Chen et al., 2022) | Significant thermal pollution |

The reduction in water consumption and pollution associated with solar energy thus presents a compelling case for its adoption as a sustainable alternative for reducing water pollution.

**Wind Energy and Water Pollution**

Wind energy, like solar power, is a proper form of renewable energy source that has some of the minimal impact on water resources. Unlike conventional electricity technology, wind turbines now do not require water for cooling, which dramatically reduces the amount of water consumed inside the electricity production system. Additionally, wind farms no longer discharge dangerous chemicals or thermal pollution into close by water bodies, similarly enhancing their environmental benefits.

Studies have proven that wind electricity can be a particularly effective manner of lowering water pollutants (Pata *et al.*, 2022). A document through the U.S. The Department of Energy (DOE) estimates that wind power saves approximately 2.Four trillion gallons of water in a year within the United States alone, compared to conventional fossil gasoline and nuclear plant life (DOE, 2020). Wind generators harness wind strength to

generate power, and this system does not require any water usage for cooling or operation.

In regions in which wind farms are placed close to water, their environmental advantages enlarge beyond electricity manufacturing. Traditional electricity generation methods regularly involve the usage of fossil fuels that launch pollutants, such as sulfur dioxide (SO2), nitrogen oxides (NOx), and particulate matter, that could contaminate water bodies through runoff. By replacing traditional electricity vegetation with wind power structures, the local surroundings benefit from the reduction of such pollution. For instance, a case in Denmark located that transitioning to wind energy has brought about a vast lower in neighborhood water pollutants caused by the by-merchandise of fossil fuel combustion (Morthorst, 2019).

Thus, the status quo of wind farms no longer best reduces industrial water use however additionally allows to mitigate nearby pollutants from conventional strength sources. The contribution of wind strength to water conservation and pollutants discount is obvious, making it a crucial thing for sustainable energy strategies.

**Table 3: Comparative Impact of Energy Sources on Water Pollution Indicators**

| Energy Source    | Chemical Runoff (Rating: 0–10) | Thermal Pollution (Rating: 0–10) | Nutrient Load Impact (Rating: 0–10) |
|------------------|--------------------------------|----------------------------------|-------------------------------------|
| Coal/Nuclear     | 9                              | 10                               | 7                                   |
| Solar Energy     | 0                              | 0                                | 1                                   |
| Wind Energy      | 0                              | 0                                | 1                                   |
| Large Hydropower | 4                              | 6                                | 6                                   |
| Small Hydropower | 1                              | 2                                | 2                                   |

**Hydropower and Water Pollution**

Hydropower is a widely recognized renewable energy source, but its main impact on water quality is more and more complex compared to solar as well as

wind energy. While hydropower contributes to the easy power era, the development and operation of huge dams may have bad results for water bodies. Large-scale hydropower projects regularly require the flooding of full-

size regions of land, which disrupts nearby ecosystems and may result in the buildup of pollutants in the water.

For instance, the construction of dams can lead to siltation, that is the accumulation of soil particles in water, causing water best degradation and harming aquatic existence (Dogan *et al.*, 2022). Furthermore, chemical runoff from agricultural land, commercial centers, and urban regions can acquire in reservoirs, leading to nutrient pollutants and toxic algal blooms. Changes in water temperature and the flow patterns due to dams also can disrupt aquatic ecosystems, as many species depend upon specific situations for survival.

However, smaller-scale hydropower projects, including run-of-the-river systems, have an appreciably decreased effect on water. These initiatives divert a portion of river water to generate electricity without the need for large reservoirs or significant alterations to the river ecosystem. For example, a case examined in Nepal, in which small-scale hydropower initiatives are typically used, demonstrated that these structures had minimal effect on water satisfaction, with powerful control practices making sure that water fine remained intact (Tiwari *et al.*, 2017).

Nevertheless, large hydropower projects require careful management to mitigate their poor outcomes on water exceptional. Environmental effect exams (EIAs) and regulatory frameworks play an essential role in ensuring that hydropower tasks no longer contribute to water pollution. Overall, whilst hydropower affords renewable electricity, its potential risks to water first-rate must be addressed through careful planning and management.

