AICCEES

Africa International Conference
on Clean Energy & Energy Storage

CONFERENCE REPORT: AICCEES

2nd Edition

Tovero Energy
Energy to power your dreams

PREFACE

Welcome to the Africa International Conference on Clean Energy and Energy Storage (AICCEES) 2024. In the pursuit of advancing clean energy and energy storage solutions for a sustainable future in Africa, AICCEES 2024 brings together an assembly of brilliant minds, innovative researchers, and industry leaders. This book is a testament to the vibrant exchange of ideas and knowledge that took place during the conference. AICCEES serves as a pivotal platform for researchers, practitioners, and policymakers to converge and deliberate on the latest developments in the field of clean energy.

The conference aims not only to showcase the current state of research but also to foster collaborations and inspire future breakthroughs. We extend our deepest gratitude to all the authors who shared their insights, research findings, and expertise. Your dedication to advancing the discourse on clean energy is evident in the quality and diversity of the abstracts included in this compilation. A special appreciation goes to Tovero Energy Ltd, team: the driving force behind the organization of AICCEES 2024. Their commitment to fostering knowledge exchange and innovation has been instrumental in the success of this conference.

We also express our heartfelt thanks to the Conference Chairs, members of the Scientific Committee, Master of Ceremony, and Keynote Speakers for their leadership, guidance, and contributions that shaped the conference agenda. The success of AICCEES 2024 would not have been possible without the support of organizations that share our commitment to advancing clean energy solutions. We extend our appreciation to Consortium for the Development and Advancement of Hydrogen Economy in Africa (CODAHEA), African Centre of Excellence in Future Energies and Electrochemical Systems (ACE-FUELS), Transforming Energy Access Learning Partnership (TEA-LP), ENERPRO Consulting, Integrated African Power, Energy Technology Institute (ETI) University of Port Harcourt, Modern Energy Cooking Services (MECS), and others who have played a vital role in supporting this conference. As we present this Book of Abstracts, we invite readers to explore the cutting-edge research and ideas that emerged from AICCEES 2024. May this compilation serve as a source of inspiration and a reference for those committed to the pursuit of sustainable and cleaner energy solutions. Thank you for being a part of this transformative journey.

Engr. Anthony Mbukobong Akpasoh
Tovero Energy Ltd

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5 ELECTRIC COOKING DEMONSTRATION

Anchor: Esuuk Ikpokonte,
Projects Coordinator, Tovero Energy Ltd

SUMMARY OF CONFERENCE PROCEEDINGS

DAY 1 – 26th September 2024

1 COMMENCEMENT OF THE CONFERENCE

Willie Akpan, the Master of ceremony, warmly welcomed everyone to the highly anticipated 2nd edition of the Africa Internal Conference on Clean Energy and Energy Storage (AICCEES) 2024. He acknowledged the distinguished presence of invited guests, renowned speakers, and all attendees who had gathered from far and wide to be part of this momentous event.

2 WELCOME SPEECHES

Professor Owunari Abraham Georgewill, the Vice Chancellor, University of Port Harcourt addressed and welcomed all attendees, presenters, speakers and invited guests to the conference, joining both physically and virtually. He emphasized that the conference theme for this year's edition **"Empowering Africa's Sustainable Energy Future"** is significant and very timely as Africa drives towards embracing cleaner and sustainable energy solutions to solve its energy deficiency and equally reiterated the imperativeness of more collaborations between the academia, industry and government, known as the **"Triple helix"** to achieve this. In his speech, he highlighted that Africa is richly blessed with abundant resources yet has been struggling to tackle energy deficiency, reduce carbon footprints and address global climate crisis. Moving further, he commended the organizers of the conference; ***Tovero Energy Ltd,*** and her partners for working together to provide a platform for advancing research and fostering dialogue in the clean energy space. He concluded by wishing everyone fruitful deliberations and a peaceful stay throughout the conference period.

Dr. Veronica Akpasoh, CEO Tovero Energy Ltd, in her presentation emphasized the company's commitment to clean energy and the importance of collaboration between academia, industry, and government. She expressed frustration that research often fails to translate to tangible innovations that can impact lives. Explaining the clean cooking vision, **Dr. Akpasoh** showcased Tovero Energy's clean cooking initiatives, including the Controlled cooking test, Nigeria ecookbook, and Nigeria market readiness assessment for electric cooking, urging everyone to visit the Modern Energy Cooking Services (MECS) website for more information. She announced that an electric cooking demonstration would be held during the conference to promote the e-cooking vision and noted that mini-grid development projects are viable options for addressing energy access challenges in rural African communities.

Prof. Roland Uhunmwangho, the conference chair and Director, Centre for Power Systems, University of Port Harcourt in his opening speech highlighted the following key points:

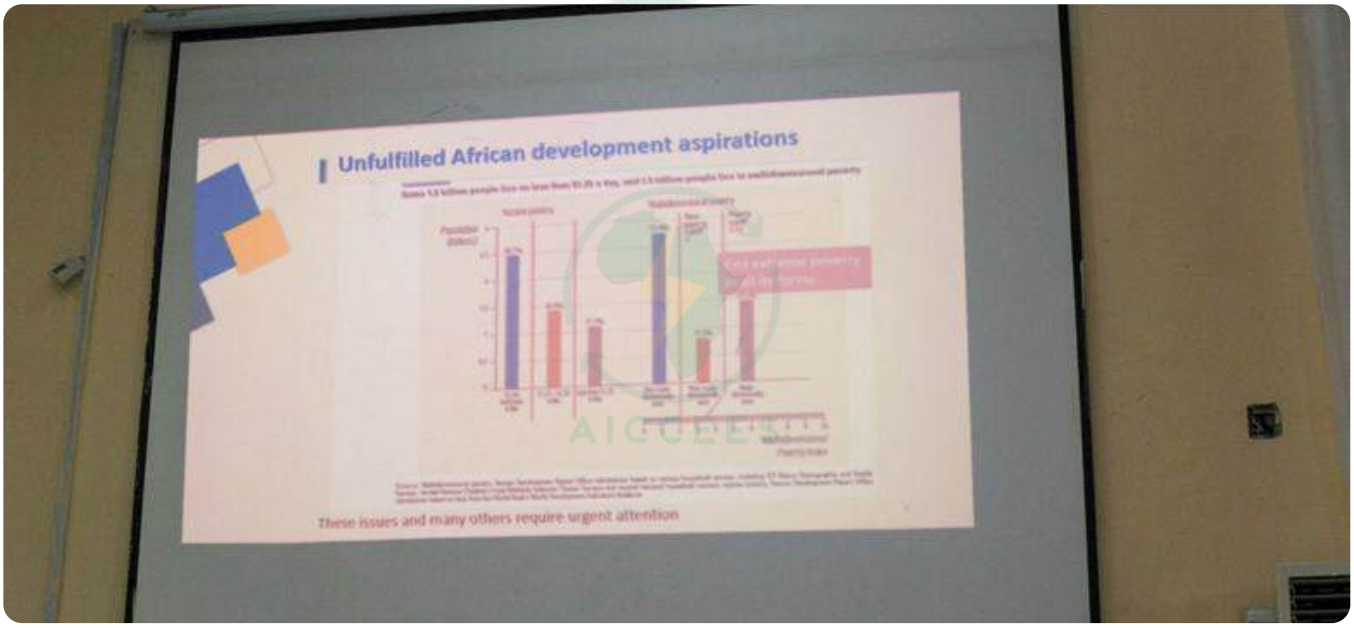
1. Africa International Conference on Clean Energy and Energy Storage (AICCEES) presents a pivotal moment for Africa as the continent as we address the energy challenges of the 21st century.
2. Clean energy solutions and efficient storage technologies are crucial for sustainable energy practices, climate change mitigation, and economic development across the continent.
3. The development of renewable energy must go hand in hand with advancing storage systems to ensure sustainability.
4. AICCEES serves as a key platform for networking, exchanging knowledge, fostering partnerships, and inspiring the next generation of researchers, engineers, and policymakers to lead the clean energy transition across Africa and beyond.

5. The Conference Chair expressed heartfelt appreciation to the organizers, Tovero Energy Ltd., and partners, including Consortium for the Development and Advancement of Hydrogen Economy in Africa (CODAHEA), African Centre of Excellence in Future Energies and Electrochemical Systems (ACE-FUELS), Transforming Energy Access Learning Partnership (TEA-LP), ENERPRO Consulting, Integrated African Power, Energy Technology Institute (ETI) University of Port Harcourt, Modern Energy Cooking Services (MECS), as well as the keynote speakers, panelists, and Local Organizing Committee, for their contributions to the event's success.
6. He encouraged participants to fully utilize the conference's sessions, workshops, and networking opportunities, urging them to collaborate, innovate, and work together towards creating a cleaner, more sustainable future for Africa and the world.
7. Wrapped up by welcoming all attendees and invited guests to the conference.

3 KEYNOTE ADDRESS

Topic: Prospects for Climate Resilient Development and Just Energy Transition in African Countries by ***Professor Youba Sokona***

Prof. Youba Sokona, spoke on the prospects for Climate resilient development and just energy transition in Africa. Some of the findings he reported are thus:



1. Statistics have shown that Africa has vast natural resources, including 30% of the world's minerals, 8% of natural gas, and 12% of oil. However, despite this wealth, many African countries struggle with debt and lack of investment in their own development.
2. Over 600 million people lack electricity, and 970 million lack clean cooking facilities. Thus, there is a need to prioritize transition from traditional biomass and other fossil fuels used for cooking, energy access, electrification, private sector financing, energy for development, and utilizing leapfrogging and late-comer advantages to adequately address the devastating effects of its continued use.

3. The structural issues bewitching Africa are traceable to colonialism.
4. Moving on to the energy capacity of the continent, he stated that Sub-Saharan Africa's installed energy capacity was only 100GW in 2021.

Critical questions on the time horizon for progress and sectors to be prioritized were raised, including how to address the fossil fuel dilemma. Africa must address questions on progress timelines, sector prioritization and fossil fuel dilemmas.

1. To succeed, Africa needs stimulated political will, context-specific innovations, resource access and aligned short- and long-term aspirations. Transitions are crucial: energy, land, urban development and industrial systems.
2. There is need to mitigate global warming's harmful effects and to achieve this, four key systems (energy, land, urban development and industrial systems), which must be far reaching and unique bearing the continent's challenges and opportunities.

Prof. Sokona urged African leaders to prioritize sustainable development, energy access and innovative solutions.

Questions From Audience

Question: *Is it the will of the political class to remain dependent on fossil fuel?*

Following the above question, the following points were made:

1. Energy is not currently a top priority for many African leaders.
2. Energy is not widely recognized as a root cause of conflict.
3. Innovation and technology are not yet to become focal points for leadership, with little emphasis on their role in national growth.
4. There is a tendency to overlook the fact that a nation cannot achieve sustainable development by relying solely on its mineral resources and not investing in improving technological skills of its populace.

4 PAPER PRESENTATIONS

SESSION 1 : HYDROGEN DEVELOPMENT IN AFRICA

The objective of this session was to present research findings on the role of hydrogen in low- carbon energy transitions, transportation and industrial applications as well as the need for supportive policies, incentives and collaboration between the industry experts, researchers, policy makers and investors.

Associate Prof. Ogheneruona Diemuodeke, moderated the session and introduced the various presenters.

Paper 1

DESIGN AND ANALYSIS OF A SUPERCRITICAL METAL-WATER REACTOR FOR HYDROGEN GAS PRODUCTION.

Presented by:
Eze Paschal

Key Findings

This study focused on providing an alternate means of large-scale production of hydrogen for energy generation without the use of fossil fuel. The key findings are:

1. The maximum stress and strain effect on a Supercritical Metal-Water Reactor at constant pressure is 1153 Mpa and 0.028mm.
2. The temperature analysis showed that the maximum stress was 250 Mpa with negligible strain effect at design temperature.

3. The fatigue analysis per 100 cycles showed 0.001 damage percentage and 10,000,000 Total life cycle of the reactor.

Questions From Audience

Q: *Should Africa and Nigeria have their own standards for the reactors?*
A: Yes, they should as it will be more beneficial.

