

Green Technology and Artificial Intelligence: Bridging Innovation and Planetary Protection for a Sustainable Future"

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Abstract :

This study presents green technology as a cornerstone of global sustainability, leveraging innovative technologies to mitigate environmental footprints and enhance efficiency.

Key domains of this study include:

- Renewable energy (solar, wind), reducing fossil fuel dependence and carbon emissions.*
- Green buildings, utilizing eco-friendly materials and thermal insulation to minimize energy consumption.*
- Sustainable transport, deploying electric vehicles and AI-driven traffic management to alleviate congestion.*
- Circular economy, transforming waste into resources via advanced recycling and AI-enabled systems.*
- Green chemistry, replacing hazardous chemicals with biodegradable alternatives.*

this study achieved , Artificial Intelligence (AI) plays a pivotal role in optimizing these systems monitoring emissions, streamlining supply chains, and predicting equipment failures. Despite challenges such as high costs and data security risks, solutions lie in global cooperation, infrastructure investment, and supportive policies. Future implementation requires collaborative efforts among governments, corporations, and individuals to ensure equitable access and transform sustainability from a theoretical concept into a practical reality. By prioritizing resource preservation and climate justice, green technologies can secure a viable future for generations to come.

Keywords: Sustainability , Green Technology , Renewable Energy , Circular Economy, Artificial Intelligence

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1. INTRODUCTION

In a world where nature's cries for rescue grow louder, and climate crises declare a global state of emergency, green technology emerges as a compass guiding humanity toward a more sustainable and balanced future. This technology is not merely a set of modern tools—it is a scientific, economic, and ethical revolution redefining humanity's relationship with the planet. From solar panels that devour sunlight to transform it into clean energy, to smart cities managed by AI systems that minimize waste and maximize efficiency, these innovations weave together an integrated tapestry of solutions capable of addressing the most urgent environmental challenges.

Green technology transcends the notion of "reducing harm" to "creating sustainable benefit." In the renewable energy sector, wind turbines and hydropower systems convert natural forces into electricity without emissions. In green buildings, smart structures reduce energy consumption through innovative insulating materials and natural cooling systems. Meanwhile, in sustainable transportation, electric vehicles and hydrogen-powered trains redefine mobility, supported by intelligent networks that optimize traffic flow and slash emissions.

This technology is not confined to developed nations. In remote villages, homes glow with solar power, while in bustling cities, self-sufficient skyscrapers generate their own energy. It is a journey of global collaboration governments crafting supportive policies, companies investing in innovation, and communities embracing conscious consumption.

Yet challenges persist: **How do we balance technological progress with environmental ethics?**

The answer lies in a holistic vision where green technology becomes a bridge to climate justice a future where planetary preservation is not a luxury, but an inherent human right.

Today, we stand on the brink of historic transformation. Green technology is not a choice—it is an imperative necessity to write a new chapter in humanity's relationship with Earth. A chapter where resources are

preserved, life flourishes, and sustainability becomes the legacy we leave for generations to come.

2. Renewable Energy

The renewable energy sector experienced substantial growth in 2024, driven by unprecedented public and private investment and escalating demand for clean energy. Utility-scale solar and wind dominated new power generation capacity, constituting nearly 90% of additions in the first nine months of 2024, a significant rise from 57% in 2023. Solar capacity surged by 88% to 18.6 GW, surpassing hydropower and nuclear to become the fourth-largest installed capacity source, while wind additions declined by 14% (2.6 GW) due to persistent supply chain and permitting challenges. Despite this, wind generation exceeded coal-fired output for two consecutive months, marking a historic milestone. Battery storage capacity expanded by 64% (7.4 GW), primarily utilized for energy arbitrage and grid frequency regulation.