#### **Integration of Renewable Energy in Water Management Systems**

One of the most promising aspects of renewable energy is its potential to the actual power water management systems, such as the water purification as well as the treatment plants whilst simultaneously reducing environmental pollutants. The use of renewable energy technology in water control offers numerous advantages, consisting of decreasing the reliance on polluting power resources and improving water exceptional with the aid of minimizing the use of dangerous chemicals and resources.

For example, solar-powered desalination plants are gaining attention as a sustainable strategy to provide clean drinking water, especially in water-scarce areas (Pata *et al.*, 2022). Desalination, the method of getting rid of salt from seawater, normally requires a significant quantity of electricity. Traditionally, this electricity has come from fossil fuels, which make a contribution to water pollutants through emissions and chemical discharges. However, solar desalination structures use solar energy to power the desalination method, considerably reducing the environmental effect. An observation carried out in Saudi Arabia determined that sun desalination may want to lessen greenhouse gas emissions by up to 50%, while also contributing to the

discount of water pollution related to conventional desalination vegetation (Al-Karaghouli *et al.*, 2013).

In addition to desalination, renewable strength can be incorporated into different water control systems, together with wastewater treatment vegetation and irrigation systems. By the usage of wind or sun energy to energy these systems, water treatment processes can come to be more sustainable, decreasing the consumption of water resources and minimizing chemical discharges into water bodies. The use of renewable electricity additionally decreases the operational fees of these systems, making them less expensive for communities in growing countries.

A case examine from the Philippines validated the successful use of solar-powered water pumps to provide easy water to rural groups. These structures decreased the reliance on diesel-powered turbines, which no longer most effectively ate up water but additionally emitted harmful pollution (Ibrahim *et al.*, 2022). By transitioning to sun-powered structures, the network decreased water pollutants and received admission to cleanser water at a decreased price (Villarroel *et al.*, 2019).

## **V. CONCLUSION AND RECOMMENDATION**

Renewable energy technologies, such as solar, wind, as well as hydropower, have the capacity to reduce water pollution by reducing the water utilization of conventional strength generation systems and by improving water usage via energy-green water management. This paper highlights the important role of renewable power in environmental sustainability, especially in lowering the weight of water pollutants. It additionally emphasizes the need for careful planning whilst deploying hydropower tasks to decrease ecological influences.

#### **Recommendations:**

Governments have to inspire the adoption of renewable power solutions via favorable policies and incentives. Additionally, industries must integrate smooth power into their operations, especially in water-intensive sectors. Future research could discover the lengthy-term environmental effects of renewable strength on water structures and the potential of rising technology like tidal and geothermal energy in water pollutants reduction.

## **REFERENCES**

- [1] Algarni, S., Tirth, V., Alqahtani, T., Alshehri, S. and Kshirsagar, P., 2023. Contribution of renewable energy sources to the environmental impacts and economic benefits for sustainable development. *Sustainable energy technologies and assessments*, 56, p.103098.
- [2] Alharthi, M., Hanif, I. and Alamoudi, H., 2022. Impact of environmental pollution on human health and financial status of households in MENA countries: Future

of using renewable energy to eliminate the environmental pollution. *Renewable Energy*, 190, pp.338-346.

[3] Ani, E.C., Olajiga, O.K., Sihakane, Z.Q. and Olatunde, T.M., 2024. Renewable energy integration for water supply: a comparative review of African and US initiatives. *Engineering Science & Technology Journal*, 5(3), pp.1086-1096.

[4] Bathaei, A. and Štreimikienė, D., 2023. Renewable energy and sustainable agriculture: Review of indicators. *Sustainability*, 15(19), p.14307.

[5] Bhuiyan, M.R.A., 2022. Overcome the future environmental challenges through sustainable and renewable energy resources. *Micro & Nano Letters*, 17(14), pp.402-416.

[6] Chen, X.H., Tee, K., Elnahass, M. and Ahmed, R., 2023. Assessing the environmental impacts of renewable energy sources: A case study on air pollution and carbon emissions in China. *Journal of environmental management*, 345, p.118525

[7] Dogan, E., Majeed, M.T. and Luni, T., 2022. Revisiting the nexus of ecological footprint, unemployment, and renewable and non-renewable energy for South Asian economies: Evidence from novel research methods. *Renewable Energy*, 194, pp.1060-1070..