Q: *What type of hydrogen was produced? Was the reactor physically built or simulated?*
A: Hydrogen was not produced, and simulation was not physical. The reactor was simulated.

Q: *Why should Africa invest in hydrogen?*
A: Hydrogen is clean, water is abundant, and the metal can be easily transported, allowing on- site production.

Paper 2

FULL SPECTRUM-DRIVE PHOTOCATALYTIC HYDROGEN PRODUCTION USING FE-DOPED TIO2-MOS2.

Presented by:
Oleka Ikechukwu John

Key Findings

This study aimed to investigate the potentials of using Fe-doped TiO2-MoS2 nanocomposites for full spectrum-driven photocatalytic hydrogen production, focusing on reducing the impacts of climate change and environmental pollution associated with burning fossil fuel for energy and electricity production.

The key findings are:

1. That Fe-doped TiO2 and Fe-doped TiO2-MoS2 have can be successfully synthesized through impregnation and a solid-state approach respectively.
2. From the preliminary results from the experiment, a physical characterization of FTIR, UV-vis and AFM is feasible

Questions From Audience

Q: *Which is better, hydrogen from solar sources or energy from Photo Voltaic (PV) cells?*
A: Hydrogen has higher density and power, making it better.

Q: *What is the cost implication of the hydrogen production system?*
A: It is expensive but scalable.

Q: *What factors affect hydrogen yield, and is lifecycle analysis considered?*
A: Factors include pressure, temperature and salinity. Life Cycle Analysis (LCA) will be considered.

Paper 3

A TWO-PARAMETER COMPUTATIONAL THERMODYNAMIC ANALYSIS OF HYDROGEN IMPURITY MIXTURES IN A REPURPOSED PIPELINE

Presented by:
Elijah Binfa Bongfa

Key Findings

This research investigated the behaviour of gas pressure in response to the molar concentration of the hydrogen impurity mixture in a repurposed natural gas pipeline. The key findings are:

1. As the number and molar concentration of impurities increase, the gas pressure decreases.
2. Detecting H2S would be a serious challenge owing to its similar behaviour to

that of hydrogen gas.

3. A non-destructive acoustic hydrogen purity monitoring scheme for hydrogen travelling in a natural-gas-repurposed pipeline is viable, except for H_2S detection.

Questions From Audience

Q: *What is the optimal pressure to transport the hydrogen in the pipeline?*
A: Did not check for the optimal pressure, only checked for impurities which was the study focus.

Q: *What prompted the equation of solution utilized in the work?*
A: Because it accurately captures the gas properties.

Paper 4

DEVELOPMENT AND EVALUATION OF AN ALKALINE ELECTROLYZER FOR HYDROGEN AND ELECTRICAL ENERGY PRODUCTION IN A FUEL CELL.

Presented by:
Igwe Chijindu

Key Findings

This study aimed to develop a low-cost electrolyzer for hydrogen production. The key findings include:

1. Polytetrafluoroethylene (PTFE) commonly known as Teflon and Polypropylene (PP) plastic materials are suitable for the alkaline water electrolyzer though teflon proved to be more efficient.
2. Polyester fabric degraded due to corrosion, whereas PP fabric proved to be a low-cost and efficient membrane material for the alkaline water electrolyzer.
3. The optimal performance of the electrolyzer cell was obtained at 2.2 V and 1.30 A, while producing 14 ml/min of hydrogen gas. This performance gave an electrolysis efficiency of 55.6 %, energy efficiency of 67.3 %, and a hydrogen production efficiency of 75.4 %.

4. The hydrogen gas produced was tested for confirmation and generated electrical energy in a fuel cell device which powered a 0.2 W DC electric motor.

Questions From Audience

Q: *Can you Clarify Figure 6 in the presentation?*
A: Clarification was provided by the Presenter.

SESSION 2 : ENERGY EFFICIENCY AND SMART SYSTEMS

The objective of this paper presentation session was to showcase innovative solutions and explore recent advancements in the fields of energy efficiency, smart grids, and Internet of Things (IoT), with a focus on applications in appliances, buildings, and lighting.
Dr. Celestine Ebieto moderated the session and introduced the presenters.

Paper 1

ENERGY EFFICIENCY, COST SAVING OPPORTUNITY AND NEARLY ZERO EMISSIONS ANALYSIS IN THE RESIDENTIAL SECTOR; A CASE STUDY OF NIGERIA AND GHANA.

Presented by:
Omata David Omakoji

Key Findings

This study aimed to highlight the potential of energy efficiency and renewable energy integration in reducing costs, energy consumption, and emissions in the residential sectors of Ghana and Nigeria, focusing on fridges, freezers, and lighting systems. Key findings include:

1. Ghana has higher daily usage rates for appliances, with fridges and freezers averaging 20.3 hours/day, compared to 11.8 hours/day in Nigeria. This difference contributes to higher energy demand in Ghana.
2. In Nigeria, annual electricity costs for non-energy-efficient households are $109.69, reduced to $79.31 for energy-efficient households. Ghana shows significantly higher costs, with non-energy-efficient households spending $379.97 annually, reduced to $317.55 with energy-efficient appliances. The difference is attributed to higher energy tariffs and greater energy demand in Ghana.
3. In Nigeria, the solar Photovoltaic (PV) payback period is 22 years, making it economically unviable at current tariffs while Ghana has a shorter 10.3-year payback period demonstrating financial feasibility, incentivizing renewable energy investments.
4. Light Emitting Diodes (LEDs significantly reduce greenhouse gas (GHG) emissions, equating to the environmental impact of removing cars from roads or increasing forest carbon absorption.

Questions From Audience

Q: *Did you do comparison to know if residential sector has more electricity consumption?*

A: Data gotten from the National Energy Commission (NEC) affirms that the residential sector has more electricity consumption.

Q: *How was the consumption for the refrigerator calculated? The payback time is too high; how did you arrive at that?*

A: Based on surveys conducted and experience in the field of solar installations.

Comments

Prof. Ogheneruona explained that if a refrigerator is plugged in for 24 hours, the maximum consumption time for the refrigerator is 7 hours and not 24 hours. This disparity could affect the calculations significantly and influence the payback, making it high as this case.