Projections indicate continued growth, with solar and storage expected to reach 128.2 GW and 30.9 GW, respectively, by year-end. Emerging demand drivers include cleantech manufacturing, AI-powered data centers, and direct air capture (DAC) facilities, collectively anticipated to add over 57 GW of demand by 2030. However, supply chain constraints, policy uncertainties, and competition with alternative clean energy sources pose challenges. Key 2025 trends encompass federal industrial policy alignment, AI-driven operational optimization, 24/7 renewable solutions, workforce development, and carbon market integration. The sector's trajectory hinges on leveraging technological maturity, modular scalability, and AI-enabled innovation to address escalating infrastructural demands while maintaining cost competitiveness and sustainability integrity (Deloitte, 2024)

2.1 The Role of Artificial Intelligence in Advancing Solar Energy Systems

As solar energy gains prominence as a clean and sustainable alternative, advancements in artificial intelligence (AI) have unlocked new frontiers for optimizing solar systems through intelligent solutions. By integrating advanced analytical algorithms, AI enables these systems to operate with higher efficiency and productivity (Ashif & Farhana, 2023)

✓ Predictive Analytics:

AI algorithms analyze historical data on solar output and weather patterns to forecast future energy production with increasing accuracy, leveraging machine learning techniques. These predictions enhance grid integration, distribution planning, and energy storage management

✓ **Smart Energy Management Systems:**

AI-driven systems monitor and coordinate key components such as solar panels, storage units, and inverters. By analyzing real-time data on solar irradiance, energy demand, and electricity pricing, these systems dynamically adjust operations to maximize production and minimize costs .

✓ **Fault Detection and Diagnosis:**

AI algorithms detect anomalies in sensor data from panels and equipment, facilitating proactive maintenance and reducing downtime. They also identify root causes of malfunctions, improving system reliability

✓ **Adaptive Solar Panel Tracking:**

AI-powered tracking systems optimize panel angles based on the sun's trajectory and weather conditions, boosting energy capture by up to 20%. This technology is particularly effective in regions with variable weather or partial shading.

✓ **Load Balancing and Energy Distribution:**

AI analyzes real-time consumption, generation capacity, and grid status to allocate energy between storage, grid export, and direct use. This intelligent automation minimizes waste and enhances solar reliance.

✓ **Holistic System Optimization:**

AI models identify inefficiencies such as shading or misaligned panels, proposing targeted improvements to boost productivity. These optimizations maximize economic returns and ensure long-term project sustainability

2.2 Artificial Intelligence-Driven Optimization in Hydropower Systems

Artificial Intelligence (AI) is a multidisciplinary field integrating computer science, mathematics, control theory, and related disciplines to design intelligent systems capable of optimizing complex operations, such as hydropower plants. Contemporary AI applications in this sector focus on operational performance enhancement through advanced computational models, as illustrated in. (Ashish , 2024)

a- AI Applications in Hydropower Performance Optimization:

✓ Load Management Optimization:

A study by Conteh et al, developed a hybrid system (ANFIS) combining Backpropagation Artificial Neural Networks and Fuzzy Logic for optimal load shedding. The ANFIS system demonstrated superior accuracy with lower error rates compared to traditional neural networks, particularly in sudden plant failure scenarios. **(Conteh, Tobaru, & All, 2017)**

✓ Energy Production Modeling and Prediction:

In a study focused on the Kayabogazi Dam, four artificial intelligence (AI) models were evaluated for predicting the dam's energy production output. These models included: XGBoost: An advanced machine learning model leveraging ensemble decision-tree architectures to iteratively refine predictions using historical data. MARS, ANN, and

SVM: Comparative models employing distinct algorithmic frameworks, such as artificial neural networks (ANN) inspired by biological neural processing and statistical pattern recognition techniques.

The findings revealed that the XGBoost model achieved superior predictive accuracy, closely aligning its estimates with empirical measurements. In contrast, the other models demonstrated incrementally diminished performance. This underscores the capacity of advanced AI methodologies to interpret complex interdependencies within energy production datasets (e.g., water flow variability, turbine efficiency parameters) more effectively than conventional approaches. Such capabilities hold significant potential for optimizing hydropower plant operations, minimizing energy losses, and enhancing grid reliability through data-driven decision-making. **(Kurt & Aslan, 2013)**

✓ Turbine Efficiency Enhancement

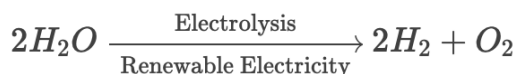
Other studies (e.g., Herath et al.) employed AI algorithms to forecast energy prices and identify optimal turbine operating conditions under demand constraints, improving economic sustainability. (Herath & Venayagamoorthy, 2016)

2.3 The Role of Artificial Intelligence in Advancing Green Hydrogen Production

a. Green Hydrogen: Definition and Significance

Green hydrogen is a form of hydrogen produced through water electrolysis powered exclusively by renewable energy sources (e.g., solar, wind, hydro). This process splits water (H_2O) into hydrogen (H_2) and oxygen (O_2) without carbon emissions, positioning it as a fully clean energy carrier.

