TETFund CENTRE OF EXCELLENCE FOR NIGERIAN CONTENT DEVELOPMENT IN RENEWABLE ENERGY UTILIZATION

(COEREU)

Kaduna Polytechnic, Kaduna, Nigeria

www.tetfundkadpolycoex.org.ng

Centre of Excellence Research Focus and Guidelines for the Support of Research Publications

Publication of the

Research and Publication Department

Authors:

S.N. Mumah, *PhD, FNSChE*

Hassan F Akande, *PhD*

Adekunle I Obasa, *PhD*

Nurudeen Abdul, ND

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Authors:

S.N. Mumah, *PhD, FNSChE*

Hassan F Akande, *PhD*

Adekunle I Obasa, *PhD*

Nurudeen Abdul, *ND*

TETFund CoE Implementation Committee

Engr. Dr S.N. Mumah	*Centre Director*
Job O. Belamo	*Communication Officer*
Ahmad Attahir	*Project Accountant*
Umar Muhammad	*Procurement Officer*
Seidu Momoh Atebune	*Auditor*
Tanimu Garba Ibrahim	*Monitoring and Evaluation Officer*
Dr David Duniya Adams	*Safeguard Officer*
Auwal Anwar	*Technical Officer*
Abdul Nurudeen	*Technical Assistant*

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This document is available on our website: www.tetfundkadpolycoex.org.ng

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EXECUTIVE SUMMARY

Inadequate education and skills development have trapped the Nigerian economy in a vicious circle of low education, low productivity and low income. The strategy employed by the Institution was first to identify the areas where skill gaps exist in the North-West region of the country and come up with ways to up-skill and enhance skills training in the selected skill areas, thereby improving access to employment and encourage more women and the vulnerable population to be self-employed. The Institution reviewed data on the skill areas and noted a substantial skills gap in the country in the energy sector. Therefore, the Centre's focus would be on building local Capacity and enhancing energy production in the country. The supply of energy is important to Nigeria's economic development. Another consideration in this selection is the gender attractiveness of the selected area. The funds for the establishment of the Centre shall be provided by the Tertiary Education Trust Fund (TETFund). The projected amount is 1 billion Naira for a lifespan of 4 years.

Vision of the Centre of Excellence

To become a foremost Skills Development, Research and Facilitation Centre of Excellence for Nigerian Content Development in Renewable Energy Utilization.

Mission of the Centre of Excellence

A Skill Acquisition and Development Centre that Promotes Nigerian Content Development in Renewable Energy Utilization by Focusing on Well-tested Innovative and Entrepreneurial approaches in this Sector.

Core Activities of the Centre of Excellence

S/No	Activities
	Enhance Capacity to deliver high-Quality training
1	Enroll students for short-term courses in selected Renewable Energy Programmes
2	Review/Develop short-term National Occupational Standards (NOS) with Stakeholders to meet accreditation status and Engage

	accreditation agencies for the Accreditation of programs. (National and International)
3	Renovate Laboratory/Workshops.
4	Procure/install Laboratory/Workshop/teaching equipment/ Installation of solar-powered borehole Systems
5	Procure and install Internet (wired/wireless) facilities.
6	Procure/Installation ICT teaching equipment in 2 Digital Classrooms
7	Improve e-library facilities in the Library
8	Procure and install Backup 250kVAGenerator/Backup inverters/solar/ Lithium-ion systems for the Laboratory
9	Procurement of Operational Vehicle
10	Procurement of Centre Vehicle
	Improve teaching and learning environment for high-quality teaching and learning:
1	Improve female 'students' research capacity and expertise through one month Internship Programmes.
2	Improve male 'students' research capacity and expertise through one month Internship Programmes
3	Improve staff research capacity and expertise through one month Internship Programmes.
4	Engage in research collaboration with industry and other partners.
5	Increase subscription to selected databases and journals at E-library to support research activities.
6	Organize/attend research and innovation fairs.
7	Write research proposals to attract grants from partners and national and international research agencies to fund research activities of the Park.
8	Provision of Research Grant in Renewable Energy Research
9	Support of Staff for Publications in reputable journals
10	Procurement of relevant computer software and training on use to support teaching and learning
11	Procurement of consumables for workshop/laboratories

	Management and Governance (Financial + Procurement
1	Provision of Office Equipment/Furniture/Provision of Safety Equipment
2	Sponsorship for staff to attend Conferences/Workshops/ Seminars

Anticipated Results

S/No	**Item**	**2023**	**2024**	**2025**	**2026**
1	Curricula reviewed	2	2		
2	National Accreditation		1	1	
3	International Accreditation		1	1	
4	Male trained – short courses	50	50	50	50
5	Female Trained– short courses	30	30	30	30
6	Master students sponsored	3	4	3	2
7	PhD Students sponsored	2	2	2	1
8	Equipment Designed and fabricated	2	2	2	2
9	Researches Carried out	4	4	4	4
10	Publication in Standard Journals	10	10	10	10
11	Workshop organized	3	2	2	1
12	Conferences/Workshop attended	2	2	2	2
13	Fair/Exhibition attended	1	1	1	1

TETFund CoE Support for Journal Publication

One of the Performance Indicators for the Centre of Excellence is the publication of per-reviewed journal articles. To this end, the Centre of excellence will support those wishing to publish articles in peer-reviewed Journals. The support for publishing research journal papers is intended to accelerate research excellence and rapid dissemination of research information. This is an avenue for significant energy efficiency and renewable energy innovation. This support is designed to fast track the publication of excellent research papers. This support includes the following components:

1. Assistance in the selection of topics;
2. Assistance in paper organization and structure;
3. Assistance in literature materials;
4. Assistance in proofreading, grammar and plagiarism check;
5. Assistance in Journal Selection;
6. Assistance in the cost of publishing.

The target number of Journal articles is 100.

It is important to note that any financial commitment is reimbursed only after the paper has been published and the TETFund Centre of Excellence duly acknowledged. All interested authors must register with the Centre, and the paper's focus must be related to renewable energy. The total number of the author shall not exceed three in number. However, an exception may be granted if the scope of the article is wide.

The main research efforts concentrate on improving the energy efficiency of established energy sources to meet the targets set by The Paris Agreement to limit climate change. However, that has not stopped the exploration of new venues like using algae for energy. Work on your elevator pitch if you have an idea that could produce clean energy. You just might get funded. When you're ready to publish your research, we're here to help you choose a journal, evaluate your work, and edit your submission.

Selecting a Research or Journal Paper Topic

Renewable energy is a topic which is at the forefront of energy development. The global drive to manage, mitigate and prevent climate change has seen the contribution of renewable energy, as an alternative to traditional fossil fuels, to global energy generation increase significantly over the past decade. The growing importance of renewable energy as a solution to the global climate crisis has seen extensive research undertaken and necessitates substantial future research. This has made renewable energy a prevalent choice for research, dissertations or journal paper writing.

When selecting a topic focused on renewable energy, it is crucial to choose a topic that presents a novel and engaging approach. There is an extensive body of published literature which the topic should enable critical engagement with. However, it is vital to ensure that a selected topic does not simply rehash previous research, the development of renewable energy is constant and presents opportunities for numerous dissertations which examine key issues and debates, including those related to sustainability, energy security, justice, equality and development.

Topics or areas in renewable energy that can provide authors with some ideas for writing excellent Journal articles or carrying out relevant research have been compiled and presented in this document.

Introducing the Sustainable Energy Lecture Series

Starting this year, 2023, The TETFund Centre of Excellence for Renewable Energy will organize a lecture series that will analyze and discuss the scientific, technological, financial, socioeconomic, commercial, political, and regional opportunities and challenges of a renewable energy-powered future in Nigeria in particular and the sub-region in general.

The energy lecture series' aim is to facilitate discussions and ideas exchange among different stakeholders to promote a sustainable energy future for Nigeria. They are designed to promote public understanding and stakeholder dialog around key energy efficiency issues relevant to Nigeria today. This series shall feature energy sector leaders and experts and covers an array of topics – from advice on how to lower your energy bills at home and in industry, innovative solutions from the business community, to training our workforce amidst a rapidly changing energy landscape.

Other topics to be covered range from innovation in renewables to the bioenergy potential of the country, smart grids, demand side management, green buildings, energy stakeholder/consumer engagement, electricity market reforms, energy pricing, and business model innovation. The lecture series will elaborate on the role of renewable energy in energy transition, including technology and sector roadmaps, economics, and enabling frameworks. The lecture series shall further focus on planning long-term transition paths for a high share of variable renewable energy, and will explore planning to overcome operational bottlenecks and the role of storage in integrating variable renewable energy into a power system.

Designed to inform and inspire current and future leaders in renewable energy sustainability, the TETFund Centre of Excellence for Renewable Energy is expected to host the inaugural lecture of the series in the 2nd quarter of 2023. Tagged "*Effective Partnerships for Sustainability Energy utilization*", the event will bring together sustainability leaders, renewable energy experts, relevant stakeholders, students, and staff to brainstorm about critical challenges and advances related to energy, climate and the environment, and urban transformations. The series provides shall participants and the public with the opportunity to explore sustainable energy solutions, learn about the challenges facing sustainable energy use, using sustainable energy, and interact with experts from the renewable energy industry. The proposed lecture series will provide new perspectives in moving Nigeria towards a green and sustainable energy future. Topics that may be considered for the lecture series have been identified and presented in this document.

The concept of the sustainable utilization of renewable energy has been discussed, including ways Nigeria can explore it to her advantage. The main objectives and expected impact of the TETFund Skill Development Centre of Excellence have been presented in detail.

The Implementation Team and the Institution hope that staff and students go through the document in order to understand the purpose of establishing the Centre and further use the information provided in this document to key in positively to the activities of the Centre.

S.N. Mumah; *PhD, FNSChE, Reg. Engr (COREN)*
Centre Director

1.0 OVERVIEW OF THE CENTRE OF EXCELLENCE

Nigeria has a skill demand-supply gap and differences in the levels of skill acquisition, which has led to imbalances in employment rates across regions and groups, wage disparities and varying productivity levels across workers. The central aim of this Project is to establish a Skill Development Centre of Excellence financed by TETFund. The Centre will run programmes that will develop our skills base to increase both the quantity and the productivity of labour employed in the economy, particularly women and youths.

Inadequate education and skills development have trapped the Nigerian economy in a vicious circle of low education, low productivity, and low income. The strategy employed by the institution was first to identify the areas where skill gaps exist in the North-West region of the country and come up with ways to up-skill and enhance skills training in the selected skill areas, thereby improving access to employment and encourage more women and the vulnerable population to be self-employed. The Institution reviewed data on the skill areas and noted a substantial skills gap in the country in the energy sector. Therefore, the Centre's focus would be on building local capacity and enhancing energy production in the country. The supply of energy is important to Nigeria's economic development. Another consideration in this selection is the gender attractiveness of the selected area. The funds for the establishment of the Centre shall be provided by the Tertiary Education Trust Fund (TETFund). The projected amount is 1 billion Naira for a lifespan of 4 years.

1.2 Vision of the Centre of Excellence

To become a foremost Skills Development, Research and Facilitation Centre of Excellence for Nigerian Content Development in Renewable Energy Utilization.

1.3 Mission of the Centre of Excellence

A Skill Acquisition and Development Centre that Promotes Nigerian Content Development in Renewable Energy Utilization by Focusing on Well-tested Innovative and Entrepreneurial Approaches in this Sector.

2.0 IDENTIFIED NATIONAL DEVELOPMENTAL CHALLENGE

A productive, competent, and flexible workforce is a prerequisite for furthering economic development. The demand for skilled workers and technicians is already acute and will become ever more intense as acquiring relevant skills becomes necessary for economic employment. Presently, the Vocational and Technical Education (VTE) and tertiary education sub-sectors cannot respond to the changing labour market requirements because of its supply-driven (instead of demand-driven) orientation. Its curricula, instructional equipment, teaching methods, and evaluation techniques are outdated, leading to inappropriately low internal and external efficiencies.

The lack of power supply to make the production cost relatively cost-effective, leading to the near collapse of most industries. The lack of skilled labour in the energy sector has limited many industries' ability to compete globally. The outbreak of coronavirus pandemic has affected billions of people worldwide, and it is also having a growing impact on the global economy, especially the energy sector.

The electricity system in Nigeria centres on PHCN, which accounts for about 98% of the total electricity generation. Power generation by other agencies, such as the Nigerian Electricity Supply Company, relies on thermal power for electricity generation, unlike PHCN, which relies on both hydro- and thermal power. However, electricity is also a consumer of fuel and energy, such as fuel oil, natural gas, and diesel oil. The importance of these energy sources of energy and fuel energy and fuel energy sources for generating electricity has been decreasing in recent years. However, hydropower, which is relatively cheaper than these sources, has grown to be more important than other sources. However, more recently, the Power Authority has generated electricity through a mix of both thermal and hydro systems. All the power, distribution, and substations are specially interlinked by a transmission network popularly known as the national grid. The total electricity generated nationwide is pooled into the National Control Centre, Osogbo, from where electricity is distributed to all parts of Nigeria.

Effective skills development systems – which connect education to technical training, technical training to labour market entry and labour market entry to workplace and lifelong learning – can help Nigeria sustain productivity growth in the Energy sub-sector and translate that growth into more and better jobs. With competing areas needing funds for development in the country, a special focus on training is required for Renewable Energy Utilisation to address these challenges.

3.0 OBJECTIVES OF THE SKILL DEVELOPMENT CENTRE OF EXCELLENCE

The Objectives of the TETFund Skill Development Centre of Excellence include the following:

1. Conduct various skill development training programmes in Nigerian Content Development in Renewable Energy Utilization to enable unemployed and vulnerable youths to improve their employability.
2. Skill, Reskill, Cross-skill and Upskill the populace in Nigerian Content Development in Renewable Energy Utilization to ensure or improve their employability;
3. Reviewing and upgrading the curricula of the various programmes relevant to renewable energy utilization in the country;
4. Ensure that the programmes relevant to renewable energy meet national and international standards.
5. Provide and promote entrepreneurship training in Nigerian Content Development in Renewable Energy Utilization
6. Improve present teaching methodologies in Nigerian Content Development in Renewable Energy Utilization by the development of practical-based curricula and instructional materials;
7. Promote close collaborations and partnerships between the institution and the industry;
8. Promote quality Workshop Practice and innovations in Nigerian Content Development in Renewable Energy Utilization
9. Produce trainees that are self-reliant and able to compete favourably in the labour market both locally and internationally in the Renewable Energy Industry;
10. Carry out Research in Nigerian Content Development in Renewable Energy Utilization;
11. Improvement in ICT skills and knowledge acquisition for both staff and trainees in Nigerian Content Development in Renewable Energy Utilization;

12. Capacity building in Renewable Energy Utilization for academic, technical and management staff of the institution;
13. Ensure trainees in the Renewable Energy Utilization programme gain useful employment when they graduate.