Professor Roland Uhunmwangho advised that Nigerian Electricity Regulatory Commission (NERC) is the appropriate source to get energy data and information and not NEC.

Paper 2

PERFORMANCE OF A SOLAR ASSISTED HEAT PUMP DRYER INTEGRATED WITH THERMAL.

Presented by:
Alde Tchicaya Loemba

Key Findings

The main objective of this study was to design, manufacture and assess the performance of a solar-assisted heat pump dryer integrated with thermal energy storage materials for drying agricultural products. The key findings from this study are:

1. The developed dryer demonstrated excellent performance as indicated for example by the value of COP (up to 3.69) which is better compared to 2.04 reported by Singh et al., (2020) when using SAHPD.
2. The findings revealed the importance of integrating the thermal energy storage system using soapstone to enhance the performance and efficiency of the solar-assisted heat pump dryer.

Questions From Audience

Q: *What was the retention time of the soapstone during off-heat period?*
A: Twenty-Four (24) hours after sunset.

Paper 3

PERFORMANCE ANALYSIS OF A PHOTOVOLTAIC SYSTEM WITH THERMOELECTRIC GENERATOR AND PHASE CHANGE MATERIALS.

Presented by:
Okamkpa Tobechukwu

Key Findings

The study analyses how integrating Thermoelectric Generators (TEGs) and Phase Change Materials (PCMs) can improve the efficiency of Photovoltaic (PV) panels under high-temperature conditions. Key findings include:

1. The PCM helped stabilize the temperature of the PV panel, potentially enhancing its efficiency by mitigating overheating effects.
2. TEGs supplemented the energy conversion by utilizing residual heat from the PV panels.
3. The integration of TEGs and PCMs offers a promising strategy for boosting energy efficiency and sustainability in solar energy systems, especially in regions with high ambient temperatures.

Questions From Audience

Q: *Heat transfer efficiency about the three systems was not captured and equally discussed in your work. What are your thoughts?*
A: It will be incorporated into the work.

SESSION 3: MINI GRIDS SYSTEMS AND HYDROPOWER DEVELOPMENT

The objective of this session was to identify, explore and showcase the transformative potential as well as innovative applications of mini grids systems and hydropower solutions in Africa's clean energy landscape.
Prof. Ogheneruona Diemuodeke, moderated the session and introduced the presenters.

Paper 1

ASSESSING THE VIABILITY OF MINI GRIDS IN RURAL ELECTRIFICATION: OVERCOMING THE CHALLENGES AND EXPLORING SUSTAINABLE BUSINESS MODELS.

Presented by:
Ayodeji Stephen Adekanbi

Key Findings

This study aimed to evaluate the potential of mini grids for rural electrification and address their implementation challenges. The key findings include:

1. Mini grids can improve electricity access but face high costs, regulatory barriers, and technical issues.
2. Applying sustainable business models and engaging stakeholders, it is easier to identify ways to enhance mini-grid viability, address high costs and overcome regulatory and technical barriers

Questions From Audience

Q: *What do you do as an investor if after developing a mini grid, the government brings grid infrastructure to the community?*

A: Firstly, have an understanding with the government before you begin installation of mini grids. Then you show how expensive it will be to connect the community to the grid compared to mini grids installation.

Q: *How do you factor in insurance and resilience for the mini grid infrastructure?*

A: A business model and plan are imperative to tackle these issues before they arise.

Comments

Prof. Roland commented that scalability and sustainability are critical in planning and energy audits. Projections should be made for up to ten (10) years to ensure sustainability of the project. He recommended that when developing load assessment, there is a possibility of increment of number of loads also.

Paper 2

MINI GRIDS SUSTAINABILITY FRAMEWORK AND ITS APPLICATION IN SELECTED MINI GRIDS IN KENYA.

Presented by:
Maurice Wambua Kausya

Key Findings

This paper presents a simple indicator-based framework for sustainability evaluation of mini-grids. The key findings include:

1. An indicator-based framework offers a user-friendly tool for assessing mini-grid sustainability
2. While the framework is easy to use, its scoring process is subjective, a common issue in qualitative assessments. Careful application and evidence can reduce concerns about subjectivity.
3. The methodology utilized in this study helps inform policy decisions and future mini-grid projects.

Questions From Audience

Q: *Political livelihood of the people is not included in the sustainability index?*
A: It was included in the economic consideration.

Q: *You mentioned that the mini grids only supplied power for lighting, why?*
A: The extent of use is not only restricted to lighting, but the communities are also poor and may not have enough money for power. The mini grids capacity was small; thus, the community must restrict use.

Q: *How do mini grids handle issues regarding energy theft, framework should include security?*
A: The system is smart, can detect any electricity bypass and cut it off. There's been no incidence of energy theft recorded so far.

SESSION 4: ENERGY STORAGE AND SUSTAINABLE BATTERY MANUFACTURING

The objective of this session was to explore the critical role of energy storage and sustainable battery manufacturing in the transition to a low-carbon economy, examining the latest advancements in energy storage technologies, challenges and opportunities in sustainable battery manufacturing, policy and regulatory frameworks, and showcasing successful case studies and best practices, with the goal of fostering collaboration and knowledge-sharing among stakeholders.
Prof. Esosa Omoroguiwa, moderated the session and introduced all the presenters

Paper 1

INVESTIGATION OF HIGH PERFORMANCE GREEN SYNTHESIZED NA TI2(PO4)3 NANOCOMPOSITES FOR ADVANCED ELECTROCHEMICAL ENERGY STORAGE APPLICATIONS.

Presented by:
Khwesa Peredy

Key Findings

This study centered on an investigation of a new class of high-performance energy storage electrode materials: NaTi2(PO4)3/AC nanocomposites. Through a comprehensive characterization approach, the study meticulously analyzes the crystal structure, morphology, elemental composition, and electrochemical

behavior of these nanocomposites to unlock their potential for energy storage. Key findings from this study are that NaTi2(PO4)3/AC nanocomposites possesses the following features:

1. Well-defined crystal structure
2. Porous morphology contributes to exceptional energy storage capabilities.
3. High specific capacitance (241 F/g at 5 mV/s).
4. Remarkable cycling stability (90%).
5. Near-ideal capacitive behavior reinforcing their potential for high-performance energy storage devices.