Electrolyzers, powered by renewables, facilitate water splitting via the reaction:



This method ensures full decarbonization of hydrogen production.

b- The Role of Artificial Intelligence in Advancing Green Hydrogen Production

The integration of artificial intelligence (AI) into green hydrogen production has emerged as a transformative strategy to enhance operational efficiency, reduce costs, and accelerate the scalability of this critical decarbonization technology. As reported in the Global Hydrogen Review 2023, over 50 global projects now leverage AI-driven solutions, reflecting a 150% increase in AI-linked hydrogen investments from 2021 (200million)to2022(500 million) (International Energy Agency, 2023). This trend underscores the growing recognition of AI's potential to address technical and economic barriers in hydrogen ecosystems.

c- Regional and Corporate Initiatives

Europe and Asia lead in deploying AI for hydrogen innovation. In Europe, the HyAI consortium (backed by the EU Hydrogen Strategy) employs reinforcement learning to optimize a 100 MW electrolyzer plant, targeting a 15–20% reduction in levelized costs through dynamic management of electricity pricing and demand fluctuations. Similarly, Siemens Energy utilizes AI for predictive maintenance and operational analytics, aiming to preempt equipment failures and streamline energy inputs (Renewable Energy Association, 2024).

In Asia, Sinopec (China) is pioneering a digital twin platform for electrolyzers, enabling real-time operational modeling projected to boost efficiency by 10%. Indian Oil Corp integrates AI across its hydrogen value

chain, automating plant operations, refining supply logistics, and predicting maintenance needs (European Hydrogen Association, 2023). Major energy conglomerates—including Shell, BP, and Saudi Aramco—are similarly investing in AI to enhance hydrogen production scalability and grid integration (Hydrogen Council, 2024).

d- Impact on Production Efficiency

AI applications demonstrate measurable improvements in green hydrogen systems:

Operational Optimization: AI-driven electrolyzer control systems adjust parameters (e.g., voltage, temperature) in real time, narrowing the gap between theoretical and practical efficiency. The Hydrogen Council (2024) estimates a 10–15% efficiency gain, while techno-economic models project up to 25% improvement under integrated AI frameworks (EHA, 2023).

Predictive Maintenance: Machine learning algorithms reduce unplanned downtime by 30–40%, lowering maintenance costs and spare-part inventories (European Hydrogen Association, 2023).

Energy and Cost Savings: AI-enhanced renewable energy integration improves capacity factors by 25–30%, reducing electricity consumption by 10% and operational expenditures (OPEX) by 15–20% (Hydrogen Council, 2024; EHA, 2023). **(Ashish , 2024)**

3. Green Buildings

Green buildings represent a critical advancement in sustainable development, offering multifaceted environmental benefits such as waste reduction, enhanced biodiversity, and optimized renewable energy utilization. These structures are designed through methodologies prioritizing cost-effectiveness, energy efficiency, and occupant comfort, aligning with the triple-bottom-line framework of sustainability—environmental stewardship, social equity, and economic viability. The lifecycle approach to green building emphasizes eco-friendly practices from design to deconstruction, advocating for material reuse and recycling to minimize resource depletion and landfill contributions. Retrofitting existing structures with sustainable features further underscores the necessity of systemic upgrades to meet evolving environmental standards.

A significant challenge within the Architecture, Engineering, and Construction (AEC) industry is its substantial carbon footprint, responsible for approximately 40% of global greenhouse gas emissions. Traditional design practices exacerbate this issue, necessitating a paradigm shift toward low-carbon solutions. Building-Information-Modeling (BIM) emerges as a transformative digital tool, enabling precise environmental impact assessments through predictive modeling and real-time monitoring. By integrating BIM, stakeholders enhance energy efficiency, reduce emissions, and foster healthier built environments, aligning with Life Cycle Assessment (LCA) principles that identify operational phases as the most emission-intensive. (Abdulameer, Kamalrudin, & All, 2024)

3.1 Integration of Smart Technologies in Green Buildings for Enhanced Sustainability

Smart Green Buildings (SGBs) are undergoing transformative advancements through the integration of cutting-edge technologies such as Digital Twins (DTs), AI-enhanced Building Information Modeling (BIM), Internet of Things (IoT), and Genetic Algorithms (GA), aiming to achieve holistic sustainability. Recent studies highlight the following key developments:

✓ Digital Twins and Their Applications in Green Buildings

The study conceptualized a framework for Digital Twin-enabled Smart Green Buildings (DT-SGBs), emphasizing urban planning optimization through continuous ecological zones.