4.0 EDUCATION AND RESEARCH OBJECTIVES

The education objectives of the Centre of Excellence include:

a. The Development and revision of National Occupational Standards (NOS) for various levels of Renewable Energy Utilization;
b. Ensuring that our graduates are competitive;
c. Training of the Management and technical Team;
d. Development of Instructional Materials (Manuals and Modules) for Renewable Energy Utilization;
e. Conducting train-the-trainer Workshops;
f. Procurement and installation of training facilities (equipment, consumables, training aids, etc.);
g. Training on the use of the equipment;
h. Provision of short-term training to unemployed youths;
i. Enhance the capacity of trainers by sponsoring them for further training;
j. Provide entrepreneurial facilities for the selected training programme;
k. Carrying out research in relevant areas of renewable energy;
l. Dissemination of research outcomes in standard journals.

The Research Objective for the Centre of Excellence is to conduct research that will lead to patents in renewable energy utilization in the country. The research will focus on how to use local resources to build and improve the energy sector and the use of local content in improving energy use in the country.

5.0 EXPECTED IMPACT OF THE CENTRE OF EXCELLENCE

The expected impacted of the Centre of Excellence include:

a. The quality of TVET in the Renewable Energy Sector in Nigeria is improved.

b. Nigerian youth shall have improved skills in Renewable Energy Utilization for productive employment in the selected skill areas.
c. The CoE shall work to improve the opportunities for Nigerian youth and adults to find productive employment in the Renewable Energy Sector.
d. The pro-employment framework for small businesses and companies in Renewable Energy Sector in Nigeria shall improve.
e. The institutional capacities for job-oriented TVET in Renewable Energy Utilization shall improve.
f. TVET in the occupational field of Renewable Energy Utilization shall be better aligned with labour-market needs.
g. The CoE shall contribute its quota to national development by producing job providers in the Renewable Energy Sector of the economy rather than job seekers.
h. The range of active labour market measures offered by job placement, vocational training and counselling institutions for integration or reintegration into the labour market shall improve with this intervention.
i. By the end of the project's first phase, over 400 beneficiaries shall be trained in the various competency levels of National Occupational Standards (NOS) in renewable Energy Utilization. Women shall make up 40 percent of this number.
j. The Centre shall assist the beneficiaries trained to have gainful employment in the Energy Sector of the economy as a result of our work.

6.0 METHODOLOGY FOR BOTH LEARNING (PEDAGOGY) AND RESEARCH + HOW THE TWO ARE INTEGRATED

The training at the Centre will be geared towards improving the quality of graduates to compete nationally and globally. Therefore, all training will focus on improving Nigeria's energy sector by incorporating renewable energy. All training will be result-oriented and ensure that all researches are focused on solving energy challenges in the country.

7A. ANTICIPATED RESULTS BOTH QUANTITATIVE (TABLE) AND QUALITATIVE (GRADUATES' KNOWLEDGE/SKILLS/ATTITUDE AND TYPES OF APPLIED RESEARCH RESULTS)

S/No	Item	2023	2024	2025	2026
1	Curricula reviewed	2	2		
2	National Accreditation		1	1	
3	International Accreditation		1	1	
4	Male trained – short courses	50	50	50	50
5	Female Trained– short courses	30	30	30	30
6	Master students sponsored	3	4	3	2
7	PhD Students sponsored	2	2	2	1
8	Equipment Designed and fabricated	2	2	2	2
9	Researches Carried out	4	4	4	4
10	Publication in Standard Journals	10	10	10	10
11	Workshop organized	3	2	2	1
12	Conferences/Workshop attended	2	2	2	2
13	Fairs/Exhibitions attended	1	1	1	1

7B. CORE ACTIVITIES OF THE CENTRE OF EXCELLENCE

S/No	Activities
	Enhance Capacity to deliver high-Quality training
1	Enroll students for short-term courses in selected Renewable Energy Programmes
2	Review/Develop short-term National Occupational Standards (NOS) with Stakeholders to meet accreditation status and Engage accreditation agencies for the Accreditation of programs. (National and International)
3	Renovate Laboratory/Workshops.
4	Procure/install Laboratory/Workshop/teaching equipment/ Installation of solar-powered borehole Systems
5	Procure and install Internet (wired/wireless) facilities.
6	Procure/Installation ICT teaching equipment in 2 Digital Classrooms
7	Improve e-library facilities in the Library
8	Procure and install Backup 250kVAGenerator/Backup inverters/solar/ Lithium-ion systems for the Laboratory
9	Procurement of Operational Vehicle
10	Procurement of Centre Bus
	Improve teaching and learning environment for high-quality teaching and learning:
1	Improve female 'students' research capacity and expertise through one month Internship Programmes
2	Improve male 'students' research capacity and expertise through one month Internship Programmes
3	Improve staff research capacity and expertise through one month Internship Programmes
4	Engage in research collaboration with industry and other partners
5	Increase subscription to selected databases and journals at e-library to support research activities.

6	Organize/attend research and innovation fairs.
7	Write research proposals to attract grants from partners and national and international research agencies to fund research activities of the Park.
8	Provision of Research Grant in Renewable Energy Research
9	Support of Staff for Publications in reputable journals
10	Procurement of relevant computer software and training on use to support teaching and learning
11	Procurement of consumables for workshop/laboratories
	Management and Governance (Financial + Procurement)
1	Provision of Office Equipment/Furniture/Provision of Safety Equipment
2	Sponsorship for staff to attend Conferences/Workshops/ Seminars

8.0 DETAILED RESEARCH OBJECTIVES OF THE CENTRE OF EXCELLENCE

1. To conduct projects to ensure a sustainable energy supply for sustainable development;
2. To align and adapt our research activities to world best practices in the field of renewable energy;
3. To establish and develop the laboratory needed for energy research;
4. To support and contribute to research on renewable energy at the Polytechnic in particular and Nigeria in General;
5. To pursue studies to contribute to the creation of Nigeria's renewable energy policies;
6. To conduct necessary research about renewable energy sources and contribute to developing new projects;
7. To carry out comparative research activities between non-renewable and renewable energy sources to ensure more efficient and effective use of traditional energy sources such as petroleum, coal, natural gas, etc;
8. To conduct studies on environmental pollution caused by energy use and to conduct studies to reduce environmental pollution;

9. To facilitate access to resources by creating a documentation centre for energy research and development activities;
10. To organize national or international courses, conferences, seminars and similar events and raising public awareness on renewable energy;
11. To help to train students, instructors and other staff in the field of energy by cooperating with the relevant units and departments of the Polytechnic;
12. To develop scientific and technical cooperation with national and international organizations and to conduct joint studies with them;
13. To design projects according to the demands of both public and private sectors regarding energy and to evaluate and conclude the given projects;
14. To cooperate with relevant ministries, public institutions and organizations on renewable energy applications;
15. To ensure and strengthen the cooperation between the Polytechnic and sectors where energy consumption is intense;
16. To collaborate with the representatives of the business world to share ideas with the staff and students of the Polytechnic on energy and energy technologies;
17. To establish cooperation with the business world on new and advanced energy technologies and energy efficiency;
18. To disseminate research outcomes in standard journals and proceedings.

9.0 DIFFERENCE BETWEEN RENEWABLE ENERGY, CLEAN ENERGY AND GREEN ENERGY

Fossil fuels, such as coal and natural gas, have been our country's primary power source for decades. However, the process of getting fossil fuels out of the ground and into your home creates pollution and damages ecosystems. That's why more and more people have been pushing for cleaner, renewable energy solutions. These include green energy, clean energy, sustainable energy and more.

Although terms like *renewable energy*, *green energy* and *clean energy* are often used interchangeably, there are some key differences that set them apart. Here, we'll take a look at various types of renewable energy solutions, what makes them different from one another and how they are helping us move toward a future that is not dependent on fossil fuels.

Renewable energy is created by using naturally occurring resources that replenish themselves over time. So, although there's not an unlimited amount of these resources available at any moment, you'll rarely have to worry about a renewable resource running out entirely. And since renewable energy produces fewer greenhouse gases and pollutants than traditional fossil fuels, it can help to make your home more sustainable.

9.1 Types of renewable energy sources

To better understand what renewable energy is and how it works, it helps to look at some examples of renewable energy sources and the technologies that power them. Among the most common of these sources are:

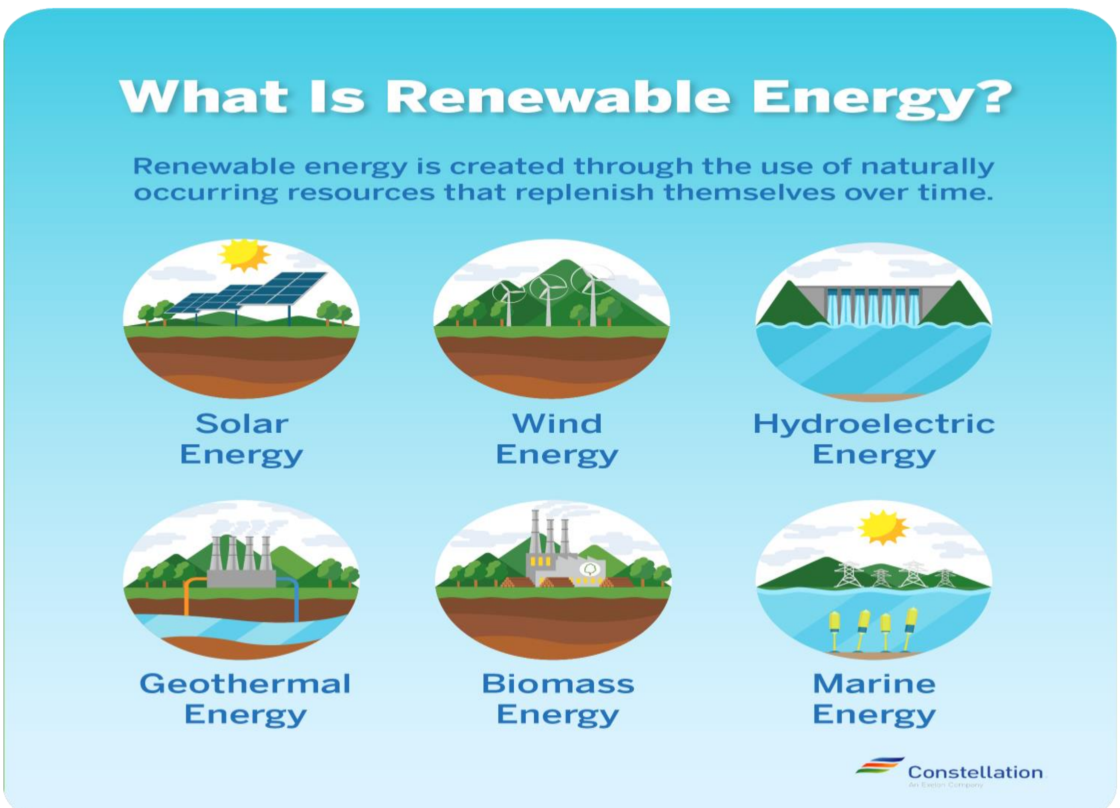

Image Extracted from https://blog.constellation.com/2021/04/30/differences-between-green-energy-renewable-energy/

- **Solar energy.** To create solar energy, photovoltaic cells on solar panels trap sunlight. Then, an inverter converts sunlight into electricity that can be used in your home.
- **Wind energy.** Wind energy works by harnessing air movement to rotate the blades on large wind turbines. The turbines then convert the kinetic energy of the rotation to mechanical power and, eventually, electricity.
- **Hydroelectric energy, or hydropower.** One of the first energy sources used to generate electricity was hydropower. In this process, the force of running water turns the blades in a turbine, spins the generator that produces electricity.
- **Geothermal energy.** Geothermal energy comes from heat located deep within the earth's interior. It works by drilling wells into the ground, allowing steam or water to reach the surface and power the turbines that create electricity.
- **Biomass energy.** Biomass is a renewable material that comes from plants and animals. Some common biomass sources include wood, agricultural crops and municipal solid waste. Biomass can be converted into energy using several methods, but the most popular approach is burning biomass to heat buildings or power steam turbines that make electricity. Bioenergy is a renewable energy source derived from biological sources. Bioenergy is an essential source of energy, which can be used for transport using biodiesel, electricity generation, cooking and heating. Electricity from bioenergy attracts an extensive range of different sources, including forest by-products such as wood residues, agricultural residues such as sugar cane waste, and animal husbandry residue such as cow dung. One advantage of biomass energy-based electricity is that fuel is often a by-product, residue or waste product from the above sources. Significantly, it does not create competition between land for food and land for fuel.
- **Marine energy.** Although it's still an emerging technology, marine energy leverages the ocean's natural movements to produce energy. There are a few different types of marine energy sources being developed, such as wave energy, tidal energy, and energy from ocean currents.

9.2 Other types of energy, explained

Most countries have access to various energy resources, from fossil fuels to renewables. However, not all types of energy fit neatly into one of these two categories. For example, energy can also be classified as green, clean, sustainable, or alternative. Below, we'll define these types of energy and explain what differentiates them from renewable energy.

9.3 What is green energy?

Green energy, or green power, represents the energy sources with the least environmental impact. These types of energy sources don't release harmful carbon emissions, meaning they're effective at helping you reduce your carbon footprint. Some examples of green energy include electricity produced from solar, wind, geothermal and other low-impact sources.