Paper 2

MODELLING AND OPTIMIZATION OF RENEWABLE ENERGY CONVERSION TECHNOLOGIES WITH DUAL ENERGY STORAGE FOR ISLAND.

Presented by:
Ekwueme Brendan Ifeanyi

Key Findings

This study focused on modelling and optimising a hybrid solar PV-Wind-Biomass energy system for an island in Delta State, Nigeria. The system incorporates both battery bank and hydrogen tank energy storage technologies. The key findings gleaned from this study are:

1. To satisfy the energy need of Patani, 0.217 MWP, 0.001MW peak rated power of PV, 16.5 MW rated power of wind turbine and 10MW rated power of Biomass are required.
2. Furthermore, the minimised storage capacity of the Battery and Hydrogen are 69.19MWh each. This implies that about 90% of the energy demand in Patani can be met by the hybrid PV-Wind-Biomass plant.
3. The levelised Cost of Energy (LCOE) was obtained as 0.62$/kWh, which is within the range of LCOE reported for renewable energy technology by IRENA (IRENA, 2018) and is well below the 0.95 $/kWh for diesel-powered electricity

generators (Olatomiwa, 2016). However, the obtained LCOE is well above the cost of electricity from the national grid, average of 0.19 $/kWh, without the consideration of the cost of grid extension and end-to-end cost analysis of grid electricity. The implication is that the combined effect of government action and appropriate finance mechanisms will guarantee the general acceptance of the proposed system.

4. The total energy generated (43.62GWh) combines the energy generated by the wind turbine and Photovoltaic energy conversion systems (refer to shown Table 2 in the published work.)
5. The excess energy generated is stored in the BT/HD and utilised during energy shortage. The total excess energy generated by Renewable Energy (RE) systems is 26.68GWh/year, while the entire energy shortage from RE systems is 11.10 GWh/year.
6. 1. Furthermore, the energy difference between excess and shortage is 15.57 GWh/year. The energy difference is about 41% of excess energy and energy deficit. Hence, the energy difference is minimised since the percentage difference is beneath 50% (Nyeche and Diemuodeke 2020). Thus, the hybrid PV-WT-BM-BT & HD plant can satisfy the energy needs of Patani.

Questions From Audience

Q: *What was the Levelized Cost of Energy (LCOE) and payback time of the respective systems?*

A: The work is still ongoing and the calculations for that have not been done yet.

Q: *Is this an off-grid solution? How can we integrate this system into the grid infrastructure?*

A: Expansion and integration to the grid is possible

Q: *How did you handle the issue of electrochemical complexities involved?*

A: The scope was just to fabricate an electrode and see how it performs in an electrolyte.

Q: *How do you know nanocomposites were formed?*

A: Results from physical characterization told us.

Comments and Recommendations

1. The use of Homer software is essential to ascertain the area of work involving costs.
2. Understanding the stability of the grid is imperative before grid integration with other systems can be done.
3. Apart from energy generation, energy losses should be accounted for as well.

Paper 3

HYBRID RENEWABLE ENERGY SYSTEM (HRES) FOR NIGERIAN PORTS: AN ECONOMIC FEASIBILITY AND STAKEHOLDER INSIGHT ASSESSMENT.

Presented by:
Chidi Cletus Emelu

Key Findings

1. Stakeholders are concerned about initial costs, reliability, and maintenance, but many are willing to invest due to the potential for long-term savings.
2. Subsidies, tax breaks, and a lower long-term cost of ownership (levelized cost of energy – LCOE) compared to the national grid are seen as key drivers for HRES adoption in these airports.

Questions From Audience

Q: *How confident are you about the response gotten from the respondent? Were you able to get the energy demand requirements of respective airports?*

A: I am very confident. I derived the energy demand for airports e.g. the Murtala Mohammed airport.

Q: *What is the energy demand and requirement of the airport?*

A: 4.2 MW for Murtala Mohammed International Airport, Lagos-Nigeria.

Paper 4

PREDICTIVE MODELLING FOR OPTIMIZING WIND TURBINE PERFORMANCE AND STRUCTURAL HEALTH MONITORING: ADOPTING TURKISH SCADA DATA FOR SUB-SAHARAN AFRICA.

Presented by:
Sikiru Abdulganiyu Siyanbola

Key Findings

This study aimed at leveraging SCADA data to develop robust predictive model that can predict wind energy generation in Sub-Saharan Africa. The key findings are:

1. AI-enhanced SHM systems show promise in optimizing wind turbine performance.
2. XGBoost predictive model demonstrated high accuracy across four Sub-Saharan locations.
3. Our study contributes to improving the operational efficiency and reliability of wind turbines in Africa's renewable energy sector.

Questions From Audience

Q: *What factors will attract investment? These indicators are missing from your study.*

A: These indicators were not considered.

Comments and Recommendations

Associate Prof. Ogheneruona pointed out the need to employ other parameters aside from the theoretical power since it is already obvious that without any analysis, the theoretical power will influence the actual power.

Prof. Roland Uhunmwangho emphasized the importance of taking into consideration the financial/business aspects of research.

Paper 5

ENHANCING CARBON IV OXIDE ABSORPTION FROM FLUE GAS MIXTURE AT ELEVATED TEMPERATURE USING COMPOSITE OF NANOPARTICLES.

Presented by:
Ojong Elias Ojong

Key Findings

The study developed and characterized cost-effective zeolitic composite nanoparticles from Niger Delta waste materials for efficient CO2 adsorption at elevated temperatures. It investigated their zeolitic properties, CO2 adsorption capacity, and effectiveness, demonstrating a sustainable approach to mitigating climate change and reducing waste disposal challenges.