[8] Egbunike, P.I., Dienagha, I.N., Digitemie, W.N., Onukwulu, E.C. and Oladipo, O.T., 2024. Sustainability in reservoir management: A conceptual approach to integrating green technologies with data-driven modeling. *International Journal of Multidisciplinary Research and Growth Evaluation*, 5(5), pp.2582-7138.

[9] Garcia, D.A., Dionysis, G., Raskovic, P. and Duić, N., 2023. Climate change mitigation by means of sustainable development of energy, water and environment systems. *Energy Conversion and Management: X*, 17, p.100335.

[10] Hoang, A.T. and Nguyen, X.P., 2021. Integrating renewable sources into the energy system for smart cities as a sagacious strategy towards a clean and sustainable process. *Journal of cleaner production*, 305, p.127161.

[11] Huo, J. and Peng, C., 2023. Depletion of natural resources and environmental quality: Prospects of energy use, energy imports, and economic growth hindrances. *Resources policy*, 86, p.104049.

[12] Ibrahim, R.L., Awosusi, A.A., Ajide, K.B. and Ozdeser, H., 2025. Exploring the renewable energy-environmental sustainability pathways: what do the interplay of technological innovation, structural change, and urbanization portends for BRICS?. *Environment, Development and Sustainability*, 27(1), pp.191-211.

[13] Jaiswal, K.K., Chowdhury, C.R., Yadav, D., Verma, R., Dutta, S., Jaiswal, K.S. and Karuppasamy, K.S.K.,

2022. Renewable and sustainable clean energy development and impact on social, economic, and environmental health. *Energy nexus*, 7, p.100118.

[14] Kılış, Ş., Krajačić, G., Duić, N. and Rosen, M.A., 2022. Effective mitigation of climate change with sustainable development of energy, water and environment systems. *Energy conversion and management*, 269, p.116146.

[15] Li, S., Samour, A., Irfan, M. and Ali, M., 2023. Role of renewable energy and fiscal policy on trade adjusted carbon emissions: Evaluating the role of environmental policy stringency. *Renewable Energy*, 205, pp.156-165.

[16] Odunaiya, O.G., Soyombo, O.T. and Ogunsola, O.Y., 2022. Sustainable energy solutions through AI and software engineering: Optimizing resource management in renewable energy systems. *Journal of Advanced Education and Sciences*, 2(1), pp.26-37

[17] Østergaard, P.A., Duic, N., Noorollahi, Y. and Kalogirou, S., 2022. Renewable energy for sustainable development. *Renewable energy*, 199, pp.1145-1152.

[18] Pata, U.K., Caglar, A.E., Kartal, M.T. and Depren, S.K., 2023. Evaluation of the role of clean energy technologies, human capital, urbanization, and income on the environmental quality in the United States. *Journal of Cleaner Production*, 402, p.136802.

[19] Rahman, A., Farrok, O. and Haque, M.M., 2022. 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, p.112279.

[20] Wang, Z., Yen-Ku, K., Li, Z., An, N.B. and Abdul-Samad, Z., 2022. The transition of renewable energy and ecological sustainability through environmental policy stringency: Estimations from advance panel estimators. *Renewable Energy*, 188, pp.70-80.

[21] Zafar, M.W., Saeed, A., Zaidi, S.A.H. and Waheed, A., 2021. The linkages among natural resources, renewable energy consumption, and environmental quality: A path toward sustainable development. *Sustainable Development*, 29(2), pp.353-362.

[22] Zakaria Zadeh, A., Ahshan, R., Al Abri, R. and Al-Abri, M., 2024. Renewable energy integration in sustainable water systems: A review. *Cleaner Engineering and Technology*, 18, p.100722.

[23] Zhan, Z., Ali, L., Sarwat, S., Godil, D.I., Dinca, G. and Answer, M.K., 2021. A step towards environmental mitigation: do tourism, renewable energy and institutions really matter? AN ARDL approach. *Science of the Total Environment*, 778, p.146209.