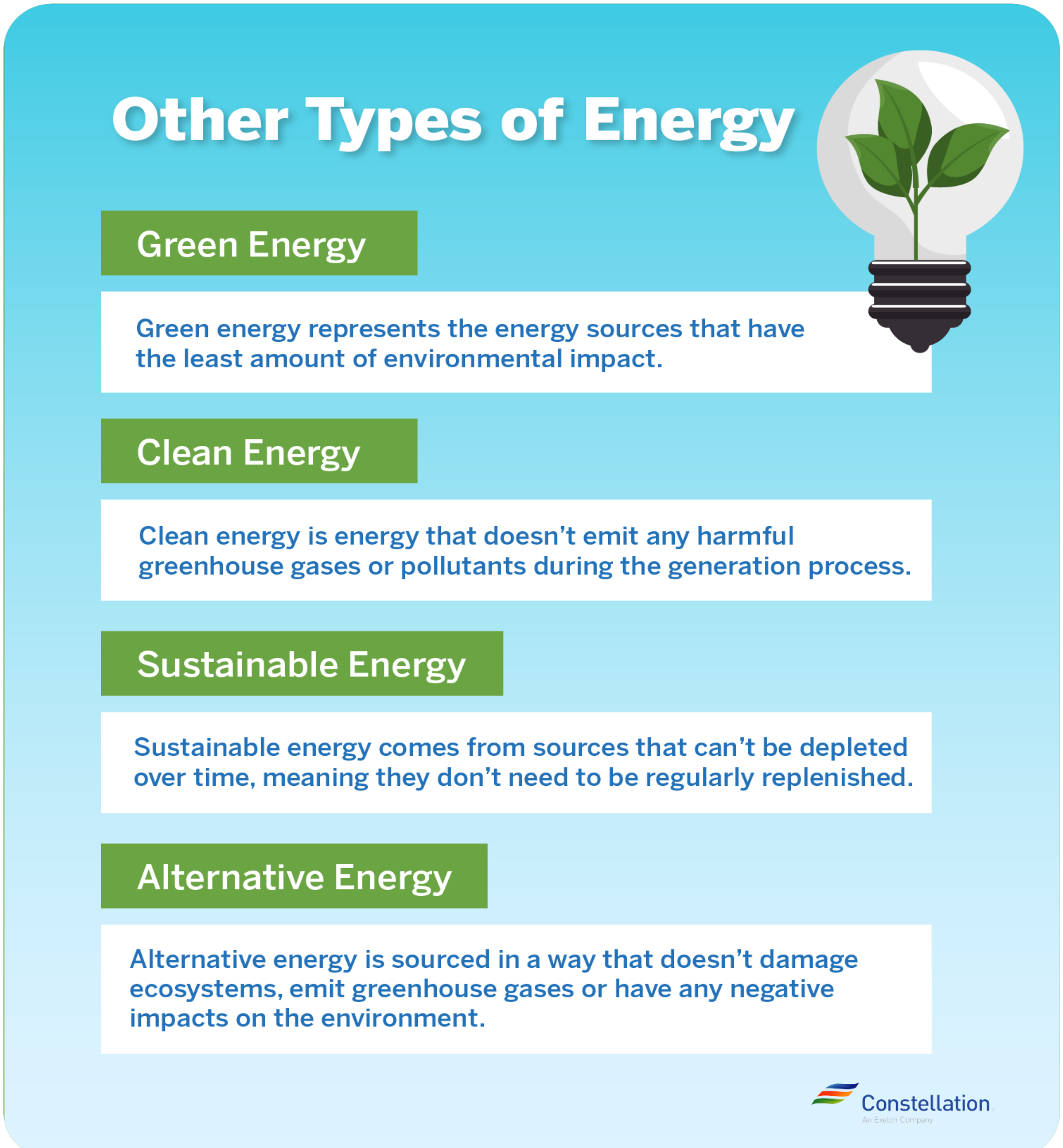

Image Extracted from https://blog.constellation.com/2021/04/30/differences-between-green-energy-renewable-energy/

9.4 Green energy vs renewable energy

Green energy is a subset of renewable energy and includes renewable energy resources that offer the greatest environmental benefit. So, although all green energy resources are renewable, not all renewable resources are considered green. For example, wind power is green and renewable; burning wood is renewable (because you can grow more trees) but not green (because it releases pollution into the atmosphere).

9.4 What is clean energy?

Clean energy is energy that doesn't emit any harmful greenhouse gases or pollutants during the generation process. All green and renewable energy sources are also clean by definition. That said, an energy source doesn't have to be renewable to be considered clean. For example, nuclear power is a clean energy source even though it doesn't naturally replenish over time.

9.5 What is sustainable energy?

Sustainable energy comes from sources that can't be depleted over time, meaning they don't need to be regularly replenished. Some examples of sustainable energy sources include both solar and wind energy. Compare these sources to wood, crops and other biomass materials that can be depleted and require time — as well as possible human intervention — to replenish.

9.6 What is alternative energy?

Alternative energy is sourced in a way that doesn't damage ecosystems, emit greenhouse gases or negatively impacts the environment. So, while energy sources like biomass and hydropower are renewable, they affect the environment too much to be considered alternatives. For example, sourcing biomass materials can lead to deforestation, and hydropower systems can negatively influence water and land animals' habitats and feeding cycles.

9.7 Making the switch to renewable energy sources

Have you ever wondered how you can help shrink your carbon footprint? It's easier than you think. For example, you can get started with renewable energy certificates (RECs) and carbon offsets. Or you may take a bigger leap and find a solar provider for your home. Ultimately, anything you can do to begin shifting away from fossil fuels will help ensure that our environment thrives well into the future.

10.0 ENERGY SECURITY

The notion of energy security is generally used, however, there is no consensus on its precise interpretation. Yet, the concern in energy security is based on the idea that a continuous supply of energy is critical for the running of an economy. Given the interdependence of economic growth and energy consumption, access to a stable energy supply is important to the political world and a technical and monetary challenge for both developed and developing countries, because prolonged interferences would generate serious economic and basic functionality difficulties for most societies. Renewable energy sources are evenly distributed around the globe compared to fossils and generally less traded on the market. Renewable energy reduces energy imports, contributes diversification of the portfolio of supply options, reduces an economy's vulnerability to price volatility, and represents opportunities to enhance energy security across the globe. The introduction of renewable energy can also contribute to increasing the reliability of energy services, specifically in areas that often suffer from insufficient grid access. A diverse portfolio of energy sources and good management and system design, can help to enhance security.

11.0 SOCIAL AND ECONOMIC DEVELOPMENT

Generally, the energy sector has been perceived as a key to economic development with a strong correlation between economic growth and expansion of energy consumption. Globally, per capita incomes are positively correlated with per capita energy use, and economic growth can be identified as an essential factor behind increasing energy consumption in the last decades. It, in turn, creates employment; a renewable energy study in 2008, proved that employment from renewable energy technologies was about 2.3 million jobs worldwide, which also has improved health, education, gender equality and environmental safety (Edenhofer et al., 2011).

12.0 WHY MUST RENEWABLE ENERGY ALWAYS BE CONSIDERED?

12.1. Consider the positives

Renewable energy is becoming the cheapest, more scalable and quickest way to provide electricity to the new demand from emerging markets. Currently, there is only one key issue, the availability of the renewable resource (no sun at night and no wind days), but new technologies (battery energy storage) are becoming more viable.

12.2. Challenge perceived obstacles

The key barrier is the persistent belief that renewables expansion is costly rather than cost-saving. Gradually, however, we are seeing the emergence of an understanding that future prosperity depends on shifting towards a low-carbon economy. There is a particular opportunity in the developing world because infrastructure is not yet locked into high emissions.

12. 3. Make COP 21 in Paris count

While much of the debate on an international agreement has focused on a small number of the world's biggest economies (China and the US), the developing nations are critical in the long haul. We have more than 50% of the world's population living in cities right now, which is projected to swell over 70% by 2050. This mass migration of humans into urban areas is happening in developing countries and will lead to more people on the electrical grid than off of it. Thus, the goals and targets that developing nations commit to are incredibly important.

12.4. Recognize that there is no business case for fossil fuels

Over the next few years, oil companies will struggle to raise finance. Institutional investors will think twice about the fossil investments in their portfolios. This won't be because of Paris's carbon risk or reputation risk from the divestment movement, but pure economic risk. When it happens, it will happen quickly.

12.5. Invest intelligence and money in grids

Good management can create a flexible, interoperable grid that employs battery storage, and dynamic pricing to influence consumption and demand-side management technologies. In my view, developing nations have an edge as they can learn from the mistakes of developed nations and leapfrog the design and management of a grid suited to de-centralised and off-grid electricity generation.

12.6. Get governments behind renewables

Policy makers have not yet gotten their head around the decline in solar photovoltaic prices. Since 2009, solar power modules have declined in price by about 60%. This means that solar and wind are now cost competitive with higher carbon alternatives in many places in the world. In addition to promoting cleaner energy, we must stop wasting taxpayer money on fossil fuels. The upper estimates of subsidies for fossil fuels are $775bn, when you add their tax breaks and trade subsidies, and then also consider the fact that coal plants don't have to pay for the public health costs that they cause from pollution.

12.7 Use technology to leapfrog developed nations

Africa must leapfrog the outdated development path followed by the big polluters, as it has already done for mobile phone technology, mobile payments, and pay-as-you-go off-grid solar.

12.8 Encourage competition, but protect consumers

We see a lot of changes in the market. Lots of competition, which is good, coming in the form of new companies, new products, an increasing number of home systems and pay-as-you-go solutions and … unfortunately, poor quality products which rip customers off. Some of the key challenges we are facing in Africa are fake or -quality solar products entering the market. In many cases, governments do not have the capacity to enforce standards.

However, there are a few questions and issues to consider when considering renewable energy as an option. They include:

a. Why it has become more important than ever to focus on renewable energy;
b. Is financing Renewable energy costly? Mitigating climate change; can renewable energy help?
c. Living Green: How many have access to Renewable energy?
d. Understanding the differences between renewable and alternative energy technology;
e. Is solar energy the way forward;
f. Approach towards renewable energy in 2030 – Sustainable Development Goal;
g. Cost of solar energy in comparison to other renewable energy.

13.0 CIRCULAR ECONOMY AND RENEWABLE ENERGY

In our current economy, we take materials from the Earth, make products from them, and eventually throw them away as waste – the process is linear. In a circular economy, by contrast, we stop producing waste in the first place.

The circular economy is based on three principles, driven by design:

1. Eliminate waste and pollution;
2. Circulate products and materials (at their highest value);
3. Regenerate nature.

A transition to renewable energy and materials underpins it. A circular economy decouples economic activity from the consumption of finite resources. It is a resilient system that is good for business, people and the environment. The circular economy is a systems solution framework that tackles global challenges like climate change, biodiversity loss, waste, and pollution. We must transform every element of our take-make-waste system: how we manage resources, how we make and use products, and what we do with the materials afterwards. Only then can we create a thriving circular economy that can benefit everyone within the limits of our planet.

What will transform our throwaway economy into one where waste is eliminated, resources are circulated, and nature is regenerated? The circular economy gives us the tools to tackle climate change and biodiversity loss while addressing important social needs. It provides us with the power to grow prosperity, jobs, and resilience while cutting greenhouse gas emissions, waste, and pollution.

14.0 SIX BENEFITS OF RENEWABLE ENERGY

Today, renewable is being considered in many homes and organizations. Solar, wind, geothermal, and other renewable energies positively impact health, economy, society and the world. Even though some people have not embraced renewable energy, it has become accepted worldwide for its numerous benefits. Below are some of the economic benefits of renewable energy comparison.

Renewable energy has come a long way. Today, energy is more effective, affordable, and more efficient. Most households can afford to invest in renewable energy. However, many people do not understand the benefits that come with energy. So, what are the economic benefits of renewable energy?

14.1 Materials

Renewable energy use less and inexpensive materials than other forms of energy. For instance, solar panels are now affordable because they are made of less expensive materials. In addition, the materials are affordable, safe, and effective in providing energy to our homes and offices.

14.2 Installation and maintenance

Besides being designed using less expensive materials, most forms of renewable energy are cheap to install and maintain. Today, it is affordable to install a solar and the maintenance is less expensive as well. It can take more than 20 years for someone to maintain the solar panels.

14.3 Energy savings

One of the main reasons why we have renewable energy is to save on energy. With non-renewable energy, much energy is used. Happily, renewable energy has managed to safeguard energy use and help save the environment and money. According to recent findings, people save more than 30 percent of their energy costs by using renewable energy.

14.4 Affordable

Renewable energy, such as solar panel, is more affordable to most people. In addition, various financing options help people transit to renewable energy. Even though some of the installation costs and the cost of purchasing the equipment might be costly, renewable energy is cheaper in the long run.

14.5 Saves money

Besides saving energy, renewable energy helps you save money in the future. It is believed that nuclear energy and fuel energy will rise in cost in the future. However, studies show that renewable energy costs will keep decreasing since many innovations are being done worldwide.

14.6 Creates jobs

According to research, renewable energy has managed to employ millions of people directly and indirectly. Due to the rise in innovations, jobs have been created, schools have been opened; factors have been established, and other great organizations. It is expected that individuals working in the renewable energy sector worldwide will reach 25 million by 2030.

Apart from the economic benefits of renewable energy, there are social, performance, and global benefits of the energy. With the energy, there is reliability, improved security, and safety in our homes. In addition, people have become independent from ordinary energy sources to something better. With less emission, renewable energy has provided a good life by improving the air we breathe.

15.0 ENERGY ACCESS

The sustainable development goal seven (affordable and clean energy) seeks to ensure that energy is clean, affordable, available and accessible to all, and this can be achieved with renewable energy source since they are generally distributed across the globe. Access concerns need to be understood in a local context, and in most countries, there is an obvious difference between electrification in the urban and rural areas. This is especially true in sub-Saharan Africa and South Asian regions (Brew-Hammond, 2010). Distributed grids based on renewable energy are generally more competitive in rural areas with significant distances to the national grid. The low levels of rural electrification offer substantial openings for renewable energy-based mini-grid systems to provide them with electricity access (Edenhofer *et al.*, 2011).

16.0 KEY AREAS FOR GREEN RESEARCH

16.1 Improving storage of renewables

Currently, the leading priority is improving energy storage from renewable sources such as solar and wind. Intermittency is one of the biggest problems facing these two energy sources, as their production can fluctuate, even within a day, depending on the weather. Batteries used to store energy are also one of the most expensive components in using renewable energy. These can vary from small units used with rooftop solar home installations or those for storing power at solar and wind generation plants. Even though the capacity of lithium-ion batteries is improving, you may be surprised at the number of alternatives being developed. Advanced materials such as magnesium, vanadium, calcium, sulfur, and lithium-air batteries are receiving increasing attention, all making energy storage research a vast field.

16.2 Stabilization of power grids

The second research priority is developing smart grids, especially micro-grids, to deal with intermittency. These rely heavily not only on digital technology, but also on compatible hardware. So if you are an engineer, a software specialist, or from the physical sciences, this study area may suit you. Two types of grids are being studied: transmission grids and distribution grids. Since solar and wind sources are increasingly becoming decentralized, distribution grids are necessary to collect energy from multiple generation points.

As production of energy increases, it’s necessary to either expand the network or make it more flexible and smarter through digitalization. Smart and better grids are needed to carry the increased loads of electricity and balance supply and demand. For example, the new wind power stations in Germany are in the north, while industries that need this energy are in the south.

