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Renewable Energy on Sustainable Development of Urban Open and Green-Space-Management in the Federal Capital Territory, Abuja

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Abstract

The research examined the nature of facilities powered by **renewable energy** *and services rendered by operators of urban open and green space management (UOGSM) in the Federal Capital Territory (FCT), Abuja. In Abuja's FCT, the integration of renewable energy into UOGSM remains underexplored, despite its potential to enhance environmental quality and improve human wellbeing. This study addresses this gap by examining the benefits, challenges, and environmental impacts of renewable energy adoption in UOGSM. The study aims to assess the benefits and challenges of renewable energy-powered green space management, evaluate environmental sustainability, and analyse its impact on human wellbeing and environmental quality. Primary data were collected from 75 questionnaires administered across 5 strategically selected UOGSM facilities and service operators in the FCT. Descriptive and statistical analyses were employed to interpret responses regarding renewable energy adoption, operational challenges, and sustainability outcomes. The study revealed that 17.3% of respondents identified improved human wellbeing and daily living as the foremost benefit of renewable energy integration. However, 21.3% cited inflation and rising operational costs as major challenges. Notably, renewable energy and sustainable practices showed no significant variation in their impact on environmental quality, underscoring their consistent benefits. The findings highlight the dual role of renewable energy in promoting human wellbeing and environmental sustainability while identifying economic barriers. This research contributes to urban planning policy by advocating for cost-effective renewable energy solutions in UOGSM. The study recommends improved management strategies for renewable energy facilities and services in urban spaces. Future research should explore scalable models for mitigating economic constraints.*

Keywords: renewable energy, sustainable development, urban green spaces, facilities and services management, Abuja.

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1. Introduction

The management of spatial patterns, urban planning, and ideal location are synonymous with environmental studies, urban planning and sustainable development (Mabogunje, 2008). The combination of threats from the high influx of human population, environmental pollution, urbanization, housing, congestion, erosion, flood, waste management, water quality, urban-open-and-green-space-management, and social vices constitutes the fundamentals for the study of urban environmental management. Planning is essential to urban and regional growth and the development of existing and upcoming towns and cities in the urbanization process. Thus, the advancement is science and technology has helped the discovery of the sources of renewable energy that have been defined and redefined over time such as the indices of (i) renewable energy initiatives, viz-a-viz solar energy, energy efficiency, (ii)benefits of renewable energy, viz-a-viz environmental sustainability, economic growth, and improved quality of life (iii)challenges and opportunities, viz-a-viz energy access, infrastructure development, public-private partnerships (iv)sustainable urban development viz-a-viz green building practices, urban farming and community garden, waste management, and (v)policy and regulation viz-a-viz as supportive policies, climate action plans are parts of the ideal variables for smart cities and planning of urban areas, space management and green space areas (SDGs, 2024; Majebi, Agbebaku, Anierobi, & Afolayan, 2023;. Meta Al, 2025).

Renewable energy is energy derived from natural sources that are replenished at a higher rate than they are consumed. Sunlight and wind, for example, are such sources that are constantly being replenished. Renewable energy sources are natural resources that are constantly or rapidly replenished, providing a sustainable, inexhaustible energy supply in contrast to finite fossil fuels. These sources, including solar, wind, hydro, geothermal, and biomass energy, harness Earth's natural processes and typically have a low-to-zero carbon footprint, making them crucial for combating climate change (Meta Al, 2025). Thus, these indices help the retention and sustainability of the environment for solar energy initiatives, reduce human congestion and pollution, conserve resources, and maintain a pleasant microclimate of the region and control environmental pollutants. Though the relationship between a community and green spaces is complex, patronage of these facilities varies from (a)residents' income level and style of living, (b)region to region, and (c)religion to religion. Urban areas such as the Federal Capital Territory, Abuja, are full of these facilities with an even distributional spread.

In addition, metropolitan space management necessitates the drive and demand for land evaluation, specification and space management to attain a pleasant microclimate and environmental aesthetics and quality of the high-sprawl environment (Paul and Steven, 2010; Ibrahim, Ahmed, Usman and Ahmed, 2015; Eseigbe, 2021; ACB Consulting Services, 2021 & Meta Al, 2025). Consequently, by default, the term 'sustainable development' connotes effective management of resources of the components of the environment and the indices of one or a combination of urban management, ecological facilities, environmental degradation, pollution, waste management and climate change; and others such as human governance, the environmental impact of conflict, health, housing and urban development, policies and programmes, transportation and infrastructural facilities, the environmental impact of project and projected impact on climate change are what the concerned of the concept of environment and sustainable development (Paul and Steven, 2010; Agbebaku, 2019; Majebi, Agbebaku, Anierobi & Afolayan, 2023; Majebi & Agbebaku, 2024). But for this study, on renewable energy on sustainable development of urban open and green-space-management in the FCT, Abuja the focus will be on (a) renewable energy initiatives, such as solar energy, energy efficiency, (b)benefits of renewable energy, such as environmental sustainability, economic growth, and improved quality of life (c)challenges and opportunities, such as energy access, infrastructure development, public-private partnerships (d) sustainable urban development such as green building practices, urban farming and community garden, waste management, and (e)policy and regulation such as supportive policies, climate action plans (Meta Al, 2025).

However, studies have shown that these indices have been an abysmal threat in most urban cities of Nigeria and Africa if compared to other places in the advanced world. The term environment serves as the totality of our immediate surroundings. It is the complexity of physical, chemical and biotic factors upon which an organism or an ecological community ultimately determines its form and survival, while on the other hand, sustainable development entails evaluating past events in preserving and protecting the present and future generations. Thus, any damage done to the environment runs down capital, which sooner or later reduces the value of its recurrent services. The implication of this is that there is a need for sustainability of the environment and its resources for future use (Encyclopaedia Britannica, Vol. 4; Odiette, 1993 & Agbebaku, 2019).