1. Material is weakly acidic with high porosity, and large surface and micropore areas as shown in Table 1, hence effective for CO2 removal.
2. The Demand Response (DR) method provided the best pore width of 5.283 nm and the best pore surface area value of 400.6 m^2/g.
3. Pore size determination (DA) analysis yielded the best pore diameter result of 2.64 nm.
4. The hydraulic diameter (DH) method of cumulative adsorption pore volume analysis gave the best pore volume value of 0.2015 cc/g.
5. Finally, the Langmuir surface area analysis yielded the highest surface area value of 704.2 m^2/g.
6. Chitosan/clay nanoparticles were successfully produced as adsorbents and can resist thermal degradation up to 4000C as it was noticed in the BJH analysis of the adsorbent, where 100% of the adsorbent was maintained in the temperature range of (00C to 3000C) and 18% of the adsorbent from 100% was able to withstand high temperatures up to 9000C.
7. Chitosan/clay nanoparticles are highly effective and efficient for the removal of CO2 from flue gas at elevated temperatures as 95% CO2 captured at the surface of the particles is evidence, and the presence of pores, large surface areas, and rough surfaces of the adsorbent proved this claim.

Questions From Audience

Q: *Your work says CO2 is poisonous, is that a good justification for your work? Is CO2 poisonous?*

A: It is a good justification for the work and that of that CO2 is poisonous.

5 CLOSING REMARKS

Engr. Anthony Akpasoh, the Chief Operations Officer (COO)- Tovero Energy Ltd in his closing remarks thanked everyone and re-echoed the imperativeness of synergy amongst the academia, industry and government to actualize the purpose of research.

SUMMARY OF CONFERENCE PROCEEDINGS

DAY 2 – 27th September 2024

1 COMMENCEMENT OF THE CONFERENCE

Willie Akpan, the Master of ceremony, warmly welcomed everyone to the highly anticipated 2nd edition of the Africa Internal Conference on Clean Energy and Energy Storage (AICCEES) 2024. He acknowledged the distinguished presence of invited guests, renowned speakers, and all attendees who had gathered from far and wide to be part of this momentous event.

2 WELCOME SPEECHES

Welcome speech by Associate Professor, Ogheneruona

He extended a warm welcome to all attendees, both physical and virtual, and highlighted the success of the inaugural AICCEES, which was fully virtual. Based on feedback, the decision was made to adopt a hybrid format to enhance inclusivity. He acknowledged the challenges faced on the first day, assured improvements, and expressed confidence that the second day would feature engaging and impactful deliberations on Africa's transition to clean energy.

Opening speech by Prof. Fidelis. I. Abam

He expressed his excitement over the current progress recorded in the clean energy sector. He emphasized that the ideas presented during the conference are gradually being domesticated, signaling a positive transition towards sustainable practices. To wrap up the opening speech, he highlighted the itinerary and program for the day and thanked everyone for their continuous support so far.

3 KEYNOTE ADDRESS

Topic: Sweden's Sustainable Waste Management Model by ***Professor Foluke Ishola***

Her presentation centered on Sweden's globally recognized waste management approach. She explained the economic prospects embedded in waste which Sweden has successfully harnessed to generate power for transportation. According to her 0.7% of Sweden's waste ends up at landfills, with the remaining wastewater recycled or used for energy recovery following a hierarchy of **reduce, reuse, recycle.**

Key Points

1. R &D efforts is still ongoing in Sweden to extract value from the percentage of waste channeled to the landfills.
2. Waste-to-energy (WTE) Systems not only provide energy but also create job opportunities.
3. Fees are charged for waste collection and treatment are usually collected from consumers in Sweden.
4. Bioethanol, previously derived from food sources, now utilizes biomass residues, addressing food security concerns.
5. Sweden's 37 WTE plants primarily employs biological (bioethanol, biogas, biohydrogen) and thermal recovery (heat and electricity)
6. Nigeria's potential for WTE is significant with its population of over 200 million compared to Sweden's 10.6 million. Bioethanol fuels are currently now in use in engines after undergoing pre-treatment and upgrading. E85 cars are examples of Europe's waste-derived energy success stories.
7. Sweden has grown and enjoyed blooming circular economy from waste to energy and yet has a population of roughly 10.6 million which is lower than the population of Lagos state.
8. Bioenergy has tremendously evolved since the discovery of second-generation feedstock; this has solved the issue of food security competition with energy generation.

9. Synthesizing energy from organic waste leads to two parts - upstream (Biogas) and downstream (Digestate, used for fertilizers)

Recommendations for Nigeria and Africa

1. Develop a robust plan for waste management.
2. Engage qualified professionals and ensure collaboration between academia and industry.
3. Establish partnerships with developed nations to cross share knowledge and expertise.

Fun Facts

1. 100km can be covered by energy obtained from 1000 pieces of banana peels
2. million m3 of biogas can be obtained from poultry manure

Questions From Audience

Q: *Why is there hesitancy about adopting WTE in Africa, despite its high potential and enormous benefit?*
A: It's largely due to a lack of political will.

Q: *Is the feedstock for WTE sustainable?*
A: Yes, if human activity continues, there will be a steady waste supply.

Q: *I hear that only two universities are focused on waste-to-energy in Sweden, how true is this?*
A: There are lots of universities working on waste to energy research in Sweden. It's not just two.

Q: *How do we foster internal drive for WTE, rather than relying on external pressures from the West?*
A: Everyone needs to push for this. I advocate for internal motivation in every platform I speak on, including the Nigerian Society of Chemical Engineers (NSE)

Comments and Recommendations

Chijindu Igwe, commented that Canada has witnessed waste to energy via incineration process. Clearing the flare gas with the scrubber and he finds this interesting.

David Omata from Ghana noted that Internal drive is required.

Prof. Ishola in her response, mentioned she was speaking with Nigerian Society for Chemical Engineers (NSCHE) in Lagos and urged policy makers to push for policies that are internally relevant and applicable.

Topic: Renewable Energy Supply For Clean And Affordable Energy Access For All by **Dr. Ioannis Tsipouridis**

Dr. Tsipouridis, with over 46 years of experience in the renewable energy sector, expressed frustration over the slow adoption of renewable energy technologies, particularly in sub-Saharan Africa. He emphasized that energy storage is critical to achieving a 100% renewable energy world, with a key focus on sustainability.