16.3 Electric vehicles (EVs)

Research in electric vehicles (EVs) is also about energy storage and grid management but addresses problems specific to automobiles. Government policy and market demand are coming to favour EVs. The increase in battery capacity increases the range of EVs and how far they can drive on a single charge. Moreover, when the grid is stabilized, there can be more EVs on the road.

16.4 Concentrating solar power

Photovoltaic solar and onshore wind power became economically viable options because their efficiency was improved, owing to a fall in operating costs. Other sources such as geothermal, concentrating solar power (CSP), and offshore wind power need more research to make them economically attractive. To this end, the EU is prioritizing research in these areas through its funding; therefore, the largest portion of its €212.5 million funds for renewable energy research, were allotted for this purpose in 2018. CSP is meant for large-scale solar energy production. This technology produces energy using solar heat that can be stored. Instead of photovoltaic panels, CSP uses mirrors and reflectors to harness sunlight to produce heat, generating electricity.

Moreover, hybrid plants can combine CSP and other sources of energy to maintain a continuous supply of electricity for cities or entire regions. This increases its appeal for immediate implementation. Because of the space needed, CSP plants are usually located in deserts where the incoming solar radiation is also optimum.

16.5 Offshore wind power

The best wind resources are available offshore, but there are very few offshore wind power facilities worldwide. This is because fixed structures are viable only in shallow seas. Therefore, floating wind turbines are being developed for deep seas because these are the places where wind power is most abundant.

16.6 Geothermal energy

Geothermal heat is produced underground in the Earth and is available in different forms, such as hot water or dry heat from the Earth's crust. Geothermal heat is harnessed by specific technologies depending on the type of geothermal heat used. These can be small, decentralized units for heating, cooling, and electricity generation at home or in institutions. The energy can also be used at the district level for heating or generating electricity. This energy source is stable and unaffected by climatic conditions but is underused; the main reason is the high initial capital costs.

17.0 SUSTAINABLE DEVELOPMENT GOAL

17.1 Goal 7: Affordable and Clean Energy

Ensure access to affordable, reliable, sustainable and modern energy for all

Goal 7 is about ensuring access to clean and affordable energy, which is key to developing agriculture, business, communications, education, healthcare and transportation. The lack of access to energy hinders economic and human development. The latest data suggest that the world continues to advance towards sustainable energy targets. Nevertheless, the current pace of progress is insufficient to achieve Goal 7 by 2030. Huge disparities in access to modern sustainable energy persist.

Rising commodity, energy and shipping prices have increased the cost of producing and transporting solar photovoltaics modules, wind turbines and biofuels worldwide, adding uncertainty to a development trajectory already far below Goal 7 ambitions. Achieving energy and climate goals will require continued policy support and a massive mobilization of public and private capital for clean and renewable energy, especially in developing countries.

17.2 Facts

- The global electricity access rate increased from 83 per cent in 2010 to 91 per cent in 2020. Over this period, the number of people without electricity shrank from 1.2 billion to 733 million.
- From 2018 to 2020, the electricity access rate rose by an average of 0.5 percentage points annually, compared to 0.8 percentage points between 2010 and 2018.
- At the current pace, only 92 per cent of the world's population will have access to electricity in 2030, leaving 670 million people unserved.
- Due to economic pressures imposed by the COVID-19 pandemic, up to 90 million people connected to electricity in Africa and developing countries in Asia could not afford to have an extended bundle of services in 2020.
- Between 2010 and 2020, the proportion of people with access to clean cooking fuels and technologies increased from 57 per cent to 69 per cent.
- 4 billion people still relied on inefficient and polluting cooking systems in 2020.
- The share of renewables in total final energy consumption reached 17.7 per cent in 2019, 1.6 percentage points higher than in 2010.
- Global primary energy intensity (energy efficiency) improved from 5.6 megajoules per US dollar in 2010 to 4.7 in 2019, with an average annual improvement rate of 1.9 per cent.
- To meet the energy efficiency target, the annual rate of improvement until 2030 will need to average 3.2 per cent a year.
- International public financial flows to developing countries in support of clean energy amounted to $10.9 billion in 2019, down by nearly 24 per cent from the previous year.
- The five-year moving average also decreased for the first time since 2008, from $17.5 billion for 2014–2018 to $16.6 billion for 2015–2019.
- Loans accounted for over 52 per cent of commitments in 2019. Grants comprised almost 17 per cent. Shares in collective investment vehicles grew to $191 million in 2019, up by 91 per cent from 2018.

17.3 Targets linked to the environment

- **Target 7.1:** By 2030, ensure universal access to affordable, reliable and modern energy services

- **Target 7.2:** By 2030, increase the share of renewable energy in the global energy mix substantially
- **Target 7.3:** By 2030, double the global rate of improvement in energy efficiency
- **Target 7. a:** By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology
- **Target 7. b:** By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, by their respective programmes of support.

18.0 GOVERNING THE RENEWABLE ENERGY TRANSITION

Governance is and will be a critical component of the regime shift to renewable energy. Government policies can support, guide and increase the rate of the energy transition. Equally, there is the potential for ineffective policies to hamper the transition to renewables-based energy sectors. A successful transition will require a transformative governance that encourages knowledge integration across all aspects of the energy sector and enables the development of a sustainable and just renewable energy-based society. Under this purview falls some dissertation topics highly relevant to current events, namely the global Covid-19 pandemic and how it and similar disruptive events may negatively impact renewable energy deployment if not appropriately managed.

The role of governance remains an on-topic aspect of renewable energy, which provides for various dissertation examinations. Some examples of dissertation topics which examine renewable energy and governance are:

- Is the urgency of energy sector reform reflected in government policies, or is there a need for new economic incentives to facilitate the transition to a renewable-based energy sector?
- How do disruptive events impact the transition to renewable energy generation?
- Will renewable energy generation enable new forms of alternative governance structures?

- Are governments effectively engaging citizens in the process of renewable energy generation and energy conservation?
- Do grassroots innovations positively contribute to the renewable energy transition, and what influence does government policy have on the success or failure of grassroots renewable energy systems?

19.0 RENEWABLE ENERGY AND ENERGY SECURITY

Increasing the capacity of renewable energy provision within a nation can contribute significantly towards enhancing energy security through the development of national energy provision which does not rely on foreign energy imports. Renewables-based energy sectors have complex interactions with energy security due to the variation in energy generation potential observed for many renewables. Reconciling renewable energy generation with energy security is an essential component of future energy sectors. If renewables-based energy sectors cannot provide energy security then they will not be successful. There are multiple perspectives that can be taken in dissertations investigating this aspect of renewable energy, ranging from the development of diverse renewable resources to energy storage and distribution. Here are a few topic suggestions which examine this aspect of renewable energy:

- Can we store enough? The future of batteries and energy storage.
- Can renewable energy resources present a viable future: Are renewables sufficient?
- Securing the future: Are Renewables the solution?
- The justice of renewable energy in developing countries; All for one and one for all.
- Energy storage: breaking the barriers to the future of energy solutions.
- Batteries: Which is the most desirable option?
- The future of energy supply, can we meet demand?

20.0 EMERGING RENEWABLE ENERGY TECHNOLOGIES

The status of the development of renewable energy technologies differs between renewable resources. Some, such as solar PV and wind turbines, are well-established, and current research focuses on refining and improving these technologies and their associated infrastructure. However, the energy demands of society are diverse and there is a need to ensure that renewable energy generation can meet this diversity of needs. The replacement of traditional fossil fuels poses a greater challenge in some areas than others, such as replacing aviation fuel with a renewable and low-carbon alternative. Dissertation topics examining emerging renewable energy technologies present an interesting option which looks to the future of renewable energy and identifies gaps in our current knowledge pool. Some examples of dissertation topics based on emerging renewable energy technologies are given below:

- How 'green' is green hydrogen? Examining the potential for green hydrogen utilisation in a sustainable society.
- Guilt-free jet setting: Can biofuels make aviation fuels carbon neutral and sustainable?
- Reconciling biofuels and food security, can we achieve both?
- Why is Geothermal renewable energy underutilised?
- Are all biofuels the same: Quantifying the environmental impact of biofuel production.

21.0 RENEWABLE ENERGY IN DEVELOPING COUNTRIES

The case of developing countries is highly relevant to the subject of renewable energy systems. This is due to the potential for developing countries to avoid the negative impacts of increasing energy demand with economic development if renewable energy resources are selected rather than traditional fossil fuels. This way the mistakes of developed nations and the resulting environmental degradation could potential be avoided. However, there comes into play issues regarding justice and equity, whereby it can be argued that developing countries should be afforded the same development opportunities as already developed countries and that imposing conditions on the energy sector development would be unjust. Dissertation topics in this area can be varied, and the following titles are just some examples of areas you could potential explore:

- How will an energy transition to a renewables-based energy sector impact energy poverty in developing countries?
- Are decentralised, small-scale renewable energy generation systems the answer to supporting the development of rural communities?
- What barriers are to renewable energy-based economic development pathways for developing countries?
- Empowering rural communities: Renewable energy for the future.
- Can renewable-based energy transitions be just?
- Economic development and renewable futures, can the two be reconciled?

22.0 RENEWABLE ENERGY WITHIN THE CIRCULAR ECONOMY

Our approach to the use and consumption of resources will influence the development of a sustainable future. The nature of renewable energy is such that it will play a vital role in reducing the consumption of natural resources and limiting environmental degradation. The circular economy is being increasingly touted as the way forward for resource use and renewable energy resources are likely to be an integral aspect of the circular economy. However, the role of renewable energy within the circular economy needs to be explored and developed. Yes, using renewable energy has a lesser environmental impact than fossil fuels, but this does not mean that renewable energy does not have a degradative environmental impact. The sustainability of renewable energy, resource consumption and their role within the circular economy is an important area of research which is likely to receive considerable attention in the coming years and, thus is a highly on-trend topic for a dissertation. Some examples of dissertation titles which would fall within this area are:

- Can the sustainability of renewable energy systems be increased through the development of end-of-life component recycling?
- The place of renewable energy resources within the circular economy: Will it be possible to produce energy without consuming natural resources?
- Which renewable resource presents the most sustainable option: A life-cycle approach to calculating the environmental impact of renewable energy?
- Does the use of limited or rare natural resources in renewable energy systems mean that there is a finite lifespan of renewable energy systems?
- Powering the circular economy, what role will renewable energy systems play?
- The future of solar energy: Will it be possible to reduce resource consumption in solar energy systems?
- Do we perceive renewable energy systems as 'greener' than they are: A case study of the environmental impact of solar photovoltaic panel production.

23.0 SOLAR ENERGY RESEARCH FOCUS AREAS THAT CAN GENERATE JOURNAL PAPERS

23.1 Applying Data Science to Solar Soft Cost Reduction

Possible disciplines: Economics, computer science, business management

The emergence of new big data tools can revolutionize how solar technologies are researched, developed, demonstrated, and deployed. From computational chemistry and inverse material design to adoption, reliability, and correlation of insolation forecasts with load use patterns, data scientists have opportunities to impact the future scaling of solar energy dramatically. The Centre of Excellence for Renewable Energy is seeking to support Publishers of Journal Papers to apply and advance cutting-edge data science to drive toward the national solar cost reduction goals.

Areas of interest include:

- Novel analysis of Green Button (smart meter) and PV performance data with the Durable Module Materials (DuraMAT) Consortium.
- Power system planning and operation modelling to better understand the performance of solar generation assets on both the transmission and distribution grid.
- Quantifying direct and total system cost and benefits of distributed energy generation and storage, especially related to reliability and resiliency.
- Data analytics for prediction of solar generation and PV system performance.
- Computational methods for revealing insights about diffusion of solar technologies at the residential, commercial, and utility scales that integrate large administrative, geospatial, economic, and financial datasets.
- Data tools for advancing photovoltaic (PV) and concentrating solar power (CSP) to reduce the non-hardware-related costs for solar energy. Specifically, this could include work related to transactive energy value, such as analysis of the potential for PV and CSP to act autonomously in response to the different grid and market signals and/or creating software that can perform these activities, as well as other novel topics not included here.
- Studies of the impact of federal government funding of solar technologies and programs (e.g. connecting scientific articles, patents,

and commercial press releases to understand how federal R&D dollars in clean energy are communicated to and understood by the marketplace).

23.2 Solar Systems Integration

Possible disciplines: Power systems engineering, electrical engineering, computer science, mechanical engineering, atmospheric sciences

The Centre of Excellence for Renewable Energy aims to address the technical and operational challenges associated with connecting solar energy to the electricity grid. We seek to support the authors of Journal papers that will focus on addressing significant challenges in the following areas:

- Power System Planning and Operation with High Penetrations of PV
    - Planning and operation models and software tools are essential to the safe, reliable and resilient operation of solar PV on the interconnected transmission and distribution grid, especially for understanding how power flows fluctuate due to clouds or other fast-changing conditions, as well as interacting with multiple inverter-based technologies.
- PV Situational Awareness and Control/Coordination Strategies from Disturbances
    - Sensors and cybersecurity communication infrastructures and big data analytics enable visibility and situational awareness of solar resources for grid operators to better manage generation, transmission and distribution, and energy consumption, especially in the face of man-made or natural threats.
- Advanced Protection Distribution Grids with High Penetrations of PV
    - Higher solar PV penetration will require more advanced protection systems in distribution grids, given that normal power flow (and fault current) are no longer unidirectional. Directional and distance relays may no longer operate as expected with inverter-based distributed energy resources.
- Cybersecurity for PV Systems Integration
    - Cybersecurity for PV systems integration into utility operations includes isolated layers of trust and mutual authentication. Advanced PV cybersecurity may be needed to ensure access control, authorization, authentication, confidentiality, integrity, and availability for the future smart grid.
- PV Power Electronics

    - Power electronic devices, such as PV inverters and relevant materials, are critical links between solar panels and the electric grid, ensuring reliable and efficient power flows from solar generation.
- Integrating Energy Storage with Solar, Including Microgrid Functionality
    - Integrating solar PV with energy storage would help to enable more flexible generation and grid and provide operators with more control options to balance electricity generation and demand while increasing resiliency. When combined with the capability to island from the area power grid, solar -- plus energy storage microgrids -- support facility resiliency. Resiliency is particularly needed for strengthening the security and resilience of the nation's critical infrastructure (e.g. for safety, public health and national security.)
- Solar Generation Analysis and Prediction
    - The ability to better predict solar generation levels can help utilities and grid operators meet consumer demand for power and reliability.