Studies have shown that there exists some

level of synergy, interactions and dependency between and among the spheres of the ecosystem to maintain and sustain environmental balance. For instance, the atmosphere depends solely on vegetative covers of the biosphere for purification and likewise the hydrosphere for precipitation. Equally, the hydrosphere depends on the atmosphere for water supply; the lithosphere depends on the atmosphere and biosphere for vegetation cover, while the biosphere depends on the lithosphere for nutrients and support. The list is endless, and lastly, man, the fauna and flora depend squarely on all of these components for life, growth, development and sustainability (Cunningham & Cunningham, 2015; Majebi, Agbebaku, Anierobi & Afolayan, 2023). In FCT, Abuja, the state of the master plan from the Abuja Geographical Information System (AGIS) and the Abuja Environmental Protection Agency (AEPA), and the natural environment have been altered, degraded and deteriorated in the past, which needs to be corrected and improved upon. Presently, the state of urban open and green-space-management is still on the decline due to the nature of one or a combination of: human actions, authority and activities, as well as their quest for comfort (Odiette, 1993; Adedeji & Eziyi, 2010 & Eseigbe, 2021). Stakeholders of the environment as part of the measures to ameliorate this scourge has lined up a series of sensitization programmes, public enlightenment campaigns and sustainable development goals on the need to protect the ecosystem from further environmental degradation and threat on one hand while on the other to enhance environmental quality and benefits of urban open and green space management as (i)improving our day-to-day lives and human health (ii)boosting mental and physical health, (iii)promoting peace and relaxation (iv)improving air quality and reducing premature mortality. (v)reducing noise, (vi)enhancing biodiversity. In addition, there is the need for (vii) moderating temperatures during hot periods, (viii) providing cool and shaded areas, (ix)protecting and enhancing a safe environment, (x)creating scientific discoveries and technical jobs, and (xi)sparking youth's interest in tourism and hospitality ventures (Cyril & Olumide, 2016; Obiadi & Onochie, 2018; Eseigbe, 2021; Majebi, Agbebaku, Anierobi & Afolayan, 2023).

However, despite these benefits, these ventures are faced with the challenges of (i)renewable energy supply, (ii)high rate of illegal land use and land use violation (iii)compliance to land use of recreational facilities (iv)perception in human attitude and measures how these spaces are managed (v) assessment of financial positive of green space, and (vi)the need to provide urban mobility to green spaces area (vii)patronage, distance factors and security, and (viii)rising cost of facilities and services (Ibrahim, Ahmed, Usman & Ahmed, 2015; Agbebaku, 2019; Cyril & Olumide, 2016; Obiadi & Onochie, 2018; Eseigbe, 2021: Majebi, Agbebaku, Anierobi & Afolayan, 2023).

The objectives of the study were to evaluate the benefits and challenges of renewable energy on urban open and green space management, evaluate environmental growth and sustainability, and examine improved quality of human life and environmental quality in Abuja. Thus, the hypotheses of the study ascertain whether there is a correlation between renewable energy initiatives, green infrastructure, **and sustainability** of facilities, which vary significantly with environmental sustainability, economic growth, and improved quality of life **in the study area.**

However, many studies on urban planning have been carried out, but none of these studies has effectively combined an in-depth **assessment of** renewable energy on sustainable development of urban open and green-space-management viz-a-viz the operational and power maintenance, ecological synergy and co-benefits, policy and institutional fragmentation, and public-private partnership (PPP) financing models of these facilities and services in the FCT, Abuja, and this is the research gap. The choice of **Abuja metropolitan area** was pre-determined by a combination of factors such as (i)hub city-coordinating administrative, economic, political and cultural activities, (ii)home for tourist and hospitability, (iii)socio-economic activities at their peak (iv)influx of foreign and locals (d)fasted growing economy in Africa, and (e)security if compared to others parts of Nigeria, call for this research.

1.2 Statement of the Problem

In the past decade, service providers on urban open and green space management were not as effective and coordinated as they are in the current state in the City of Abuja. But in recent times, the mandates and philosophy of the Abuja Geographical Information System (AGIS), and the mission and vision statement of the present Minister of the FCT, Abuja, Barr. Ezenwo Nyesom Wike are operational and enforced. Thus, before now, there have been major **challenges on renewable energy supply,** high rate of illegal land use and land use violation, free grazing of **urban open and green land,** difficulty in measuring how these spaces are used, perception in human attitude, non-compliance to land use of recreational facilities, and assessment of the financial positive of urban open and green space, need to provide urban mobility to urban open green spaces

area, and barrier of distance, environmental quality, and security management of **urban open and green spaces.**

In essence, the challenges of the study are the (a)uncontrolled urban expansion, destroying green areas, and systemic economic, technical, and regulatory barriers preventing clean energy integration. Other challenges include the (b)severe decline and encroachment of green spaces, viz-a-viz master plan distortion and rapid ecological changes; (c)high financial and capital costs, viz-a-viz high initial investment and maintenance burden; (c)regulatory and governance weaknesses, viz-a-viz weak policy enforcement and corrupt allocations; and technical barriers and social inequity, viz-a-viz deficit in technical expertise and socio-economic disparities. On the other hand, the benefits of these facilities range from improving our day-to-day lives and human health, boosting mental and physical health, promoting peace and relaxation, improving air quality and reducing premature mortality, enhancing relationships, enhancing biodiversity, moderating temperatures during hot periods, provide cool and shaded areas, protecting and enhancing safety environment, creating scientific discoveries and technical jobs, sparking youth's interest in tourism and hospitality ventures and reducing noise pollution. Given these assertions, the **environmental impacts and sustainability** of these services and facilities on human health and environmental quality **are to be aligned with the mission and vision of the theme of sustainable development goals, which have been defined and redefined over the years.**

Thus, with the innovation of renewable energy, there have been improvements in recovery, redefinition, and upgrades of service providers and facilities in line with global standards and practices. For instance, there has been an increase in the number of revitalisations of these services and facilities for the benefit of (i)human health, (ii)ecosystem balance, (iii) conservation of biotic life, and (iv) an aesthetic environment for quality air. Furthermore, there has been renewed support for the goals of sustainable development, with the government and concerned agencies working on the development of designated areas marked for such services and facilities from the master plan of Abuja and the resuscitation of non-functioning ones. While areas where these facilities have been earmarked but taken over by individuals, agencies have been relieved of such spaces, where possible, re-assigned and leased to bidders for such services and facilities by the current administration of the FCT, Abuja.