Despite the promising potential of DTs in simulating building performance, their full integration into SGB design remains limited, necessitating future designs to prioritize factors such as eco-friendly material selection and balancing development with societal needs.

✓ Energy Efficiency Optimization via Hybrid BIM Models

Researchers developed the GANN-BIM model, integrating Genetic Algorithms (GA) and Artificial Neural Networks (ANNs) to optimize internal energy consumption.

The model leverages BIM's capability to manage dynamic digital models, enhanced by AI to efficiently resolve conflicting design criteria with high computational efficiency.

Results indicate significant potential for reducing energy consumption through optimized architectural and structural layouts while maintaining occupant thermal comfort.

✓ **Green IoT and Carbon Footprint Challenges**

With IoT devices projected to exceed 170 billion by 2050, carbon emissions from their manufacturing and operation pose escalating risks.

The study proposed using Deep Learning (DL) and Data Mining Techniques (DMT) to refine Life Cycle Assessment (LCA) models, promoting device recycling and shortening manufacturing cycles.

Practical applications include reducing smart device setup costs, improving emission estimation accuracy, and advancing "Green IoT" objectives.

✓ **AI-Driven Natural Ventilation Systems**

The study focused on integrating wind catchers and solar chimneys with AI and IoT to enhance indoor air quality and reduce reliance on conventional HVAC systems.

Findings demonstrated substantial energy savings and noise reduction, aligning with green design principles.

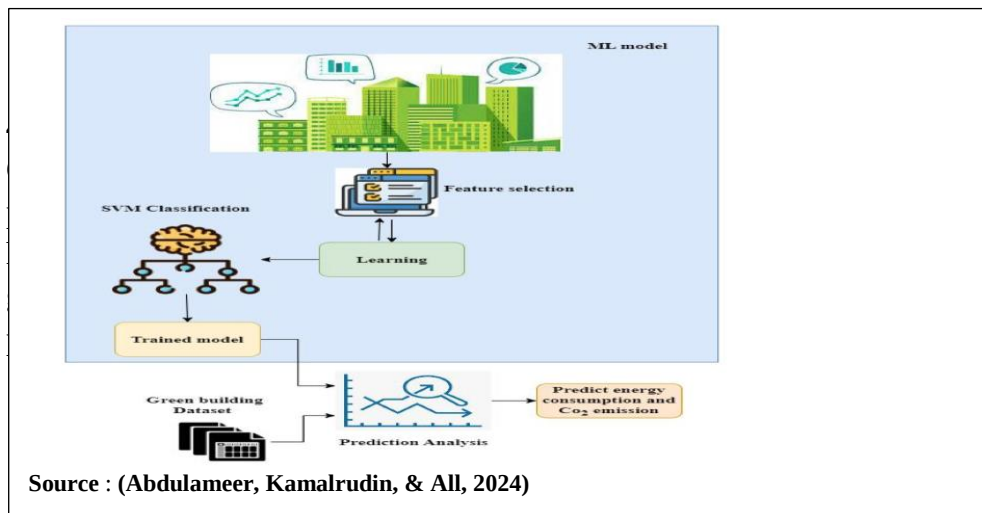
✓ **System Dynamics Models (SDM) for Holistic Sustainability**

The proposed SDM framework utilized metrics such as carbon footprint, water-food security, and nutrient recycling to optimize building performance through stormwater reuse and green energy harvesting.

In Scenario 3 (integrating rooftop farming and renewable energy), energy consumption decreased by 2.24%, with 82% nitrogen and 42% phosphorus retention, enhancing urban self-sufficiency.