23.3 Concentrating Solar Thermal for Electricity, Chemicals, and Fuels

Possible disciplines: Mechanical engineering, chemical engineering, materials science

Concentrating solar power (CSP) technologies use mirrors or other light-collecting elements to concentrate and direct sunlight onto receivers. These receivers absorb the solar flux and convert it to heat. The heat energy may be stored until desired for dispatch to generate electricity, synthesize chemicals, desalinate water or produce fuels, among other applications. The dispatchable nature of solar thermal energy derives from the relative ease and cost-effectiveness of storing heat for later use, for example, when the sun does not shine or when customer demand increases or time value premiums warrant. Heat and/or extreme UV intensities from sunlight may also be used to synthesize chemicals or produce fuels. The ability to produce heat for chemical processes without the added cost of fuel and to shift electricity production to alternative energy forms can provide benefits. To realize these benefits, operations must be efficient and cost-effective.

The Centre of Excellence for Renewable Energy seeks to support the publishing of research papers that are directed at developing processes that can occur at a competitive cost compared to traditional synthetic routes. Careful analysis of integrated solar thermochemical systems will be required due to the complexity of most chemical processes and the typically thin profit margins in commodity chemical markets.

Topics of interest include, but are not limited to:

- Novel thermochemical materials or cycles for high volumetric energy density storage systems (with accessible thermal energy storage densities > 3000 MJ/m^3 storage media). Of particular interest are designs capable of cost-effective, simple, periodic recovery from performance degradation.
- Novel concepts for using solar thermal sources to produce value-added chemicals, such as ammonia, methanol, dimethyl ether or other chemicals for which there is a sizeable market.
- Innovative catalysts, materials, and reactor designs to enhance the thermochemical conversion processes.
- Development of thermal transport systems and components. Generally, proposed innovations should support a 50% efficient power cycle (or other highly efficient end use), a 90% efficient receiver module, and multiple hours of thermal energy storage with 99% energetic efficiency and 95% exergetic efficiency while minimizing parasitic losses. Novel concepts should also be compatible with 30 years of reliable operation at the targeted temperature conditions.

23.4 Photovoltaic Materials, Devices, Modules, and Systems

Possible disciplines: Materials science and engineering, electrical engineering, chemical engineering, applied physics, physics, chemistry

In photovoltaic hardware, substantial materials and system challenges remain in many current and near-commercial technologies. Research Journal papers are sought in applied and interdisciplinary science and engineering to improve the performance and reliability of photovoltaic materials, devices, modules, and systems to drive down energy costs. Areas of interest include:

- New module architectures, module components, and innovative cell designs that enable modules to produce more electricity at lower cost and improved reliability; modules that are compatible with higher system voltage and/or have improved shading tolerance, especially in monolithically integrated thin-film modules.

- Development or adaptation of new characterization techniques to evaluate defects and increase collection efficiency of absorber materials or interfaces. Projects should expand understanding of effective methods to control material quality to improve PV device efficiency and stability.
- Scalable, high-speed measurement and characterization methods and tools for cells, modules, panels and systems.
- Fundamental understanding of degradation mechanisms in PV devices, modules and systems. Develop models based on fundamental physics and material properties to predict PV device or module degradation and lifetime to enable shorter testing time and high-confidence performance prediction.
- Cost-effective methods to recycle PV modules and related components that can be implemented into the current recycling infrastructure or module architectures designed for improved recyclability.
- Stable, high-performance photovoltaic absorber materials and cell architectures to enable module efficiencies above 25% while reducing manufacturing costs.
- Transparent electrodes and selective carrier contacts to enable low-cost cell and module architectures amenable to mass production.
- Low-cost materials and high throughput, low cost processes for current collection and transport.

24.0 TETFUND COE SUPPORT FOR JOURNAL PUBLICATION

One of the Performance Indicators for the Centre of Excellence is the publication of per-reviewed journal articles. To this end, the Centre of excellence will support those wishing to publish articles in peer-reviewed Journals. The support for publishing research journal papers is intended to accelerate research excellence and rapid dissemination of research information. This is to be an avenue for significant energy efficiency and renewable energy innovation. This support is designed to fast tract the publication of excellent research papers. This support includes the following components:

1. Assistance in the selection of topics;
2. Assistance in paper organization and structure;
3. Assistance in literature materials;

4. Assistance in proofreading, grammar and plagiarism check;
5. Assistance in Journal Selection;
6. Assistance in the cost of publishing.

The target number of Journal articles is 100.

It is important to note that any financial commitment is reimbursed only after the paper has been published, and the TETfund Centre of Excellence duly acknowledged. All interested authors must register with the Centre, and the focus of the paper must be related to renewable energy. The total number of the author shall not exceed three in number. However, an exception may be granted if the scope of the article is wide.

The main research efforts concentrate on improving the energy efficiency of established energy sources to meet the targets set by The Paris Agreement to limit climate change. However, that has not stopped exploration of new venues like using algae for energy. Work on your elevator pitch if you have an idea that could produce clean energy. You just might get funded. When you're ready to publish your research, we're here to help you choose a journal, evaluate your work, and edit your submission.

24.1 Selecting a Research or Journal Paper Topic

Renewable energy is a topic which is at the forefront of energy development. The global drive to manage, mitigate and prevent climate change has seen the contribution of renewable energy, as an alternative to traditional fossil fuels, to global energy generation increase significantly over the past decade. The growing importance of renewable energy as a solution to the global climate crisis has seen extensive research undertaken and necessitates substantial future research to be conducted. This has made renewable energy a prevalent choice for research, dissertations or journal paper writing.

When selecting a topic focused on renewable energy, it is important to choose a topic that presents a novel and engaging approach. There is an extensive body of published literature which the topic should enable critical engagement with. However, it is vital to ensure that a selected topic does not simply rehash previous research, the development of renewable energy is constant and presents opportunities for numerous dissertations which examine key issues and debates, including those related to sustainability, energy security, justice, equality and development.

The following topics or areas on renewable energy presented below can give provide the authors with some ideas for writing excellent Journal articles or carrying out research:

1. Renewable energy sources and the geological business plan.
2. Should the European Union increase the usage of renewable energy as a mainstay?
3. Renewable energy with the use of hydrogen fuel technology.
4. How can renewable Energy help the natural environment of developing countries?
5. Is Renewable energy a necessary method in Nigeria?
6. Methods of how renewable energy as the primary energy source will affect society's approach to a better standard of living.
7. The use of renewable energy must be harnessed to reverse the negative impacts of climate change caused by global warming.
8. Could the use of renewable energy sources realistically be the answer to global warming for Nigeria
9. How landfills and recycling spaces are essential renewable energy sources
10. How can the negative impact of climate change be reduced by using renewable sources of energy
11. Why can't we replace using fossil fuels with renewable energy?
12. Energy saving programs of developed countries as an example to follow.
13. Renewable energy development strategy
14. Business and energy communities that are using renewable energy sources
15. Renewable sources vs fossil fuel energy
16. Sustainability and renewable energy
17. Benefits of Renewable energy in Nigeria's development plan
18. New technologies for using renewable energy sources
19. How renewable energy affects Nigeria's future
20. Usage of biomass as a source of renewable energy
21. The Limitations of fossil fuels: the importance of renewable energy and its economic benefits
22. Power extraction methods from four-structure interactions
23. The pros and cons of renewable energy

24. Why Nigeria should use renewable energy
25. The real price of power: an environmental impact review of renewable energy
26. Smart grid technology as a renewable energy source
27. The laws the government should enforce on citizens regarding environmental issues such as renewable energy
28. The advantage of biofuels being renewable energy
29. Do renewable energy sources propose green methods of use?
30. Hydropower as the best form of renewable energy source.
31. Which changes in consumers' preferences towards alternative energy sources have contributed to lower oil prices
32. Why the use of alternative energy is beneficial and economical
33. Are alternative energy sources like solar, wind, tidal and geothermal more practical than fossil fuels?
34. Why is non-renewable energy less valuable than alternative energy
35. Why should the government increase funding for the development of alternative energy?
36. A classification of the alternative energy sources
37. Methods of alternative energy use
38. Why is the use of alternative energy beneficial and economical for modern businesses:
39. Should the government implement taxes for the purchase of hybrid or alternative energy vehicles
40. Does the government justify alternative energy sources that are useful for the climate?
41. Hydroelectric power as a popular alternative energy source in Nigeria
42. Alternative energy as a constructive and viable energy production method in comparison to destructive nuclear energy
43. The changes of alternative energy effectively replacing fossil fuels
44. Assessment of the utilization of wind energy in Nigeria
45. The potential contribution of renewable energy to electricity supply in Nigeria
46. Renewable Energy Technology and Policy for Development
47. Policies and market factors driving wind power development in Nigeria
48. Renewable energy development incentives in strengths, weakness and the interplay
49. Solar energy and the national energy dilemma: a model for policy evaluation

50. A percolation model of eco-innovation diffusion: The relationship between diffusion, learning economies and subsidies
51. Public policies and biofuels: the way forward
52. New renewable energy development and the climate change issue: a case study of Nigerian policies
53. Comparative technologies road-mapping for renewable energy
54. Initiating a sustained diffusion of wind energy: the role of public-private partnerships in Nigeria
55. Renewable energy for whom? A global systematic review of the environmental justice implications of renewable energy technologies
56. The evolution of renewable energy and its impact on carbon reduction in Nigeria
57. Determinants of carbon emissions in Nigeria: The roles of renewable energy consumption and globalization
58. Can regional trade integration facilitate renewable energy transition to ensure energy sustainability in Nigeria
59. Effects of Covid-19 outbreak on the environment and renewable energy sector
60. Renewable energy and economic growth: new insight from country risks
61. Different investment dynamics in the energy transition towards a 100% renewable energy system
62. Comparative assessment of renewable energy-based hydrogen production methods
63. The effect of renewable and non-renewable energy consumption on economic growth: Non-parametric evidence
64. Multi-aspect renewable energy forecasting
65. Impacts of innovation on renewable energy technology cost reductions
66. Do renewable energy consumption and financial development matter for environmental sustainability? New global evidence
67. The implications of renewable and non-renewable energy generating in Sub-Saharan Africa: The role of economic policy uncertainties
68. Decomposing scale and technique effects of financial development and foreign direct investment on renewable energy consumption
69. Does renewable energy modulate the negative effect of environmental issues on socioeconomic welfare?
70. Assessing the impact of transition from nonrenewable to renewable energy consumption on economic growth-environmental nexus from developing Asian economies

71. Does financial inclusion and renewable and non-renewable energy utilization accelerate ecological footprints and economic growth? Fresh evidence from 15 highest …
72. Climate change impacts on renewable energy supply
73. Trends in renewable energy production employing biomass-based biochar
74. Portfolio planning of renewable energy with energy storage technologies for different applications from the electricity grid
75. Full energy sector transition towards 100% renewable energy supply: Integrating power, heat, transport and industry sectors, including desalination
76. A critical review on environmental impacts of renewable energy systems and mitigation strategies: Wind, hydro, biomass and geothermal
77. The different types of renewable energy finance: A Bibliometric analysis
78. Renewable energy, technological innovation and the environment: A novel dynamic auto-regressive distributive lag simulation
79. The effects of regional trade integration and renewable energy transition on environmental quality
80. How Wind Turbines Convert Wind Energy into Electrical Energy
81. Usage of Alternative Energy
82. Gas Price Increasing and Alternative Energy Sources
83. Renewable Energy Usage: Advantages and Disadvantages
84. Managing Energy Demand in Lagos: Toward Sustainable City
85. Nigeria Energy Policy: Vulnerabilities and Challenges
86. Energy Independence in Nigeria
87. Green Energy and Carbon Capture
88. Industrial Fermentation as Energy Conversion
89. Renewable Energy Sources: Definition, Types and Stocks
90. Energy Crisis and Climate Change
91. The Future of Energy in Nigeria
92. Renewable Energy Sources: Popularity and Benefits
93. Sustainability and Energy Politics in Nigeria
94. Energy Efficiency and Economic Approaches
95. Meteorology for Future Commodity and Energy Markets
96. The Use of Renewable Energy: Advantages and Disadvantages
97. Renewable and Alternative Energy Sources in Nigeria
98. Energy: What Everyone Needs to Know?
99. Energy Drinks Effects and Changes in Heart Rate

100. Renewable Energy: Economic and Health Benefits
101. Energy Management: Key Components
102. Biofuels and Fossil Fuels as Alternative Energy
103. Energy Consumption and Ecosystem Restoration
104. Renewable Energy Sources for Nigeria
105. Energy Infrastructure Management in Nigeria
106. Installing Solar Panels to Reduce Energy Costs
107. Household Energy Use and Poverty
108. Energy Demand in Nigeria
109. Energy Demand and Political Will to Alternatives
110. Energy Consumption in Wireless Body Area Networks
111. International Atomic Energy Agency
112. The Way Forward in the "Sustainable Energy – Without the Hot Air" by David Mackay
113. Promoting the Use of Green Energy in Emerging Economies
111. Committee of Energy and Commerce's Role in Healthcare
112. Interactive Technologies in Weather and Energy Service Companies
113. Solar Energy and Its Impact on the Environment
114. Quantum Energy Company's Marketing Plan
115. Solar Power as the Best Source of Energy
116. Activation Energy for Viscous Flow of Water, Acetone, Toluene, and o-Xylene
117. Determining Enthalpy of Combustion of a High-Energy Candy
118. Sustainability of Energy Alternatives
119. Bio-Based Materials: Alternative Energy
120. Bio-Based Materials as Alternative Energy
121. Energy for the Future: Discussion
122. Energy-Efficient Area Monitoring for Wireless Sensor Network
123. Wind Energy as an Alternative Source
124. Energy Efficient Cars: Difficulties in Optimization
125. Nigeria Stock Market Energy Sector: Investment Analysis
126. Energy Information Agency: Overview on Gasoline
127. Energy and the Economy. Oil Addiction in Nigeria
128. Energy-Efficient Cars Harmful Effects on the Environment
129. The Problem of Energetic Supply in Kaduna
130. Energy Conservation in the Environment
131. Energy Saving Light Bulb Manufactures Ethical Issue