2. Conceptual Clarification

Urban Planning and Development

According to the studies of Ojeifo (2005) & Ivbijaro (2012), as cited by Eseigbe (2021), planning is important to any successful environmental management system. Planning offers a way to optimise resources and leads to preventive measures and anticipation of future environmental changes. It positions organisations to take a competitive advantage rather than responding only to challenges as they occur. Man plans to be able to solve his immediate problems and advance solutions to the problems that may crop up in the future to guarantee human existence on the earth's surface. Given this, effective planning smoothens implementation and minimises environmental burdens since many of the sources of environmental burdens would have been anticipated and addressed. In the past, the efforts of the Directorate of the Federal Capital Development, Abuja, have not been doing enough to enhance full compliance and address defaults in urban open and green space management.

Sustainable Development

The concept of sustainable development is concerned with improving the quality, maintainability, and conservation of the Earth's resources. According to the study of Cunningham & Cunningham (2015), Ivbijaro & Akintola (2012), and the SDGs (2024), meeting the needs of people now is the main priority of the concept of sustainable development, but guiding those resources for their great-great-grandchildren is a huge task and needs to be accomplished. Thus, Agenda 21 of the 1992 Earth Summit (Rio de Janeiro), of the United Nations, mentioned that there are twenty-seven (27) Principles for sustainable development. But thirteen (13) of these principles are of special relevance to the field of environmental sciences (Irbijaro & Akintola, 2012).

These 13 principles are: (i. combating poverty; (ii. reducing resource consumption; (iii. population growth; (iv. health care and environmental sanitation; (v. sustainable cities; (vi. environmental policy; (vii. Protection of the atmosphere; (viii. Combating desertification and drought; (ix. Combating deforestation and protecting biodiversity; (x. Agriculture and rural development; (xi. Women and youth empowerment; (xii. Freshwater and coastal water resources; and (xiii. Mountainous areas. Cunningham and Cunningham (2015) submitted that these factors of sustainable development are major problems in Africa and other developing nations of the world. For instance, un-managed waste materials render the environment filthy, degrading and abysmal,

effects from this menace lead to environmental degradation and global threat but where the waste materials are well managed, it leads to enormous prospects such as (a)job creation (b)income generation (c)foreign exchange (d)environmental quality and (e) sustainable development of the earth's resources. Furthermore, the 17 targets of the sustainable development goals (SDGs, 2024), submitted that the goals of sustainable development are to (a)end poverty in all forms everywhere, (b)end hunger, achieve food security, and improved nutrition and promote sustainable agriculture, (c)ensure healthy lives and promote well-being for all at ages, (d)ensure inclusive and equitable quality education and promote life-long learning opportunity for all, (e)achieve gender equity and empower all women and girls, (f)ensure availability and sustainable management of water and sanitation for all, (g)ensure to accessible, affordable, sustainable and modern energy for all, (i)promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all, (j)build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation, (k)reduce inequality within and among countries, (l)make cities and human settlements inclusive safe resilient and sustainable, (m)ensure sustainable consumption and productive patterns, (n) take urgent action to combat climate change and its impacts, (o)conserve and sustainable use the oceans, seas, and marine resources for sustainable development, (p)protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably menage forest, combat desertification, and halt and reverse land degradation and halt biodiversity, (q) promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels, (r)strengthen the means of implementation and revitalize the global partnership for sustainable development.

Management of Urban Open and Green Space

Urban spaces are places of encounter within metropolitan areas that can facilitate political mobilisation, stimulate actions and recreation and help prevent crime. They are environments for interaction and exchange of ideas that impact the quality of the urban environment. The components of urban space include size, shape, scale, density, land uses, building types, urban block layout and distribution of green space. Examples of urban space management include marketplaces, city squares, parks, civic buildings, even sidewalks and streets, and transport hubs, all of which are various examples of public urban spaces that need renewable energy for effective operations and management. On the other hand, green belt areas are associated with urban areas, in line with the master plan, and are areas that have been designated for beautification, greenification and the benefits of the establishment of parks for recreation that will add value to human life and enhance the quality of the environment in terms of clean air and conservation of fauna and flora of the immediate environment. Green areas are strictly reserved as recreational parks, professionally landscaped with grass and flora to retain their natural splendour and at the same time avoid disruption of the ecosystem. Numerous parks dot the entire face of the city. Private developers who are in the best position to guarantee a very high standard of maintenance manage the parks. However, the essence of the designation of urban space and green belt areas is for a clean and healthy environment from noise, pollution, traffic jams, congestion, filth and dirt (Ojeifo, 2005; Cyril & Olumide, 2016; Obiadi & Onochie, 2018; Eseigbe, 2021; Rayleigh, 2021; Majebi, Agbebaku**,** Anierobi & Afolayan, 2023).