✓ **Multi-Objective Optimization Using Genetic Algorithms**

The study introduced the GA-NSGA-II model to optimize green building designs, balancing economic efficiency and environmental sustainability. Hybrid models combining neural networks and Simulated Annealing demonstrated robust capabilities in resolving complex Multi-Objective Optimization (MOO) problems, positioning them as ideal tools for smart urban planning.



- ✓ Renewable Feedstocks: Utilizing biomass or CO₂-derived materials instead of non-renewable petroleum-based resources.
- ✓ Waste Minimization: Maximizing atom economy to ensure minimal byproduct formation.

Practical Applications:

- ✓ Biodegradable Materials: Producing polylactic acid (PLA) plastics from corn starch as alternatives to conventional petroleum-based plastics.
- ✓ Benign Solvents: Replacing hazardous organic solvents with water, supercritical CO₂, or ionic liquids.
- ✓ Sustainable Pharmaceuticals: Designing synthetic pathways for drugs that reduce toxic byproducts and energy consumption.

To establish a circular chemical economy that reduces ecological footprints, conserves finite resources, and safeguards ecosystems for future generations. By integrating innovative technologies—such as catalysis, solvent-free reactions, and AI-driven process optimization—green chemistry aims to reconcile industrial progress with environmental stewardship.

4.1 Synergizing AI and Green Chemistry for Sustainable Innovation

The integration of artificial intelligence (AI) and machine learning (ML) into green organic chemistry represents a paradigm shift, addressing the inefficiencies of traditional methodologies while aligning with the 12

principles of green chemistry. This synergy enhances reaction optimization, catalyst design, and waste reduction, fostering sustainable chemical processes. **(URINDERDEEP, EASHWAR, & All, 2024)**

✓ **AI-Driven Reaction Optimization**

Traditional reaction optimization, reliant on laborious trial-and-error experimentation, is being revolutionized by ML. By analyzing extensive datasets, ML models predict critical variables such as yield, reaction time, and selectivity, enabling chemists to pinpoint optimal conditions efficiently. For instance, developed a random forest model trained on 1,200 reactions to predict yields for pyrrole condensations, integrated into the user-friendly ChemPredictor platform. Similarly, utilized neural networks to rank reaction outcomes, achieving 71.8% accuracy in identifying major products, thereby streamlining synthetic route discovery. These advancements reduce resource consumption and environmental impact, epitomizing green chemistry's waste minimization principle.

✓ **Retrosynthesis and Pathway Design**

AI platforms like Syntelly and Chematica exemplify the shift toward eco-friendly synthesis. Syntelly's retrosynthetic analysis of pyrazoline derivatives (Fig. 1) suggests pathways prioritizing simplicity and availability of starting materials, though challenges in viability persist. further illustrate AI's capacity to propose energy-efficient routes, minimizing hazardous reagents and aligning with green chemistry's emphasis on safer solvents and reduced energy use.

✓ **Catalyst and Reagent Innovation**

Catalysts are pivotal in lowering activation energy and enhancing energy efficiency. AI accelerates their design by predicting performance and identifying sustainable alternatives. introduced the Chemical Markdown Language (CMDL) to fine-tune regression transformer models, enabling the generation of catalysts for ring-opening polymerization. employed AI subgroup discovery to identify catalytic "genes" for CO₂ conversion, correlating structural features with efficiency. These approaches reduce reliance on toxic metal-based catalysts, aligning with green chemistry's safer materials tenet.

AI also facilitates the discovery of organocatalysts and enzymes. leveraged NaviCatGA to evolve catalysts for the Pictet–Spengler reaction, while Zhou

& Huang integrated molecular simulations with ML for enzyme design, highlighting the role of comprehensive databases in biocatalyst development. Such innovations underscore AI's potential in replacing harmful reagents with biodegradable alternatives.