132. Alternative Energy Sources: A Collaborative Approach in Water Management
133. Concept of Energy Consumption in Environmental Design
134. Alternative Energy Industry's Competition Dynamics
135. Energy Safety and Earthquake Hazards Program
136. Alternative Energy Industry's Profit Pools
137. Energy Innovation Evolutionary Economics and Policies
138. Energy Consumption in Architecture and Environmental Design
139. Business Models in the Alternative Energy Industry
140. Energy Deals Derailed by Obscure Accounting Rule: Enron Case
141. Renewable Energy Programs in Five Countries
142. Energy-Efficient Architecture and Environmental Design
143. Change in Energy Crisis and Save of the Earth
144. Nuclear Energy Used for Different Purposes
145. Energy Crisis: The Processes of Globalization and the Unification
146. The Sun as an Ultimate Source of Energy
147. Renewable Energy: Why Do We Need It?
148. A World With 100% Renewable Energy
149. Biomass and Energy Crops and Technology
150. Modern Energy Technologies Introduction to Developing Countries
151. Engineering: Power Management Techniques for Energy Efficiency
152. Analysis of the Energy Consumption Coefficient
153. Utilization of Solar Energy for Thermal Desalination
154. Hybrid Energy Harvesting System
155. Environmental & Economic Benefit Analysis of Methane Capture for Energy Generation
156. Regeneration of Energy in Nigeria
157. Energy Efficiency and Renewable Energy Utilization
158. Nigeria Energy and Emissions
159. Energy and Environmental Effect of the Pipeline Bust on the Nigeria's Transportation
160. Unbundling Vertically Integrated Energy Companies: Benefits to Consumers
161. Increasing Gas Prices and Alternative Energy Sources
162. Work and Energy Forms in Physics
163. Extreme Scenarios: The Issue of Energy Resources Shortage
164. Energy Crisis and Methods of Countering It

168. Are Alternative Energy Sources the Answer to Ending Human Dependence on Oil?
169. Does Energy Consumption Affect Economic Development?
170. Can Alternative Energy Effectively Replace Fossil Fuels?
171. What Are the Barriers and Incentives for Community-Owned Means of Energy Production and Use?
172. Are Biofuels the Answer to the Energy Question?
173. How Can Alternative Energy Be Harnessed Effectively?
174. Can Wind Energy Enable the US to Become Energy Independent?
175. Does Energy Consumption Contribute to Climate Change?
176. Are Green Electricity Certificates the Way Forward for Renewable Energy?
177. Can Nuclear Energy Contribute to the Transition Toward a Low-Carbon Economy?
178. How Can Political Geography Make Sense of Energy Policy?
179. Are Building Codes Effective at Saving Energy?
180. Does Energy Efficiency Reduce Emissions and Peak Demand?
181. Can Nuclear Energy Stimulates Economic Growth?
182. What Drives the Development of Renewable Energy Technologies?
183. Are Dark Energy and Dark Matter Different Aspects of the Same Physical Process?
184. Does Financial Development Increase Energy Consumption?
185. Are Renewable Energy Policies Climate-Friendly?
186. How Important Are Current Energy Mix Choices on Future Sustainability?
187. Can China's Energy Intensity Constraint Policy Promote Total Factor Energy Efficiency?
188. Should the UK Defense Strategy Support Future Energy Security?
189. Are the Energy Efficiency Technologies Efficient?
190. Does Green Energy Supplies Enough for Our Life?
191. Who Are the Players in the Sustainable Energy Market, and What Are They Doing?
192. Exploring the economic benefits of increasing biomass conversion – a case study of the Nigeria renewable energy industry
193. Inspecting the advantages of using solar energy and its role as a solution to the global threat, i.e. Climate change.
194. Examining the strategy of embracing renewable energy by the Nigeria retail organisations to fulfil the environmental sustainability goals.

195. Critical assessment of growing concern for sustainability in Nigeria construction industry which is driving renewable energy consumption.
196. Evaluating the impact of solar energy in sustainability practices in the Nigeria agriculture industry.
197. Renewable energy resources, mapping and modelling
198. End-of-life and second-life management of RE components
199. Clean cooking and biomass transformation
200. New renewable energy resources for Africa
201. New, more efficient PV cells and components
202. Productive uses and new applications of solar energy
203. Renewable energy: Prospects and Problems Today
204. Renewable energy for sustainable development in Africa
205. Implications of COVID-19 on the biofuel market
206. Geothermal energy; an untapped abundant energy resource
207. The Future of Wind Energy
208. Home wind energy: How valuable is it?
209. Economic and environmental benefits of Renewable Energy
210. Renewable energy and biological conservation in a changing world
211. Do economic development and human capital decrease non-renewable energy consumption? Evidence for various African countries
212. Exploring the nexus between agriculture and greenhouse gas emissions in Nigeria: The role of renewable energy and human capital as moderators
213. The geopolitical risk and gain effects on the renewable energy deployment in Nigeria
214. Mitigating energy production-based carbon dioxide emissions in Nigeria: the roles of renewable energy and economic globalization
215. The cost of debt of renewable and non-renewable energy firms
216. Assessment of the public acceptance and utilization of renewable energy in Nigeria
217. How will renewable energy development goals affect energy poverty in Nigeria?
218. A review of Africa's energy supply through renewable energy production: Nigeria, Cameroon, Ghana and South Africa as a case study
219. Fundamentals of renewable energy processes

220. Do public-private partnerships in energy and renewable energy consumption matter for consumption-based carbon dioxide emissions in Nigeria?
221. Estimating the macroeconomic determinants of the total, renewable, and non-renewable energy demands in Nigeria: the role of technological innovations
222. Impact of renewable energy consumption, globalization, and technological innovation on environmental degradation in Nigeria: application of wavelet tools
223. Implementing a just renewable energy transition
224. Developing a perspective on the use of renewable energy in Nigeria
225. Nigeria's renewable energy: new insights from multi-regional input-output and structural decomposition analysis
226. A green hydrogen economy for a renewable energy society
227. Assessing the environmental sustainability corridor: Linking natural resources, renewable energy, human capital, and ecological footprint in Nigeria.
228. Analyzing the effect of natural gas, nuclear energy and renewable energy on GDP and carbon emissions: A multi-variate panel data analysis
229. Does renewable energy consumption reduce ecological footprint? Evidence from selected developing countries in Africa
230. Hydrogen-based systems for integration of renewable energy in power systems: Achievements and perspectives
231. Using green finance to counteract the adverse effects of the COVID-19 pandemic on renewable energy investment-The case of offshore wind power in Nigeria
232. Nexus between willingness to pay for renewable energy sources: Evidence from selected African Countries
233. Hybrid Renewable Energy Resources Management for Optimal Energy Operation in Nano-Grid
234. Distortions of National Policies to Renewable Energy Cooperation Mechanisms
235. Optimal Configuration and Sizing of Seaport Microgrids including Renewable Energy and Cold Ironing
236. Public policies to promote renewable energy technologies: Learning from Nigerian experiences

237. Fractional order frequency proportional-integral-derivative control of microgrid consisting of renewable energy sources based on multi-objective grasshopper …
238. The impacts of household social benefits, public expenditure on labour markets, and household financial assets on the renewable energy sector
239. Electrify Nigeria: the role of renewable energy
240. National Renewable Energy Laboratory
241. The relationship between renewable energy and retail electricity prices:
242. Economic Assessment of Renewable Energy Projects
243. Renewable Energy System Protection and Coordination
244. Applications of Nature-Inspired Computing in Renewable Energy Systems
245. How do trade liberalization and human capital affect renewable energy consumption?
246. Titanium Dioxide Nanomaterials for Renewable Energy Applications
247. Optimizing the installed capacity of hybrid renewable energy with a modified MPPT model.
248. Design and performance analysis of off-grid hybrid renewable energy systems
249. Efficient Renewable Energy Systems
250. Sustainability and renewable energy education: children of the next generation
251. Does renewable electricity supply match with energy demand?–A Spatio-temporal analysis for the Nigerian case
252. Design and Evaluation of Microgrids Based on Renewable Energy Technologies with a Perspective of Sustainable Development
253. Measurement and Analysis of Power Losses in Sintered Cores for Power Electronic Devices in Renewable Energy Systems
254. Renewable energy sources as a solution for energy security risk: Empirical evidence from African countries
255. Modelling of Risk Aversion Linked to Renewable Energy Policy and Decision-Maker Behavior
256. Power electronics technologies for renewable energy sources
257. Design and optimal energy management of community microgrids with flexible renewable energy sources

258. A new model for the use of renewable electricity to reduce carbon dioxide emissions
259. Exploring the use of renewable resources for the processing of deep-sea minerals
260. Support Vector Machine-Based Forecasting for Renewable Energy Systems
261. Optimal Economic Incentive for Renewable Energy in Composite Expansion Planning
262. Overview of Bidirectional DC–DC Converters Topologies for Electric Vehicle and Renewable Energy System
263. Efficient and Secure Storage for Renewable Energy Resource Data Using Parquet for Data Analytics
264. Fractional-Order PI-Lead Controller Design of DC-DC Power Converter for Renewable Energy Applications
265. How do feed-in tariff and renewable portfolio standard evolve synergistically? An integrated approach of tripartite evolutionary game and system dynamics
266. High Gain Converter with Switched Coupled Inductors for Renewable Energy Systems
267. Renewable Energy Education in the United Arab Emirates
268. Entropy and Exergy in Renewable Energy
269. A Study on Policies for Sustainable Investment in Renewable Energy in the Post-FIT Era
270. Role of energy efficiency for sustainable energy for all: exploring synergies with renewable energy and energy access
271. Investigating the role of globalization, and energy consumption for environmental externalities: empirical evidence from developed and developing economies
272. Rocky politics will slow Tunisia’s renewable progress
273. Solar and wind energy potential assessment at a provincial level in Nepal: Geospatial and economic analysis
274. Impact of Renewable Energy Sources on the Indian Electricity Grid
275. Analytic assessment of renewable potential in Northeast India and the impact of their exploitation on the environment and economy
276. Inertia-weight local-search-based TLBO algorithm for energy management in isolated micro-grids with renewable resources
277. Comparative Analysis of Various Types of Control Techniques for Wind Energy Conversion System

278. An evaluation of the consumer-funded renewable obligation scheme in the UK for wind power generation
279. Proposal and evaluation of two innovative combined gas turbine and ejector refrigeration cycles fueled by biogas: Thermodynamic and optimization analysis
280. Energy Management in a Smart Grid Including Demand Response Programs Considering Internet of Things
281. Clean energy consumption, economic growth, and environmental sustainability: What is the role of economic policy uncertainty?
282. Optimal sizing and deployment of gravity energy storage system in hybrid PV-Wind power plant.
283. High-resolution large-scale onshore wind energy assessments: A review of potential definitions, methodologies and future research needs.
284. Onion-ring-like g-C3N4 modified with Bi3TaO7 quantum dots: A novel 0D/3D S-scheme heterojunction for enhanced photocatalytic hydrogen production under visible …
285. Accelerating the energy transition to achieve carbon neutrality
286. The energy transition process and community engagement on geographic islands: The case of …….
287. Clean hydrogen?–Comparing the emissions and costs of fossil fuel versus renewable electricity-based hydrogen
288. Techno-economic analysis of two-tank and packed-bed rock thermal energy storages for foil-based concentrating solar collector-driven cogeneration plants
289. Morphing blades for tidal turbines: A theoretical study green tax as a path to greener economy: A game theory approach on energy and final goods in Nigeria
290. A Paradigm Shift of Energy Sources: Critical Review on Competitive Dynamics of Solar PV Industry in Nigeria
291. Solar wind, hybrid renewable energy systems
292. Prioritization of solar electricity and hydrogen co-production stations considering PV losses and different types of solar trackers: A TOPSIS approach
293. Densifying lignocellulosic biomass with sulfuric acid provides a durable feedstock with high digestibility and high fermentability for cellulosic ethanol production

294. Extreme management strategy and thermodynamic analysis of high-temperature H_2O/CO_2 co-electrolysis for energy conversion
295. Are coupled renewable-battery power plants more valuable than independently-sited installations?
296. High-resolution data shows China's wind and solar energy resources are enough to support a 2050 decarbonized electricity system
297. Waste-to-energy forecasting and real-time optimization: An anomaly-aware approach
298. Continuous and flexible Renewable-Power-to-Methane via liquid CO_2 energy storage: Revisiting the techno-economic potential
299. Optimal battery capacity of grid-connected PV-battery systems considering battery degradation
300. Evaluating the suitability of Sentinel-1 SAR data for offshore wind resource assessment around Lagos
301. Cu–Mn–O nano-particle/nano-sheet spinel-type materials as catalysts in methanol steam reforming (MSR) and preferential oxidation (PROX) reaction for purified …
302. Energy consumption of the wood size reduction processes with the employment of low-power machines with various cutting mechanisms
303. Energy-based fuzzy supervisory non-integer control for performance improvement of PMSG-Based marine energy system under swell effect and parameter
304. Field-scale experimental and numerical analysis of a downhole coaxial heat exchanger for geothermal energy production
305. Assessment of the driving factors of CO_2 mitigation costs of household biogas systems in Nigeria: A LMDI decomposition with the cost analysis model
306. Is small always beautiful? Analyzing the efficiency effects of size heterogeneity in renewable electricity auction
307. Development of a solar nano-grid for meeting the electricity supply shortage in developing countries (Nigeria as a case study)
308. Econometric estimation of the impact of oil prices and economic growth on the diffusion of renewable electricity in Nigeria: using VECM model
309. Numerical modelling and dynamic response analysis of a 10 MW semi-submersible floating offshore wind turbine subjected to ship collision loads
310. Wave energy flux in the Caribbean Sea: Trends and variability

311. Multi-objective optimization of HCCI combustion fuelled with fusel oil and n-heptane blends
312. Upscaling scenarios for ocean thermal energy conversion with technological learning in Indonesia and their global relevance
313. Renewable-and fragmentation-aware VM placement for geographically distributed green data centres
314. Numerical investigation of a small-scale sloped solar chimney power plant
315. Prospection of catole coconut (Syagrus cearensis) as a new bioenergy feedstock: insights from the physicochemical characterization, pyrolysis kinetics, and …
316. Positive energy districts: Mainstreaming energy transition in urban areas
317. Cost-optimal wave-powered persistent oceanographic observation
318. Multi-criteria prioritization of the renewable power plants in Nigeria using the fuzzy logic in decision-making method (FMCDM)
319. Design-eligibility study of solar thermal helically coiled heat exchanging system with annular dimples by irreversibility concept
320. Simultaneous short-term significant wave height and energy flux prediction using zonal multi-task evolutionary artificial neural networks
321. Optimization of high-pressure blade edge to reduce pressure fluctuations in pump-turbine hump region
322. Oxy-fuel and air atmosphere combustions of Nigerian medicine residues: Performances, mechanisms, flue gas emission, and ash properties
323. The role of environmental technology for energy demand and energy efficiency: Evidence from African countries
324. A geospatial analysis approach for the operational assessment of solar ORC systems. Case study: Performance evaluation of a two-stage solar ORC engine in Nigeria
325. Net zero electricity systems in global economies by life cycle assessment (LCA) considering ecosystem, health, monetization, and soil CO2 sequestration impacts
326. Time-series aggregation for the optimization of energy systems: Goals, challenges, approaches, and opportunities
327. Technical potential of floating photovoltaic systems on artificial water bodies in Nigeria