Key Points

1. **Adoption of Renewable Energy in Sub-Saharan Africa is Slow:** The Adoption of renewable energy in Sub-Saharan Africa has been sluggish due to several challenges, including inadequate infrastructure, limited access to financing, and a lack of strong policies supporting renewable energy development. These slow-paced hampers efforts to address energy poverty and meet global climate goals, leaving the region heavily reliant on fossil fuels.
2. Energy storage technologies, such as batteries, are critical for integrating renewable energy into the grid. They enable the storage of surplus energy generated by intermittent sources like solar and wind, ensuring reliable power supply even during periods of low generation. Without robust energy storage systems, scaling up renewables will remain a significant challenge.

3. A 100% Renewable world is Possible, but a WISE Sustainability plan is key. Achieving a fully renewable energy world is technically feasible, but it requires a comprehensive and well-implemented sustainability plan. The WISE approach involves balancing environmental, economic, and social priorities ensures that the transition to renewables is sustainable, equitable, and economically viable, addressing potential challenges like job displacement and energy access disparities.
4. Despite the abundant availability of renewable resources such as solar, wind, and hydro, Sub-Saharan Africa lags in their adoption. Contributing factors include high upfront costs, limited technical expertise, and inadequate policy incentives. This slow adoption rate perpetuates energy poverty and hinders progress toward sustainable development goals.
5. Fossil Fuel Subsidies Exceed Renewable Energy Development Funding. The vast subsidies allocated to fossil fuels significantly outweigh the funding directed toward renewable energy development. This financial imbalance discourages investments in renewables, as it makes fossil fuels more economically attractive. Shifting subsidies from fossil fuels to renewables is essential to create a level playing field and encourage a cleaner energy transition.
6. The primary aim of transitioning to green energy is to limit the global temperature rise to well below 2°C, as outlined in the Paris Agreement, rather than reversing the already irreversible impacts of climate change. This goal focuses on mitigating further harm and creating a sustainable future, emphasizing the urgency of reducing greenhouse gas emissions.

Questions From Audience

Q: *Given Nigeria's reliance on oil and gas, what is your advice for transitioning to renewable energy?*

A: Nigeria does not fully enjoy the benefits of their oil and gas reserves so it should not be hard to replace. Fossil fuel must give way to renewables. Nigeria's will to transition is wholly political.

Q: *How do you think the financing will come by?*

A: Don't you think the global north owes the global south money? In whatever name it decides to be called – be it reparation or whatever – that money is enough to invest heavily in renewables in sub-Saharan Africa.

Q: *What do you think are the impediments to Africa in tackling the issue of adopting renewables?*

A: Renewables are the most flexible and easy means of obtaining energy. Sub-Saharan Africa cannot take decisions by itself which is apolitical.

Topic: Improved Architectural Design In Enhancing Energy Efficiency by Associate Prof. Amina Batagarawa

Her presentation focused on climate change and buildings, taking into cognizance the lifecycle of a building process and how it impacts climate change.

Topic: Skilling - Up For The Energy Transitions by Prof. Emeka Oguzie represented by Dr. Chris

Highlights

1. Carbon Capture Utilization and Storage (CCUS) is a vital technology for reducing carbon emissions by capturing CO_2 from industrial and energy processes, utilizing it in applications like enhanced oil recovery or chemicals, and storing it underground. It is critical for decarbonizing hard-to-abate sectors like heavy industry and power generation.
2. Education on CCUS and related technologies should begin at the primary and secondary levels to create a pipeline of skilled professionals. Promoting STEM education with a focus on clean energy will foster innovation and prepare the workforce for future challenges in carbon management.

3. Nigeria's Energy Transition Plan emphasizes CCUS as a key strategy to reduce emissions while supporting economic activities. The plan aligns CCUS with the country's emission reduction targets and international climate commitments.
4. Natural gas, with lower emissions compared to coal and oil, is identified as a bridge fuel in the transition to renewables. Combined with CCUS, it offers a cleaner, reliable energy source while supporting economic and energy security needs.
5. CCUS allows Nigeria to continue utilizing its fossil fuel reserves while reducing environmental impact, enabling the country to balance economic growth with emission reduction goals.
6. CCUS plays a unique role in achieving net-zero targets by capturing emissions directly from sources or the atmosphere, providing a practical solution for sectors with unavoidable emissions and complementing renewable energy and energy efficiency efforts.

Questions From Audience

Q: *Where will the point of capture be?*
A: At the point of release from the exhaust in industries.

Q: *Can CCUS alone help curtal rapid global emissions and climate change?*
A: Yes, it can.

4 PAPER PRESENTATIONS

SESSION 1: RENEWABLE ENERGY SYSTEMS

The primary objective of this session was to explore opportunities, address challenges and forge a sustainable energy future through renewable energy systems in Africa.

Professor Fidelis Abam moderated the sessions and introduced all the presenters.

Paper 1

THE POTENTIAL OF GEOTHERMAL ENERGY IN DECARBONIZATION AND DIRECT USE APPLICATIONS.

Presented by:
Dominic Kata

Key Findings

This study aimed to explore the potential of geothermal energy in agricultural applications through the Geotto innovation and to better understand the role of geothermal energy in sustainable agriculture and food production. The key findings are:

1. Demonstrated Geothermal Benefits:
   - Improved energy efficiency and reduced operational costs.
   - Increased agricultural productivity and economic gains.
   - Validated geothermal energy's applicability in food production and other sectors.
2. Geothermal energy is a strategic option for decarbonization, offering a reliable and affordable power source compared to solar and wind.
3. The Geotto project highlighted geothermal energy's effectiveness and potential for scaling, with future innovations in AI and IoT expected to enhance its efficiency and global applicability.

Questions From Audience

Q: *What was the cost of the prototype?*
A: About $1,000 US Dollars.

Q: *What was the minimum temperature obtained?*
A: Minimum temperature was 37.5oC 0.01. This temperature was used for hatching eggs.

Q: *How many spots were needed to obtain the required temperature?*
A: Only one spot. If more temperature is needed one can always drill deeper.

Q: *What was the depth of the geothermal reservoir? Did you analyze steam impurities for environmental suitability?*
A: The geothermal reservoir was not very deep because in the case study location in Kenya, the pockets were very close to the surface. However, companies drilling can go 3000m (i.e. 3km) for very substantial heat. Also, steam has trace elements of H2S, but studies show that they are negligible.