5. Sustainable Transportation

By transitioning to systems such as electric vehicles and renewable energy-powered transit, it reduces emissions, enhances public health, and fosters inclusive access to essential services. However, challenges like fossil fuel dependency, infrastructural gaps, and high costs hinder progress. Artificial Intelligence (AI) emerges as a transformative enabler, optimizing route efficiency through machine learning algorithms (e.g., Google Maps), managing electric vehicle fleets via predictive maintenance, and enhancing public transit accessibility through data-driven demand analysis. AI also supports energy transitions by integrating smart charging networks with renewable sources and promoting social inclusion via tailored mobility solutions for vulnerable groups. Despite its potential, barriers such as the digital divide, cybersecurity risks, and funding limitations require strategic interventions, including international partnerships, robust encryption frameworks, and public-private financing models. Looking ahead, technologies like blockchain for transparent supply chains and digital twins for system simulations promise to further revolutionize sustainable transport, underscoring the need for multidisciplinary collaboration to realize a low-carbon, equitable future aligned with global sustainability targets. (Vujadinovic, Damnjanovic, & All, 2024)

5.1 Sustainable Transportation and Artificial Intelligence in Achieving Global Development Goals

Sustainable transportation is a cornerstone for achieving the Sustainable Development Goals (SDGs) and the Paris Climate Agreement, due to its direct impact on economic, social, and environmental dimensions. Its benefits include

- ✓ Reducing carbon emissions by transitioning to clean energy-powered transport systems.
- ✓ Improving access to essential services (e.g., healthcare and education) in remote areas, thereby alleviating poverty.

- ✓ Promoting inclusive economic growth by creating jobs in sectors such as electric vehicle manufacturing and smart infrastructure maintenance. (Dhulasi & Saranya, 2023)

a- Applications of Artificial Intelligence in Transportation Systems

Road Transport:

- **Self-Driving Vehicles:**

Rely on computer vision to detect obstacles and analyze visual data.

Reduce accidents by up to 45% and optimize fuel efficiency through route enhancements.

- **Smart Truck Platooning:**

Electronically connected trucks synchronize acceleration and braking, cutting emissions.

Road and Parking Management:

Machine learning algorithms detect potholes and cracks via image analysis, enabling proactive maintenance.

- **Traffic Control**

Smart Congestion Management Techniques like Fuzzy C-means clustering and neural networks analyze traffic flow to reduce pollution.

- **Delay Prediction:**

Big data analytics predict arrival times, enhancing passenger experience and minimizing wait times.

- **Railways**

AI detects rail faults and infrastructure issues preemptively.

Example: Obstacle detection systems on Indian railway tracks.

- **Smart Infrastructure**

Automated Bridge and Road Inspections :Drones capture high-resolution images analyzed by deep learning algorithms, reducing human error and maintenance costs by 30%.

b- Challenges and Future Opportunities

- ✓ **Challenges:**

Technological Gaps: Countries like India face adoption barriers due to inadequate infrastructure and expertise.

Data Security: Collecting sensitive data (e.g., user locations) increases cybersecurity risks.

High Costs: Smart transport systems require significant investments in hardware and software.

✓ **The Future: AI as a Transformative Tool**

- Weather and Disaster Prediction:
- Deep learning models forecast conditions to prevent flight cancellations and ensure safer travel.
- Smart Maritime and Air Logistics:
- Data analytics optimize shipping schedules and reduce waste.
- Fully Autonomous Vehicles:
- Expected to revolutionize safety and efficiency by 2030.

6. Circular Economie

The circular economy is founded on a regenerative model aimed at minimizing waste and maximizing resource utilization through closed-loop production systems. Unlike the traditional linear "take-make-dispose" model, products are designed for multiple lifecycles. Artificial Intelligence (AI) plays a pivotal role in:

- ✓ **Resource Lifecycle Tracking:** Utilizing smart sensors and data analytics to monitor material flows from production to recycling.
- ✓ **Predictive Analytics:** Forecasting optimal intervention points to enhance recovery efficiency and reintegration.
- ✓ **Efficiency Enhancement:** Analyzing consumption patterns and identifying opportunities to improve supply chain efficiency.
- ✓ **Eco-Design:** AI tools are employed to assess the environmental impact of products, recommend sustainable materials, and enhance recyclability.
- ✓ **Waste-to-Resource Transformation:** AI applications contribute to automated waste sorting, improved recycling technologies, and innovative solutions for converting waste into energy or raw materials.

6.1 Current Applications of AI in Sustainability

- ✓ **Energy Management:** Optimizing consumption patterns and integrating renewable energy sources.
- ✓ **Precision Agriculture:** Increasing crop yields through climate and soil fertility data analysis.

- ✓ **Smart Transportation:** Reducing emissions via route optimization and traffic management.
- ✓ **Environmental Monitoring:** Tracking pollution and deforestation via satellites and sensors.