328. Simulation of heat loss in $Cu_2ZnSn_4SxSe_4$− x thin film solar cells: A coupled optical-electrical-thermal modelling
329. A one-pot route to tunable sugar-derived sulfonated carbon catalysts for sustainable production of biodiesel by fatty acid esterification
330. A multi-rotor medium-voltage wind turbine system and its control strategy
331. Large-eddy simulation and Co-Design strategy for a drag-type vertical axis hydrokinetic turbine in open channel flows
332. Energy efficiency and sustainable development goals (SDGs)
333. Receiver with light-trapping nanostructured coating: A possible way to achieve high-efficiency solar thermal conversion for the next-generation concentrating solar
334. Assessment of organosolv, hydrothermal, and combined organosolv and hydrothermal with enzymatic pretreatment to increase biogas production from Napier …
335. Renewable diesel as fossil fuel substitution in Nigeria: A review
336. Realization and Implementation of Peak Energy Management
337. Clean energy from salinity gradients using pressure retarded osmosis and reverse electrodialysis: A review
338. Multiperiod stochastic programming for biomass supply chain design under spatiotemporal variability of feedstock supply\
339. Combined effects of composite thermal energy storage and magnetic field to enhance productivity in solar desalination
340. Waste cooking oil transesterification by sulfonated polyphenylsulfone catalytic membrane: Characterization and biodiesel production yield
341. Optimal configuration and economic analysis of PRO-retrofitted industrial networks for sustainable energy production and material recovery considering uncertainties …
342. Biofuel and biotech: a sustainable energy solution
343. Conceptual design of solar/geothermal hybrid system focusing on technical, economic and environmental parameters
344. Using incomplete complex modes for model updating of monopiled offshore wind turbines
345. Performance evaluation of natural and forced convection indirect type solar dryers during drying ivy gourd: An experimental study
346. Job creation during a climate-compliant global energy transition across the power, heat, transport, and desalination sectors by 2050

347. Stochastic optimal scheduling of demand response-enabled microgrids with renewable generations: An analytical-heuristic approach
348. Derivation of operating rule curves for cascade hydropower reservoirs considering the spot market: A case study of River Niger reservoir system
349. Stability Improvement of Renewable Source Integrated Hybrid System Using SVC Controller and ALO Technique
350. Performance analysis of photovoltaic module with reflector: Optimizing orientation with different tilt scenarios
351. Two-stage anaerobic digestion with direct electric stimulation of methanogenesis: The effect of a physical barrier to retain biomass on the surface of a carbon cloth …
352. Mesoporous $SrTiO_3$ perovskite as a heterogeneous catalyst for biodiesel production: Experimental and DFT studies
353. Mapping the photovoltaic potential of the roads, including the effect of traffic
354. Organic photovoltaic modules integrated inside and outside a polytunnel roof
355. Control of a boundary layer over a wind turbine blade using distributed passive roughness
356. An Efficient Energy Utilization of Biomass Energy-Based System for Renewable Hydrogen Production and Storage
357. Realizing the Transactive Energy Future with Local Energy Market: an Overview
358. The power generation expansion planning in Nigeria: Considering the impact of greenhouse gas emissions in an Investment Decision Model
359. A resilient drop-in biofuel supply chain integrated with existing petroleum infrastructure: Toward more sustainable transport fuel solutions
360. Empirical greenhouse gas assessment for flexible bioenergy in interaction with the Nigerian power sector
361. Economics of electric energy storage. The case of Nigeria
362. Grid integrated non-renewable based hybrid systems: Control strategies, optimization, and modelling
363. Global assessment of historical, current and forecast ocean energy infrastructure: Implications for marine space planning, sustainable design and end-of …

364. Regulating Sustainable Economics: A Legal and Policy Analysis in the Light of the United Nations Sustainable Development Goals
365. Effects of free surface on a flapping-foil-based ocean current energy extractor
366. Effects analysis on heat dissipation characteristics of lithium-ion battery thermal management system under the synergism of phase change material and liquid cooling …
367. Microwave pyrolysis of biomass for low-oxygen bio-oil: Mechanisms of CO2-assisted in-situ deoxygenation
368. Energy generation from palm oil mill effluent: A life cycle cost-benefit analysis and policy insights
369. Research on the size optimization of photovoltaic panels and integrated application with Nigerian solar greenhouses
370. Modelling of the Ability of a Mixed Renewable Generation Electricity System with Storage to Meet Consumer Demand
371. In-situ micro aeration of anaerobic digester treating buffalo manure for enhanced biogas yield
372. Hybrid fossil fuel/renewable systems for polygeneration
373. Novel use of the enhanced thermal response test in crystalline bedrock
374. Assessing Hawaii's Clean Energy Options
375. Dependence of spectral factor on the angle of incidence for monocrystalline silicon-based photovoltaic solar panel
376. PV temperature and performance prediction in free-standing, BIPV and BAPV incorporating the effect of temperature and inclination on the heat transfer coefficients …
377. The comprehensive performance analysis on a novel high-performance air-purification-sterilization type PV-Trombe wall
378. Prediction of hydroelectric turbine runner strain signal via cyclostationary decomposition and kriging interpolation
379. Applying analytic hierarchy process to industrial process design in a Nuclear Renewable Hybrid Energy System
380. Performance and genetic diversity of pre-commercial sweet sorghum hybrids in Nigeria
381. Performance enhancing and improvement studies in a 600 kW solar photovoltaic (PV) power plant; manual and natural cleaning, rainwater harvesting and …

382. Role of ZSM5 catalyst and char susceptor on the synthesis of chemicals and hydrocarbons from microwave-assisted in-situ catalytic co-pyrolysis of algae and plastic
383. A novel reconfiguration technique for improvement of PV reliability
384. Ex-post analysis of energy subsidy removal through integrated energy systems modelling
385. Governing decentral energy systems
386. Heterogeneous preferences for EVs: Evidence from Nigeria
387. Conceptual development and optimization of the main absorption systems configurations
388. Thermal modelling and experimental evaluation of a novel concentrating photovoltaic thermal collector (CPVT) with parabolic concentrator.
389. Can Declining Energy Intensity Mitigate Climate Change?
390. Energy Management and System Modeling: Long-range Energy Alternatives Planning combined with Water Evaluation and Planning System (LEAP & WEAP software)
391. Optimization of Renewable Energy for Power Generation ~ Micro power system, microgrid and mini-grid system, using software HOMER & RET Screen, etc.
392. Hybrid Power Systems (Mixed of Wind, Solar, Micro-hydro, Biomass, Fuel Cell etc.)
393. Power Electronics and Data Acquisition for Renewable Energy Systems (power conditioning systems, inverter, MPPT maximum power point tracking system, etc.)
394. Live Remote Monitoring and Control for Renewable Energy Systems
395. Optimization Approach for Long-Term Planning of Charging Infrastructure for Fixed-Route Transportation Systems
396. Simultaneous Long-Term Planning of Flexible Electric Vehicle Photovoltaic Charging Stations in Terms of Load Response and Technical and Economic Indicators
397. Socio-Economic Barriers to Adoption of Electric Vehicles in South Africa: Case Study of the Gauteng Province
398. Primary Energy Use and Environmental Effects of Electric Vehicles
399. Enhancing the Power Quality of the Grid Interactive Solar Photovoltaic-Electric Vehicle System

400. Impact of Relaxation Time on Electrochemical Impedance Spectroscopy Characterization of the Most Common Lithium Battery Technologies—Experimental Study and Chemistry-Neutral Modeling
401. A Brief Survey on Important Interconnection Standards for Photovoltaic Systems and Electric Vehicles
402. Beyond the State of the Art of Electric Vehicles: A Fact-Based Paper of the Current and Prospective Electric Vehicle Technologies
403. Feasibility of Innovative Smart Mobility Solutions: A Case Study for …
404. Advantages and Disadvantages of Electric Cars Essay
405. Analysis of the Better Place Electric Car Scheme
406. Comparison of Electric and Gas-Powered Vehicles
407. Pricing of Electric Cars and How to Encourage People to Buy Them
408. Electric Car and the Environment
409. Electric Cars: Types, Pros and Cons
410. Electric Cars: Advantages and Concerns
411. Electric Cars and Benefits of Their Early Adoption
412. Electric vs. Internal Combustion Engine Vehicles: Comparison
413. Electric vs. Internal Combustion Engine Vehicle
414. An Electric Vehicle Characteristics
415. Business Report: Volkswagen and Electric Vehicle Risk
416. Electric vs. Gasoline-Powered Cars
417. Hybrid Electric Vehicle Batteries: Charging and Discharging
418. Selecting Specification of Electric Vehicle
419. Accelerated Model Predictive Control for Electric Vehicle Integrated Microgrid Energy Management
420. Acceptability, Energy Consumption, and Electric Vehicle Costs for Ride-Hailing Drivers in Nigeria
421. Adaptive Intelligent Energy Management System of Plug-in Hybrid Electric Vehicle
422. Analyzing Consumer Attitudes Towards Electric Vehicle Purchasing Intentions in Nigeria
423. Battery Durability and Longevity-Based Power Management for Plug-in Hybrid Electric Vehicle
424. Preferences for Electric Vehicle Charging and Implications for Charging Infrastructure Planning
425. Charging Infrastructure Projects: How to Boost the Nigeria Electric Vehicle Market.

426. Citizens' Electric Vehicle Purchase Intentions in Nigeria: Micro- And Macro-Level Factors Analysis
427. Coupling Local Renewable Energy Production With Electric Vehicle Charging
428. Development Scheme and Key Technology of an Electric Vehicle: An Overview
429. Designing Policy Incentives for Cleaner Technologies: A Nigerian's Plug-in Electric Vehicle Rebate Program
430. Divergent Technological Strategies Among Electric Vehicle Firms in Africa
431. Driving Smart Growth: Electric Vehicle Adoption and Off-Peak Electricity Rates
432. Economic and Environmental Impacts of Electric Vehicle Society in Nigeria
433. Electricity-Price Arbitrage With Plug-in Hybrid Electric Vehicle: Gain or Loss
434. Electricity Rates for Electric Vehicle Direct Current Fast Charging options for Nigeria
435. Electric Vehicle Charging Demand Forecasting Model Based on Big Data Technologies
436. Engineering and Economic Analysis for Electric Vehicle Charging Infrastructure
437. Electric Vehicle Charging Station Markets for Nigeria: A feasibility Study
438. Enhancing Electric Vehicle Sustainability Through Battery Life Optimal Charging
439. Electric Vehicle Charging System Market Growth, Trends, Analysis, and Forecast
440. Electric Vehicle Fleet Contributions for Isolated Systems: Rural Areas in Nigeria Case
441. Optimizing Plug-in Electric Vehicle and Vehicle-To-Grid Charge Scheduling to Minimize Carbon Emissions
442. Expecting the Unexpected: Disruptive Technological Change Processes and the Electric Vehicle
443. Factors Influencing Early Battery Electric Vehicle Adoption in Nigeria
444. Electric Vehicle Safety Requirements for Electric Vehicles
445. Fuel Cell Electric Vehicle as a Power Plant and SOFC as a Natural Gas Reformer

446. Electric Vehicle Virtual Power Plant Dilemma: Grid Balancing Versus Customer Mobility
447. Future Standard and Fast Charging Infrastructure Planning: Electric Vehicle Charging Behaviour Analysis
448. Increasing Electric Vehicle Policy Efficiency and Effectiveness by Reducing Mainstream Market Bias
449. Infantry Mobility Hybrid Electric Vehicle Performance: Analysis and Design
450. Integrating Renewable Energy Sources by Electric Vehicle Fleets Under Uncertainty
451. Joint Charging Mode and Location Choice Model for Battery Electric Vehicle Users
452. Interacting With Limited Mobility Resources: Psychological Range Levels in Electric Vehicle Use
453. Key Drivers Behind the Adoption of Electric Vehicle in Nigeria
454. Lithium-Ion Batteries for Electric Vehicle Batteries
455. Market Dynamics and Indirect Network Effects in Electric Vehicle Diffusion
456. Methodology for Assessing Electric Vehicle Charging Infrastructure Business Models
457. Mirroring Hypothesis and Integrality in the Electric Vehicle Industry
458. Plug-in Hybrid Electric Vehicle Impacts on Hourly Electricity Demand in Nigeria
459. What Are the Disadvantages to an Electric Car?
460. What Are the Main Types of Electric Vehicles?
461. Are Electric Cars Safe?
462. How Long Does It Take to Charge an Electric Car?
463. How Far Can an Electric Car Go On One Charge?
464. What Are the Advantages of Electric Cars?
465. How Do Electric Vehicles Work?
466. What Is the Biggest Problem With Electric Cars
467. What Is the Main Problem With Electric Cars?
468. Do Electric Cars Pay Road Tax?
469. Are All Electric Cars Automatic?
470. Can You Jumpstart a Car With an Electric Car?
471. What Happens to an Electric Car Battery When It Dies?
472. Do Electric Cars Need Servicing?
473. Which Type of Electric Vehicle Is Best?

474. What Is Difference Between a Hybrid Car and an Electric Car?
475. What Happens When an Electric Car Runs Out of Power?
476. Are Electric Cars the Future?
477. How Long Does It Take to Charge an Electric Car at a Charging Station?
478. How Much Does It Cost to Replace an Electric Car Battery?
479. What Are the Economic and Environmental Impacts of the Electric Vehicle Society in Nigeria?
480. Do Electric Cars Need Servicing?
481. What Is the Market for Electric Vehicle Charging Stations in Nigeria?
482. How Long Does It Take to Charge an Electric Car From Empty to Full?

We would strongly suggest authors and researchers scan through the above list in order to come up with relevant titles for research titles or projects. In addition, the next section provides some selected renewable energy project topics and materials.