Renewable Energy on Sustainable Development of Urban Open and Green-Space-Management

According to the studies of Dokun (2008), Mabogunje (2008), Ujoh, Fanan, Isa & Olarewaju (2011). Ivbijaro & Akintola (2012), Ivbijaro (2012), Cyril & Olumide (2016), Eseigbe (2021), Majebi, Agbebaku**,** Anierobi & Afolayan (2023), SDGs (2024), Meta Al (2025), the essentials of renewable energy on sustainable development of urban open and green space management, focused on:

a. Renewable Energy Initiatives

i. Solar Energy: Abuja has already started exploring solar energy initiatives, such as installing solar panels on city halls, households, parks, and street lighting. This shift to clean energy not only reduces carbon emissions but also lowers energy costs.

ii. Energy Efficiency: Implementing energy-efficient technologies in buildings and infrastructure can significantly reduce energy consumption and promote sustainable development

iii. Green Building Synergy: Discuss integrating renewable energy systems into green building designs within and around green spaces to reduce overall urban energy demand and footprint.

iv. Other Renewables: Examine potential for biomass energy or other localised renewable solutions suitable for urban green spaces.

b. Green Infrastructure and Renewable Energy

i. Green Networks: Investigate how green networks (parks, tree-lined streets) can be integrated with

renewable energy systems, such as solar-powered lighting for pathways.

ii. Biophilic Design: Link green building principles to energy efficiency and occupant well-being, creating healthier, more sustainable urban environments within open spaces.

iii. Water Management: Discuss how green spaces with features like water features can contribute to city evaporative cooling, and also incorporate renewable energy for water pumping and irrigation.

c. Socio-Economic & Environmental Aspects

i. Community Well-being: Assess how renewable energy in green spaces can improve quality of life and community access to resources like reliable lighting and sustainable power.

ii. Economic Viability: Analyse the cost-effectiveness of renewable energy solutions for managing green spaces, including potential savings on energy bills and job creation in green technologies.

iii. Environmental Benefits: Highlight how renewable energy use in green spaces reduces greenhouse gas emissions and mitigates the urban heat island effect, improving the environmental quality of Abuja.

d. Benefits of Renewable Energy

i. Environmental Sustainability: Renewable energy can help mitigate climate change by reducing greenhouse gas emissions and promoting sustainable urban development.

ii. Economic Growth: Investing in renewable energy can drive economic growth, create jobs, and improve energy access for millions of Nigerians.

iii. Improved Quality of Life: By promoting green spaces and reducing pollution, renewable energy can contribute to a better quality of life for Abuja's residents

e. Challenges and Opportunities

i. Energy Access: Despite Nigeria's abundant resources, many areas lack access to reliable energy. Thus, renewable energy can help bridge this gap.

ii. Infrastructure Development: Developing robust supply chains and infrastructure is crucial for scaling up renewable energy solutions.

iii. Public-Private Partnerships: Collaboration between government agencies, private sector stakeholders, and civil society organisations is essential for successful renewable energy projects.

f. Sustainable Urban Development

i. Green Building Practices: Abuja has seen an increase in green building practices, with a focus on sustainable design, materials, and energy-efficient technologies.

ii. Urban Farming and Community Gardens: Initiatives like urban farming and community gardens can promote local food production, reduce reliance on imported goods, and foster community engagement.

iii. Waste Management: Effective waste management strategies, including recycling programs and waste reduction initiatives, are critical for maintaining a clean and healthy environment.

g. Policy and Regulation

i. Supportive Policies: The government can play a crucial role in promoting renewable energy by implementing policies that incentivise investment and foster fairness.

ii. Climate Action Plans: Abuja's Sustainable Energy Access and Climate Action Plan is a step in the right direction, aiming to reduce emissions and increase access to clean energy.

iii. Policy Frameworks: Review existing urban planning policies and their effectiveness in integrating renewable energy and green space management for sustainable development in the FCT.

iv. Regulatory Gaps: Identify any policy or regulatory challenges hindering the adoption of renewable energy and sustainable practices in the management of green spaces.

v. Community Engagement: Ascertain the importance of involving residents in planning and managing green spaces to ensure the successful adoption and maintenance of renewable energy solutions.

vi. Public-Private Partnerships**:** Explore ways to foster collaborations to fund, develop, and implement renewable energy projects within Abuja›s urban green infrastructure



Plate 1: A glimpse of renewable energy

Sources: Open Access Resources, Google Maps, 2025



Plate 2: A glimpse of renewable energy

Source: Open Access Resources, Google Maps, 2025



Plate 3: A glimpse of urban open and green space



Plate 4: A glimpse of the BMT garden is located in Wuse 2, FCT, Abuja.

Source: Open Access Resources, Google Maps, 2025

3. Research Methods

This paper is purely an experimental survey and a combination of content analysis of articles from the literature and field surveys. It utilises evidence mainly from primary and secondary sources and observed information from field surveys. Secondary data were sourced mainly from existing literature, academic journals, conference papers, theses, internet materials and other archival sources. The research instrument was the use of questionnaires and in-depth interviews as designed and framed by the researcher for the study. The questionnaire was in two sections, viz-a-viz, section A and section B. Section A sought personal or demographic data from the respondents on their age, sex, marital status, and qualification. Section B focuses on questions regarding the subject matter that would enhance the validity and reliability of results; allowance is made for sampling error as well as a standard error that could result due to imperfection in the sampling procedure.

Questionnaire Administration and Distribution

A total of seventy-five (75) copies of questionnaires were designed and administered to 5 selected major service providers and clients of the urban open and green space areas within the Abuja metropolitan area for firsthand information on their facilities, services, operations and patronage. From the total number of 75 copies of questionnaires administered, 15 copies of the questionnaires were administered each to the 5 selected service providers and operators of these facilities on the ratio of 3/12, that is 3 copies of the questionnaires were administered to staff of each service providers (manager, supervisor/ foreman and environmental attendance) on each facility and service centre and the remaining 12 copies were administered to clients, that is 1 copy each to 12 clients, bringing the total administered per centre to 15. Given this, from the 12 copies administered to clients, 4 copies of the questionnaires were administered in the morning between the hours of 9am to 1pm, and from the remaining 8 copies, 4 copies were administered in the afternoon between the hours of 1pm to 5pm, and the remaining 4 copies were administered in the evening between the later hours of 6pm to 10pm on daily bases during the duration of study. Each copy of the questionnaire was administered at an interval of one hour and within a period of 5 days, inclusive of the weekend (Wednesday to Sunday), where the buildup to a high level of patronage was recorded. The choice of the selected facilities and service providers was characterised by a combination of factors such as (i)non-compliance with the Land Use Act on recreational facilities; (ii) geographical location of facilities across the city (iii) level of patronage; (iv)level and nature of facility and services rendered; (v)aesthetics and environmentally friendliness; (vi)space management; (vii)scenic landscapes; (viii)areas of outstanding natural beauty; and (ix) proximity of facilities and security.