6.2 Economic Impact

- ✓ **Cost Reduction:** Enhancing efficiency and minimizing waste.
- ✓ **Job Creation:** Generating employment opportunities in recycling and renewable energy sectors.

6.3 Corporate Responsibility

- ✓ **Adoption of Eco-Design Principles:** Incorporating sustainability into product development.
- ✓ **Investment in Research Partnerships:** Fostering innovation in sustainable solutions.

(Singh, 2023)

7. Conclusion

this exploration of green technology's role in achieving sustainability, it becomes evident that these technologies are not merely alternatives to traditional models but an imperative necessity to address the environmental, economic, and social challenges facing the world. Innovations in renewable energy, green buildings, sustainable transportation, the circular economy, and eco-friendly chemistry have demonstrated their capacity to balance human progress with the preservation of natural resources. However, the path to a sustainable future demands intensified efforts and unprecedented global collaboration.

Recommendations to Advance Green Technologies:

▪ **Scaling Renewable Energy Adoption:**

Increase investments in solar and wind energy projects, particularly in developing nations, while advancing innovative energy storage systems (e.g., solid-state batteries) to ensure grid stability.

▪ **Integrating AI into Environmental Management:**

Develop specialized AI platforms for real-time carbon emission monitoring, resource efficiency optimization, and e-waste management, ensuring data ethics and transparency.

▪ **Strengthening Circular Economy Frameworks:**

Enact legislation mandating companies to recycle more than 80% of their products and support startups converting waste into construction materials or biofuels.

▪ **Building Integrated Smart Cities:**

Design cities fully powered by clean energy, featuring smart infrastructure such as electric public transit networks, innovative water management systems, and energy-positive buildings.

▪ **Boosting Research and Education:**

Allocate ..% of national GDP to green technology research and embed sustainability principles into educational curricula from early stages.

8. Liste Bibliographique

1. Journal article

- Abdulameer, M., Kamalrudin, M., & All. (2024). Artificial Intelligence-Enhanced Green Building Design for Environmental Sustainability. *Journal of Information Systems Engineering and Management*, 10(8).
- Ashif, M., & Farhana, M. (2023, June). Revolutionizing Solar Energy: The Impact of Artificial Intelligence on Photovoltaic Systems. *International Journal of Multidisciplinary Sciences and Arts*, 2(1).
- Ashish , K. (2024). AI-Driven Optimization for Green Hydrogen Production Efficiency. *Journal of Scientific and Engineering Research*, 11(6).
- Conteh, F., Tobaru, S., & All. (2017, SEP). An effective Load shedding technique for micro-grids using artificial neural

network and adaptive neuro-fuzzy inference system. *AIMS Energy*, 5(5).

- Dhulasi , P., & Saranya, K. (2023, Juin). Significance of artificial intelligence in the development of sustainable transportation. *The Scientific Temper*, 12(2).
- Kurt, H., & Aslan, Y. (2013, March). OPTIMIZATION OF POWER OUTPUT OF A MICRO-HYDRO POWER STATION USING FUZZY LOGIC ALGORITHM. *International Journal on "Technical and Physical Problems of Engineering*, 5(14).
- Singh, J. (2023, Dec). Artificial Intelligence in Circular Economies: A Pathway to Sustainable Resource Management. *International Journal of Science and Research*, 12(12).
- URINDERDEEP, S., EASHWAR, S., & All. (2024, Dec). Artificial Intelligence in Green Organic Chemistry: Pathway to Sustainable and Eco-Friendly Chemistry. *ASIAN JOURNAL OF CHEMISTRY*, 36(12).
- Vujadinovic, V., Damnjanovic, A., & All. (2024, Sep). AI-Driven Approach for Enhancing Sustainability in Urban Public Transportation. *Sustainability*, 16(17).

2. Website

- Deloitte. (2024, DEC). *2025 Renewable Energy Industry Outlook*. Consulté le sur Energy & Industrials: <https://www2.deloitte.com/us/en/insights/industry/renewable-energy/renewable-energy-industry-outlook.html> (MARS 2025)

3. Conferences

- Herath, P., & Venayagamoorthy, G. (2016). A service provider model for demand response management. *IEEE symposium*

*series on computational intelligence, Athens, Greece ,
December 2016*