24.2 Some Selected Renewable Energy Project Topics and Materials

1. Experimental Design and Construction of a Prototype Solar Powered Intermittent Absorption Vapor Refrigerator
2. Optimization of Biodiesel from Coconut (Cocos Nucifera) Seed Oil
3. Strategic Developments in Renewable Energy In Nigeria
4. Optimisation of Bioethanol Production From Some Plants Waste Using Acids Pretreatment
5. Evaluation of The Potentials of Large-Scale Photovoltaic Power Generation for Rural Electrification In Nigeria
6. Wireless Power Transmission Via Solar Power Satellite
7. Generation of Electricity Using Road Transport Pressure
8. Space Vector Pulse Width Modulation for Three-Level Converters: A Labview Implementation
9. Solar Powered Induction Motor-Driven Water Pump Operating On A Desert Well, Simulation and Field Tests
10. Power Quality In Low Voltage Grids with Integrated Microproduction
11. A Single-Stage Grid Connected Inverter Topology for Solar PV Systems with Maximum Power Point Tracking
12. Power Generation Using Speed Breaker with Auto Street Light
13. Low Energy Wake-Up Logic

14. Energy Efficient Dynamic Cluster Algorithm for Ad Hoc Sensor Networks
15. Interface Issues In Induction Motor Drives
16. Harvesting Energy with H and-Crank Generators To Support Dismounted Soldier Missions
17. Design and Performance Analysis of Low-Noise Amplifier with B and-Pass Filter for 2.4-2.5 Ghz
18. Solar Power Water Pump Studies for Small-Scale Irrigation
19. Piezoelectric Energy Harvesting Devices for Recharging Batteries
20. Design Space Exploration of Time-Multiplexed Firfilters On Fpgas
21. A Digital Automatic Sliding Door with A Room Light Control System
22. Wireless Power Transmission Methods
23. Low Power and Low Complexity Shift- and-Add Based Computations
24. A New Low Power 32×32-Bit Multiplier
25. Automatic Night Lamp with Morning Alarm
26. Automatic Night Lamp with Morning Alarm Using Microprocessor
27. The Design of A Low Power Asynchronous Multiplier
28. Driver Training with Look Ahead On Lowering Fuel Consumption
29. Real Time Matlab Interface for Speed Control of Induction Motor Drive Using Dspic 30f4011
30. Low Power Shift and Add Multiplier Design
31. High Speed 16×16-Bit Low-Latency Pipelined Booth Multiplier
32. High-Speed and Low-Power Multipliers Using The Baugh-Wooley Algorithm and Hpm Reduction Tree
33. A Novel Approach for High Speed and Low Power 4-Bit Multiplier
34. Low Power 32×32 Bit Multiplier Architecture Based On Vedic Mathematics Using Virtex 7 Low Power Device
35. Interface Issues In Induction Motor Drives
36. A High Speed and Low Power Vlsi Multiplier Using A Redundant Binary Booth Encoding
37. An Asynchronous Pipelined 32×32-Bit Iterative Multiplier Using Hybrid Handshaking Protocol
38. Low Power Smartdust Receiver with Novel Applications and Improvements of An RF Power Harvesting Circuit
39. Bicycle Power Generator Design: off Grid Energy Solutions
40. Piezoelectric Energy Harvesting Devices for Recharging Batteries
41. Parasitic Power Harvesting In Shoes
42. Piezo-Electric Power Scavenging for Mining Applications

43. Design of Small Photovoltaic(PV) Solar-Powered Water Pump System
44. Commercialization Possibilities of Stirling Engine Technology for Microscale Power Generation
45. Rural Electrification Using Renewable Energy Resources
46. Wake Measurements Behind An Array of Two Model Wind Turbines
47. Characterization and Utilization of Agro forestry Residues As Energy Source
48. Implementation of Solar Thermal Energy In A Small Residential Area
49. Cavitation Assessment of The Discharge Tunnel – Using Computational Fluid Dynamics
50. Design of A PV System with Variations of Hybrid System
51. Evaluation Methods for Market Models Used In Smart Grids
52. Influence of Scaling Effects On Hub Loads of A Horizontal Wind Turbine
53. Large Scale Monolithic Solar Panel Simulation – A Study On Partial Shading Degradation
54. Automatic Solar Tracker
55. Sea wave Power Generator with Solar
56. Self-Charging Solar Powered Drone
57. Wind & Solar Mobile Charging Station
58. Floating Sun Tracker Hydraulic Solar Panel
59. Solar Outdoor Air Purifier & Air Quality Monitor
60. Power Generation Using Speed Breakers
61. Electricity Generator Tiles Project
62. Enhanced Vertical Windmill System
63. Power Generation Using Electromagnetic Suspension
64. Design & Fabrication of Mechanical Footstep Power Generator
65. Mini Windmill Power Generation Project
66. Rotating Solar Panel Using Arduino
67. Solar Panel with Sun Position Tracking
68. Pedal Powered Electricity Generator Project
69. Irrigation System Running On Solar Power
70. System To Measure Solar Power
71. Controlling Solar Energy Charge
72. Fully Automated Solar Grass Cutter
73. Smart Solar Grass Cutter with Lawn Coverage
74. Dual Power Generation Solar Plus Windmill Generator
75. Advanced Footstep Power Generation System

76. Use of big data technologies for the implementation of energy-saving measures and renewable energy sources in buildings
77. Study of a hybrid renewable energy system for a school in Kaduna, Nigeria
78. Classification of Nigeria among African Countries by Years in Terms of Energy Efficiency, Total Renewable Energy, Energy Consumption, Greenhouse Gas Emission and Energy it. report Dependency by Using Machine Learning
79. Possibility to use renewable energy sources for increasing the reliability of the responsible energy consumers on the enterprise
80. Technical Feasibility in Reaching Renewable Energy Targets; Case Study on Nigeria
81. Analysis and Inspiration of the National Load all Powered by Renewable Energy in Nigeria
82. Electrospun semiconducting nanofibers as an attractive material for renewable energy applications
83. A Study on the Implementation of Economic Zero Energy Building according to Nigeria's Renewable Energy Support Policies and Energy Consumption Patterns
84. Policies and strategies for renewable energy development in Nigeria
85. Numerical investigation of damage progressive in a composite tidal turbine for renewable marine energy

25.0 INTRODUCING THE SUSTAINABLE ENERGY LECTURE SERIES

Starting this year, 2023, The TETFund Centre of Excellence for Renewable Energy will organize a lecture series that will analyze and discuss the scientific, technological, financial, socioeconomic, commercial, political, and regional opportunities and challenges of a renewable energy-powered future in Nigeria in particular and the sub-region in general.

The energy lecture series aim to facilitate discussions and exchange ideas among different stakeholders to promote a sustainable energy future for Nigeria. They are designed to promote public understanding and stakeholder dialog around key energy efficiency issues relevant to Nigeria today. This series shall feature energy sector leaders and experts and covers an array of topics – from advice on how to lower your energy bills at home and in industry, innovative solutions from the business community, to training our workforce amidst a rapidly changing energy landscape.

Other topics to be covered range from innovation in renewables to the bioenergy potential of the country, smart grids, demand side management, green buildings, energy stakeholder/consumer engagement, electricity market reforms, energy pricing, and business model innovation. The lecture series will elaborate on the role of renewable energy in energy transition, including technology and sector roadmaps, economics, and enabling frameworks. The lecture series shall further focus on planning long-term transition paths for a high share of variable renewable energy, and will explore planning to overcome operational bottlenecks and the role of storage in integrating variable renewable energy into a power system.

Designed to inform and inspire current and future leaders in renewable energy sustainability, the TETFund Centre of Excellence for Renewable Energy is expected to host the inaugural lecture of the series in the 2nd quarter of 2023. Tagged "Effective Partnerships for Sustainability Energy utilization", the event will bring together sustainability leaders, renewable energy experts, relevant stakeholders, students, and staff to brainstorm about critical challenges and advances related to energy, climate and the environment, and urban transformations. The series provides shall participants and the public with the opportunity to explore sustainable energy solutions, learn about the challenges facing sustainable energy use, using sustainable energy, and interact with experts from the renewable energy industry. The proposed lecture series will provide new perspectives in moving Nigeria towards a green and sustainable energy future.

Topics to be considered for the lecture series include:

S/No	Lecture Series Topics
1	**Innovative Energy Solutions: A Nigeria Business Roundtable** This lecture shall serve as a more business-focused conversation, featuring a panel of local business leaders who are forging connections, introducing new technologies, and building innovative solutions to create jobs and address Nigeria's looming energy problems.
2	**Preparing ' 'Nigeria's Workforce for Clean Energy Jobs** Changing how we source and use energy is critical for our planet's future, but ' 'it's also an opportunity to create jobs and support the

	economy here in Nigeria. With record-level investment in energy efficiency, renewable energy, energy storage, and advanced vehicles and transportation, experts are predicting that as many as 10 million jobs could be created in the clean energy sector in the coming years, if Nigeria gets involved now!. Our third lecture will showcase a panel of leaders shaping ' 'Nigeria's workforce development ecosystem.
3	**Saving on Utility Bills through Energy Efficiency** (As home heating costs are expected to spike this winter, Nigerians are looking for ways to cut costs on their utility bills. The good news: you can take several simple steps right now to increase your energy efficiency and save money.
4	**Energy Efficiency, Human Health, and COVID-19** The COVID-19 pandemic has highlighted the links between health and the built environment. Adequate ventilation is essential to reducing transmission of the virus causing COVID-19, and people living without proper ventilation may be at an increased risk of exposure. Is energy efficiency an effective solution to increasing health and safety in buildings and reducing exposure to COVID-19?
5	**Energy Efficiency in Schools: Safer Buildings, Healthier Students** There is strong evidence that building environments affect the health and performance of individuals learning or working inside. How has COVID-19 required us to re-examine our treatment of school buildings concerning air quality, and how can attention shift towards energy efficiency and help schools reopen safely amidst the pandemic? How can we leverage energy efficiency in schools to create healthier, more productive environments that inspire students to join the energy-efficiency workforce?
6	**Barriers to Energy Efficiency in Rental and Affordable housing** The economic benefits of improved energy efficiency in homes are well documented. However, energy efficiency programs are not easily accessible to all. The COVID-19 pandemic has highlighted how many communities already struggling with economic and social hardships are less likely to live in properly ventilated, energy-efficient housing. What are the economic, social and cultural barriers to participation in energy efficiency programs? How

	can/should energy efficiency programs be designed to specifically address these barriers to entry?
7	**Nigeria and Sustainable Development Goal 7: Affordable and Clean Energy** In reaching the targets for Goal 7, Nigeria must develop effective national energy strategies and energy policies based on domestic energy demand and the international energy situation. Nigeria has abundant and promising clean energy resources, which is an important foundation for achieving a clean, diversified, reliable and economical supply of energy in the future. How can these goals be achieved?
8	**Decarbonization of Nigeria – from the perspectives of impacts, justice and governance** Climate change concerns and awareness and policy are growing. However, there is still a need to understand better the quantities of emissions reduction that can be made from each of the sectors of the economy such as power, oil and gas, transport, agriculture, industry, and others. The Federal Government of Nigeria formulated and communicated its Long-Term Low GHG Emission Development Strategies (LT-LEDS) envisioned that By 2050, Nigeria will be a country of low-carbon, climate-resilient, high-growth circular economy that reduces its current level of emissions by 50%, moving towards having net-zero emissions across all sectors of its development in a gender-responsive manner. Why do we need such a strategic plan? What the future has in store for us? How much time do we have? What tools do we have to achieve our goals? This lecture will address those questions, present the current and projected state of the climate, and touch upon some core issues of the challenge, namely from the dimension of justice and governance.

Other lecture topics that can be considered include:

1. Innovation Driving the Energy Sector Transformation
2. Improving Energy Access with Renewable Energy Project Facilitation
3. The True Costs of Renewables

4. Energy System Transformation for the Developing World
5. Energy Sustainability and Climate Goals
6. Facilitating Data-Driven Innovation for Sustainable Energy Transition
7. The impact of COVID-19 and climate change on energy transition
8. Management of Higher Education and Staff and Students' Well-being under COVID-19 Pandemic in Nigeria: Lessons and solutions for future health crisis.
9. Green Energies and Environmental Sustainability
10. Energy Efficient Building
11. Smart Electric Grid for Sustainable Energy Future
12. How can global action on climate change be accelerated? Reflections from an African perspective
13. An off-grid solar frontier: the scalar geographies of the photovoltaic turn in Nigeria
14. The evolving role of finance in renewable electricity systems in Nigeria,
15. Barriers to sustainable electrical energy transition in Nigeria
16. Gendering energy, representation and the political ecology of an electric energy transition in Nigeria
17. The political economy of renewable energy in Nigeria: The role of donors and domestic priorities

25.1 Modes of Presentation and Participation

The Lecture Series shall be held in the presence (in-person event) and online-only events due to the COVID-19 pandemic. Of course, we know that the COVID-19 still imposes severe travel restrictions on many, who would have been forced to miss a full in-presence event. Hence, each lecture is conceived as a hybrid event that will run in-person and virtually, aiming to provide the best possible experience for both participants and presenters researchers attending in presence and for those participating in the virtual program. However, the main presenter shall present in person.

The videos of the presentations of all papers in the lectures shall be made available to registered attendees in an on-demand fashion. Moreover, for each presentation, registered attendees can directly download the papers and provide comments through the Discussion/Comments Section. All live streaming will be held through zoom webinar. A downloadable version of the lecture proceedings will be made available on the Centre's website.

26.0 CONCLUSION

The conventional energy resources like oil, gas, and coal are very important for the improvement in economics of a country. A country like Nigeria is fully dependent on the conventional energy sources in spite of knowing its negative effects for health and environment like greenhouse effect, global warming effect, etc. Nigeria is blessed with all the renewable energy sources like solar, hydro, biomass, wind, and geothermal. However, the main challenges to generate power from renewable energy resources are funds, low level of awareness, inadequate research, and politics. It is expected that energy migration to renewable will lead to more employment, better health, more job opportunities, job creation, consumer choice, improvement of life standard, income generation and community development.

Nigeria has a skill demand-supply gap and differences in the levels of skill acquisition, which has led to imbalances in employment rates across regions and groups, wage disparities and varying productivity levels across workers. The establishment of the TETFund Centre of Excellence will reinvigorate the development of our skills base to increase both the quantity and the productivity of labour employed in the economy, particularly women and youths. The Institution has reviewed data on the skill areas and notes a substantial skills gap in the country in the energy sector. Therefore, the Centre's focus would be on building local capacity and enhancing energy production in the country. The supply of energy is important to Nigeria’s economic development. Another consideration in this selection is the gender attractiveness of the selected area.

The Centre of Excellence has provided this document to enable staff, students and other relevant stakeholders in the energy sector be acquainted with its activities especially those focused on research and publications. The Institution hope that staff and students go through the document in order to understand the purpose of establishing the Centre and further use the information provided to key in positively to the activities of the Centre.

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