To achieve this, 60% of the selected recreational centres that constitute the major service providers for these facilities and services were randomly selected. These facilities and service centres were spatially distributed within the highly populated areas of Garki 1 and 11, and Wuse 1 and 11 districts of the FCT metropolitan area. Thus, the five (5) selected facilities used for the study, comprising urban open and green space management such as the Abuja Millennium Park, National Arboretum and Botanical Garden, and Nelson Nuke Garden, located in Garki metropolis, covered an area of 50 to 100 hectares. The other two facilities for the study were recreational parks and services, such as the River Parks and Garden and the Park View and Garden, located in Wuse, covering an area of 40 to 80 hectares. The questionnaires were systematically and purposively administered to the hosts and visitors. Data from the study were analysed using the appropriate descriptive and inferential statistical techniques. Figures, plates, and tables were used for the descriptive analysis, while the inferential statistical techniques of 2-way analysis of variance (ANOVA) were used to test the stated objective and hypothesis of the study.

4. Results Presentation and Discussion

Table 1

Characteristics of renewable energy on the sustainable development of urban open and green-space-management

Variables of Renewable Energy	Frequency	Percent (%)
a. Renewable Energy Integration		
Solar energy	5	4.0
Energy efficiency	3	3.3
Green building synergy	3	3.3
Other renewables	3	3.3
b. Green Infrastructure and Renewable Energy		
Green networks	5	4.0
Biophilic design	3	3.3
Water management	5	4.0
c. Socio-Economic & Environmental Aspects		
Community well-being	5	4.0
Economic viability	3	3.3
Environmental benefits	3	3.3
d. Benefits of Renewable Energy		
Environmental sustainability	3	3.3
Economic growth	5	4.0
Improved quality of life	3	3.3
e. Challenges and Opportunities		
Energy access	5	4.0
Infrastructure development	2	2.12
Public-private partnerships	5	4.0
f. Sustainable Urban Development		
Green building practices	2	2.12
Urban farming and community gardens	2	2.12
Waste Management	5	4.0
g. Policy and Regulation		
Supportive policies	5	4.0
Climate action plans	2	2.12
Policy frameworks	3	3.3
Regulatory gaps	1	0.78
Community engagement	3	3.3
Public-private partnerships	5	4.0
Total	**75**	**100**

***Source**: Fieldwork, 2025*

The results from Table 1 show responses on the characteristics of renewable energy on the sustainable development of urban open and green-space-management. From the Table, it was revealed that responses from the characteristics of solar energy, green networks, community well-being, economic growth, energy access, waste management, supportive policies, and Public-private partnerships were tied and

had the highest count of 5, and this represents 4.0%. This was followed by responses with counts from energy efficiency, green building synergy, biophilic design, economic viability, environmental sustainability, improved quality of life, policy frameworks, and community engagement, which were also tied, and these represent 3.3%. Thus, these two variables and characteristics constitute 80%, while the remaining 20% is spread across other variables and characteristics. These findings are consistent with the summation of Majebi, Agbebaku, Anierobi, & Afolayan (2023) and SDGs (2024) that there are shared characteristics of renewable energy on the sustainable development of urban open and green-space-management.

Table 2

Benefits of **urban open and green space management** *on humans*

Variables	**Frequency**	**Percent (%)**
Improving our day-to-day lives and human health.	13	17.3
Boosting mental and physical health.	10	13.3
Promoting peace and relaxation.	08	10.7
Improving air quality and reducing premature mortality.	03	04.0
Enhances relationships	06	08.0
Enhancing biodiversity.	03	04.0
Moderating temperatures during hot periods.	06	08.0
Providing cool and shaded areas.	05	07.7
Protecting and enhancing a safe environment.	07	09.3
Creating scientific discoveries and technical jobs.	06	08.0
Sparking the youth's interest in tourism and hospitality ventures.	03	04.0
Reducing noise pollution.	05	07.7
Total	**75**	**100**

***Source**: Fieldwork, 2025.*

The results from Table 2 show responses on the benefits of **urban open and green space management** on human health. From the Table, it was revealed that responses on improving our day-to-day lives and human health have the highest count of 13, and this represents 17.3%. This was followed by responses of boosting mental and physical health, which resulted in 10 counts, and this represents 13.3%. Next to these were the responses of promoting peace and relaxation with 08 counts, thus representing 10.7%. Responses for protecting and enhancing the safe environment account for 07, and this represents 09.3%. Furthermore, the trio of responses from the combination of enhanced relationships, moderating temperatures during hot periods and creating scientific discoveries and technical jobs were tied, and these account for 06 and represent 08.0% each, respectively.

In addition, responses to the above-mentioned benefits account for a total of 56 counts and thus represent 74.7% while the remaining benefits of **urban open and green space management** on human health such as improving air quality and reducing premature mortality, enhancing biodiversity, providing cool and shaded areas, sparking youth's interest in tourism and hospitality ventures and reducing noise pollution accounts for a total of 19 counts and this represents 25.3. Thus, these benefits of the facilities and services have helped in one way or the other to promote, relax and improve human health physically and mentally owing to the scenic

environment. These findings are consistent with the summation of Majebi & Agbebaku (2024), SDGs (2024), & Meta Al (2025) that there are shared benefits and relationships of renewable energy on sustainable environmental development, economic growth and improved quality of life.

Table 3

Challenges of **urban open and green space management** *on the environment*

Variables	Frequency	Percent (%)
Energy access	10	13.3
High rate of illegal land use and land use violation	04	5.4
Difficult to measure how these spaces are used.	05	7.7
Perception in human attitude	04	4.0
Non-compliance with land use of recreational facilities	13	17.3
Assessment of the financial benefits of urban open green space	04	5.3
Need to provide urban mobility to urban open green space areas	10	13.3
The barrier of distance and security	10	13.3
Moderate patronage, inflation and rising cost of facilities and services	15	21.3
Total	**75**	**100**

***Source**: Fieldwork, 2025.*

Thus, Table 3 shows responses to the challenges of **urban open and green space management** on the environment. From the Table, it was revealed that responses from service operators on moderate patronage due to inflation and the rising cost of facilities and services got the highest count of 15, which represents 21.3%. This was followed by responses to non-compliant land use of recreational facilities, with 13 counts, which represent 17.3%. Furthermore, the responses from the combination of energy access, the need to provide urban mobility to urban open green spaces areas, and distance and security were tied, and these accounted for 10, which represented 13.3% each, respectively. In addition, responses from difficult-to-measure how these spaces are used were 05 counts, thus representing 07.7%.

In addition, responses to the assessment of the financial benefits of urban open green space account for 04, and this represents 05.3%, and responses of perception in human attitude constitute the least counts from the rear, and this accounts for 03, and this represents 04.0%, respectively. However, one or a combination of the above-mentioned challenges are reasons faced by operators of these service providers within the Abuja metropolitan area. These findings are consistent with the summation of SDGs (2024) and Meta AI (2025), that despite Nigeria's abundant resources, many areas lack access to reliable energy, while collaboration between government agencies, private sector stakeholders, and civil society organisations is essential for successful renewable energy projects that will further enhance patronage of these facilities and services.

Table 4

Environmental impacts and sustainability of urban open and green space management on humans and the environment

Variables	Frequency	Percent (%)
Positively influence human health.	15	20.0
Promote noise pollution and environmental ill-quality.	12	16.0
Environmental degradation	09	12.0
Land excavation.	09	12.0
Loss of biodiversity and attraction of insects	07	9.3
Enhances relationships and attractiveness, given an enabling environment	14	18.7
Balances the health, environmental and economic needs of our communities for sustainability	19	25.3
Total	**75**	**100**

***Source**: Fieldwork, 2025*

The result from Table 4 shows responses on the **environmental impacts and sustainability of urban open and green space management on humans and the environment**. From the Table, it was revealed that responses on balancing the health, environmental and economic needs of our communities for sustainability got the highest count of 19, and this represents 25.3%. This was followed by responses of positively influencing human health, and this resulted in 15 counts, thus representing 20.0%. Next to these were the responses of enhanced relationships and attractiveness, giving an enabling environment, with 14 counts and thus representing 18.7%, while responses of promoting noise pollution and environmental ill-quality were 12 counts and thus represented 16.0%.

Furthermore, the two responses from the combination of environmental degradation and land excavation were tied, and these accounted for 09 and represented 12.0% each, respectively. In addition, responses from difficulty in measuring how these spaces are used were 05 counts and thus represent 07.7%. In addition, responses of loss of biodiversity and attraction of insects account for 07, and this represents 09.3%. Given these analyses, there is a correlation between the impacts of the facilities and services on humans in particular and on the need to sustain these facilities and services on environmental quality and the friendliness of the physical and human environment. In summary, the **environmental impacts and sustainability of urban open and green space management on humans and the environment** can be classified into **c**ommunity well-being, economic viability, and environmental benefits.

Table 5

Variables Used to Compute the Hypothesis

Renewable Energy Initiatives and Green Infrastructure	**Non-Compliance with the Land Use Act on Recreational Facilities**	**Aesthetic and Environmentally Friendly**	**Facility and Services Rendered**	**Historic Landscapes Outstanding Natural Beauty**	**Space Management: Proximity of Facilities**
Solar Energy	Clean Air	Clean Air	1st Class Modern	Springs Lakes and Ponds	Small, Medium and Large
Energy Efficiency	Clean Water	Clean Water	2nd Class Semi-Modern		Central and Easily Accessible
Other Renewables	Clean Land	Clean Land	3rd Class In-between	Mountains, Hills and Bays	Hidden and Barrier Distance
Green Building Synergy	Safety of Human Health	Safety of Human Health	4th Class	Carves	Accommodating and Spacious
Green Networks	• Environmental Balance • Scenic Environment	• Environmental Balance • Scenic Environment	Rudimentary	• Valleys and Plateaus • Biological Garden of Flora and Fauna	• Congested and Crowded • More Weekend and Seasonal Management
Biophilic Design					
Water Management					

***Source**: Fieldwork, 2025*

The result from the Table 5, shows the 6 variables and their characteristics such as renewable energy initiatives and green infrastructure, non-compliance to the land use act on recreational facilities, aesthesis and environmentally friendly, facility and services rendered, historic landscapes outstanding natural beauty and space management proximity of facilities and their sub-indices used in the analyses of variance on renewable energy initiatives and green infrastructure **and sustainability** of facilities does not vary significantly on environmental sustainability, environmental growth and improved quality of life **in the study area.**

Table 6

Analysis of Variance on renewable energy initiatives and green infrastructure and **sustainability** *of facilities does not vary significantly on environmental sustainability, environmental growth and improved quality of life* **in the FCT-Abuja**.

2-Way ANOVA						
		Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Renewable Energy Initiatives and Green Infrastructure	Between Group	9.320	1	8.354	15.564	0.000
	Within Groups	8.456	74	0.563		
	Total	**17.776**	**75**			
Non-Compliance with the Land Use Act on Recreational Facilities	Between Groups	9.150	1	9.150	16.757	0.000
	Within Groups	4.265	74	0.546		
	Total	**13.415**	**75**			
Aesthesis and Environmentally Friendly	Between Groups	29.467	1	29.467	5.600	0.020
	Within Groups	26.220	74	5.262		
	Total	**55.687**	**75**			
Facility and Services Rendered	Between Groups	1.686	1	1.686	8.447	0.005
	Within Groups	16.169	74	0.200		
	Total	**17.855**	**75**			
The Historic Landscapes Outstanding Natural Beauty	Between Groups	1.353	1	1.353	5.720	0.019
	Within Groups	19.153	74	0.236		
	Total	**20.506**	**75**			
Space Management Proximity of Facilities	Between Groups	1.853	1	1.686	5.702	0.004
	Within Groups	16.153	74	0.198		
	Total	**17.006**	**75**			

***Source**: Fieldwork, 2025*

The results from the table show a 2-way ANOVA of the sum of squares and mean square for (a) renewable energy initiatives and green infrastructure between groups were 9.320 and 8.354, respectively, and within groups were 8.456 and .563, respectively. (b)Non-compliance with the land use act on recreational facilities between groups was 9.150 and 9.150, respectively, and within groups was 4.265 and .546, respectively. (c)aesthesis and environmentally friendly between groups were 29.467 and 29.467, respectively, and within groups were 26.220 and 5.262, respectively. (d)Facility and services rendered between groups were 1.686 and 1.686, respectively, and within groups were 16.196 and .200, respectively. (e) Historic landscapes outstanding natural beauty between groups were 1.353 and 1.353, respectively, and within groups were 19.153 and .236, respectively, and (f)space management proximity of facilities between groups were 1.853 and 1.686, respectively, and within groups were 16.153 and .198, respectively. Standard deviation (pdf) was constant between groups 1 and 74 within groups for all the variables from a to f, respectively. However, there were variations in the values of the frequency column of the computed Table. From a significant point of view, the stated hypothesis indicates that the

correlation of renewable energy initiatives, green infrastructure **and sustainability** of facilities does not vary significantly with environmental sustainability, economic growth, and improved quality of life **in the FCT-Abuja,**

5.1 Summary of Findings

The study examined the role of renewable energy in the sustainable development of urban open and green-space-management in the FCT, Abuja. People's perceptions, knowledge and attitudes toward the environment and sustainable development need to be defined and redefined from time to time. Summits on environment and sustainable development aimed at turning the lofty goals, promises and commitments of varied Earth summits on sustainable development into concrete and tangible actions, to advance and strengthen the interdependent and mutually reinforcing pillars of sustainable development in the sectors of economic, social and environmental. **Thus, urban open and green space management helps to** improve our day-to-day lives and human health, boosting mental and physical health, improving air quality and reducing premature mortality, enhancing biodiversity, providing cool and shaded areas, sparking youth's interest in tourism and hospitality ventures and reducing noise pollution.

The focus of renewable energy on sustainable development are: (a)renewable energy initiatives, viz-a-viz solar energy, energy efficiency, (b)benefits of renewable energy, viz-a-viz environmental sustainability, economic growth, and improved quality of life (c)challenges and opportunities, viz-a-viz energy access, infrastructure development, public-private partnerships (d)sustainable urban development viz-a-viz green building practices, urban farming and community garden, waste management, and (e)policy and regulation viz-a-viz supportive policies, climate action plans.

5.2 Conclusion

This study reveals that the significance of renewable energy and green infrastructure on human well-being is a major benefit of urban open and green spaces, accompanied by facilities. However, the benefits of renewable energy and challenges confronting UOGSM have been revealed by this study. Stakeholders should take the initiative on renewable energy and green infrastructure, viz-a-viz the benefits of renewable energy, such as environmental sustainability, economic growth and improved quality of life. In promoting green spaces and reducing pollution, renewable energy can contribute to a better quality of life for Abuja's residents. Consequently, stakeholders can work together to create a more sustainable and resilient urban environment in Abuja, leveraging renewable energy to drive economic growth, improve quality of life, and protect the environment. Furthermore, the indices of renewable energy and green infrastructure will enhance the improvement in the provision of facilities, service providers and delivery to mitigate the benefits of urban open and green space management for human health and sustainability of environmental quality. In addition is a drive for stricter measures from the government, and defaulters are brought to book for the sustainability of the industry. Thus, the findings confirm that renewable energy offers significant benefits for human health and environmental sustainability. However, economic challenges, particularly inflation and high operational costs, present substantial barriers to wider adoption.

1.3 Recommendations

The study recommends that for the operations of the industry to be sustained, there should be integration of renewable energy and green infrastructure with improvements in facilities and services for the well-being of humans and environmental quality. To overcome the identified challenges, there should be policy intervention, capacity building, public-private partnerships and future research.

References

Abuja Geography Information System (AGIS, 2022). *AGIS yearly bulletin*, Abuja.

abujalandagents.com; https://www.abujalandagents.com

ACB Consulting Services (2021). *The challenges of urban green space and how they might be resolved*. Sustainable Construction Project Management. Online Resource. https://www.acbconsultingservices.com/

Adams, H. (2010). *Awake: Our Battered Earth* (January 22, 2000), 3-11.

Adedeji, D., & Eziyi, O.I. (2010). Urban environmental problems in Nigeria: Implications for Sustainable Development. *Journal of Sustainable Development in Africa. 12(1),* Pennsylvania.

Adejoke, O. A. (2024). Sustainable development goals (SDGs) and targets. United Nations Information Centre (UNIC), Lagos

Adewole, A. T. (2009). Waste management towards sustainable development in Nigeria: A Case Study of Lagos State. *International NGO*

Journal, 4(4), 173-179. http;// www. academicjournals.org/1993–8225 © 2009 Academic Journals.

Agbebaku, H. U. (2018). *A spatial analysis of solid waste management and environmental quality in Benin Metropolis, Edo State, Nigeria*. A Ph.D. Research Proposal Presented to the Department of Geography and Environmental Management, Ambrose Alli University, Ekpoma, Edo State, Nigeria.

Agbebaku, H. U. (2016). *Environmental degradation in Nigeria*, A PhD Seminar Paper Presented to the Department of Geography and Environmental Management, Ambrose Alli University, Ekpoma, Edo State, Nigeria.

Agbebaku, H.U. (2019). An empirical analysis of the indices of environment and sustainable development in Nigeria from 2008 to 2018. *Journal of Geography and Development, Benue State University, Makurdi,* 9(1), 1099-1116.

Agbebaku, H.U. (2019). An empirical analysis of the indices of environment and sustainable development in Nigeria from 2008 to 2018. *Journal of Geography and Development, Benue State University, Makurdi,* 9(1), 1099-1116.

Basoru, J. O. (2004). *Basic elements of urban and regional planning*. Shalon Publishers. Akure, Ondo State.

Cunningham, W. P., & Cunningham, M. A. (2012). *Environmental Science: A Global Concern*, America, 12(17).

Cunningham, W. P., & Cunningham, M. A. (2015). *Environmental Science: A Global Concern*, McGraw-Hill International Edition, 12(17), 123-134.

Cyril, K. E., & Olumide, A. O. (2016). Assessment of recreational facilities in the federal capital city, Abuja, Nigeria. *Indonesian Journal of Geography, 48(1), 21-27.*

Dokun, O. O. P. (2008). Sustainable development: *Issues and Challenges* for Nigeria. Ibadan

Eseigbe, J. O. (2021). *Environmental planning and management*. ESM346: Course Material of the Department of Environmental, National Open University of Nigeria, Abuja.

Federal Capital Development Authority (FCDA, 1979). *The master plan for Abuja, the new federal capital of Nigeria*. FCDA, Abuja. https://www. fcda.gov.ng/administration/ executive-secretary

Ibrahim, S., Ahmed, M. B., Usman, S. A., & Ahmed, Y. U. (2015). An overview of the functions of the Abuja geographic information system (AGIS) as a tool for monitoring growth and development in Abuja, Nigeria. *IOSR Journal of Environmental Science, Toxicology and Food Technology* 9(11).

Ivbijaro, F. A. (2012). *Sustainable environmental management in Nigeria*. Edited by Matt. F.A. Ivbijaro & Akintola, F. Second Edition. Book Builders Editions Africa. Ibadan, Nigeria.

Ivbijaro, M. F. A., and Akintola, F. (2012). *Sustainable environmental management in Nigeria*. 2, 9-37.

Mabogunje, A. L. (2008). *Urbanization in Nigeria*, London University Press, UK, 90-100.

Mabogunje, A. L. (1999). *Abuja: the promise, the performance and the prospects*. In Kalgo, M.S.U and Olatubosun, A. (Eds.*)*. The Review of Abuja Master Plan. Fountain Publications, Ibadan.

Majebi, E. C., & Agbebaku, H. U. (2024). People's Perception of Environmental Quality at Selected Recreation/Tourist Sites in Abuja, Nigeria. *Journal of Environmental and Tourism Education,* **7(**1), 209-226. https://jeate.net/index.php/Jete/issue/ archive, ISSN: 2659 0794 (Print), ISSN:2659-0808(Online).

Majebi, E. C., Agbebaku, H. U., Anierobi, C., & Afolayan, S. O. (2023). Assessment of urban green open spaces and environmental impacts on recreation and environmental sustainability: Evidence from Abuja, Nigeria's Federal Capital Territory. *Benin Journal of Geography, Planning and Environment*. 3(1), 207 – 222.

Obiadi, B. N., & Onochie, A. O. (2018). Abuja, Nigeria, urban actors, master plan, development laws and their roles in the design and shaping of Abuja federal territory and their urban environments. IARD International *Journal of Geography and Environmental Management*, 4 (23). Available from [accessed Dec 07, 2022].

Odiette, W. O. (1993). Environmental impact assessment for sustainable development. 1, Nigeria, 56-80.

Ojeifo, M. O. (2005). *Elements of planning and design*. Easy-Way Publishers. Benin City, Edo

State.

Omofonmwan, S. I., & Segynola, A. (2008). Conceptual and philosophical framework for environmental management and sustainable human development. *Environmental Management for Sustainable Human Development*, Edo State University (EDSU) Library

Onokerhoraye, A. G. (1984). *Social Services in Nigeria: An Introduction*. London, Kegan Paul.

Paul, K., & Steven, P. (2010). *Urban social geography: An Introduction*, England, 6, Prentice Hall, Pearson. 4, 234-256.

Sridhar, M. K. C. (2012). *Waste management policy and implementation in Nigeria,* Federal Ministry of Environment, edited by Ivbijaro and Akintola in Sustainable Environmental Management in Nigeria. 2, 253-259.

Ujoh, Fanan, Isa., & Olarewaju, O. (2011). *An overview of the functions of the Abuja geographic information system (AGIS) as a Tool for Monitoring Growth and Development in Abuja, Nigeria*. Available from: [accessed Dec 08, 2022].

Ujoh, Fanan, Isa., & Olarewaju, O. (2011). Urban expansion and vegetal cover loss in and around Nigeria's federal capital city. *Journal of Ecology and Natural Environment*, 3(1), 1-10

Withgoth, J., & Brennan, S. (2011). *Essential Environmental*: The Science Behind the Stories, Indonesia, 3.

Wright, R.T., & Boorse, D. F. (2011). *Environmental Science*: Toward a Sustainable Future, 11(10).