Q: *Where do we have these hot spots for geothermal energy in Sub-Saharan Africa?*
A: Geothermal reservoirs are everywhere. The question is, how deep?

Q: *What factors will attract investment? These indicators are missing from your study.*
A: These indicators were not considered.

Paper 2

DESIGN AND ASSESSING THE EFFECTIVENESS OF SOLAR DISINFECTION SYSTEM IN TREATING ROOFTOP HARVESTED RAINWATER FOR SANITATION AND HYGIENE PURPOSES IN RURAL MATERNAL HEALTH FACILITIES.

Presented by:
Desire Clifford Mussa

Key Findings

This study aimed to support climate-resilient maternal health facilities in Malawi through sustainable access to water using solar disinfection of harvested rainwater. Key findings include:

1. The rooftop harvested rainwater Solar Disinfection (SODIS) method is more effective and dependable for rural maternal healthcare facilities.
2. Using solar disinfection of harvested rainwater, provision of safe and clean water for maternal healthcare is feasible.

Questions From Audience

Q: *Does the water conform to WHO or other standards?*
A: Yes, it does

Q: *What is the science behind this technology? What about purification?*
A: Rainwater is treated with UV-A energy, which destroys harmful pathogens. After UV treatment, the water is further filtered for purification before it is eligible for drinking.

Paper 3

SIMULATION AND EXPERIMENTAL PERFORMANCE ANALYSIS OF PORTABLE LOCALLY MADE SOLAR POWERED COOLER FOR VACCINE STORAGE

Presented by:
Vincent Marwa Kikohi

Key Findings

This study aimed to keep the vaccine in remote areas without electricity.

1. Results show that the solar-powered cooler managed to cool the vaccine up to -14.9 oC
2. Based on the previous challenge of melting, we had consistent temperatures throughout.

3. The temperature fluctuation within the cabinet cooler and natural air flow can be successfully controlled.

Questions From Audience

Q: *I didn't see any performance parameter of the cooler in the presentation. Was there any COP?*
A: Yes, there was, though it was not on the presentation slide, but the COP was 4.5.

Q: *What happens during off peak periods?*
A: It utilizes battery storage, allowing for 8 hours of use.

Q: *What is the timeframe for the storage of the vaccine for it to be safe and did you do validation of the temperature?*
A: Storage is required throughout the lifetime of the vaccine. For temperature validation the minimum temperature in literature was -10oC while for our study the cooler reached 14 degrees Celsius.

Paper 4

A FRAMEWORK FOR SIZING SOLAR PV SYSTEMS ADAPTABLE TO OFF GRID AREAS.

Presented by:
Kerina Isaac

Key Findings

The study aimed to develop a solar PV sizing framework that factors in unique characteristics of off-grid areas that influence solar PV sizing to enable better adaptability of developed solar PV systems. The key findings include:

1. The approach of sizing solar PV system has an impact on the adaptability of the system to the end user.
2. Solar PV systems for off-grid areas should be sized differently from other areas.
3. The focus should be on the factors that make off-grid areas unique from other areas.

3. Considering unique factors in solar PV sizing has enhances adaptability in terms of pricing, ease of deployment, and reliability.

Questions From Audience

Q: *What existing framework did you use want was the price compared to yours?*
A: The 5% framework is a world bank recommended standard. This means that the cost of the solar system should not cost more than 5% of the household income.

Q: *Did the work consider future demand?*
A: Yes, it did.

Paper 5

IMPACT OF PROTECTION DEVICES ON PHOTOVOLTAIC (PV) SYSTEM PERFORMANCE AND INSTALLATION.

Presented by:
Cyril Francis Praise

Key Findings

This study aimed to explore how protective devices mitigate these issues and improve the reliability of PV systems.

1. Protective devices play an important role in the protection of the photovoltaic system against overcurrent, surges, and other forms of electrical disturbances.
2. Properly sized and certified protection devices ensure longevity, reliability, and performance for PV systems and protect the financial and operational interests of investors and contractors.
3. Finally, a qualitative approach by contractors and investors in selecting protection devices and adhering to standards and best practices will minimize risks, improve system performance, and go a long way in ensuring that renewable energy solutions become sustainable.

Questions From Audience

Q: *What are the factors leading to the failure of the protective systems, because it cannot just be due to substandard products?*

A: Improper Sizing.

Paper 6

OPTICAL CHARACTERIZATION OF DYE SENSITIZED SOLAR CELLS (DSSCS) USING NATURAL DYE OBTAINED FROM LEAVES OR DACRYODES EDULIS, MIMOSA PUDICA, DELONYX REGIA AND XANTHOSOMA SAGGITTIFOLIUM.

Presented by:
Ujoatuonu Amaka Love

Key Findings

This research has succeeded in replacing the costly component in the production of DSSCs thereby reducing the cost of production and making it affordable for the public. The key findings are:

1. Energy can be successfully harvested from leaves (readily available) which are employed as dye sensitizer thereby replacing ruthenium dye which is expensive and unfriendly to our environment in the fabrication of dye sensitized solar cells.
2. Employing dyes obtained from natural leaves of Mp, Xs, De and Dr showed various efficiencies.
3. The best efficiency is generated by Delonyx regia with efficiency of 0.06%, compared to those DSSCs for dye extracted from MP leaves is 0.05%, xs and de 0.01%.

Questions From Audience

Q: *Does the negative value on the Figure 2 in the presentation have any implication?*

A: No, it does not.

Q: *Was there comparison with what was available as this information is not visible in the presentation slide?*

A: Yes, a comparison was carried out.

Q: *Was there an analysis on how long it would take to scale up the efficiency of the solar cells produced?*

A: No, the focus of the work was on the leave and its effects.

Comments

Prof. Roland noted that it is important to carry out validation exercises at every step of the research.

Paper 7

ASSESSING THE IMPACT OF GENERATOR-RELATED AIR POLLUTION ON STRESS LEVELS AMONG PRINTING PRESS WORKERS IN THE UTC GARKI AREA 10, ABUJA: A GENERALIZED LINEAR MODEL (GLM) ANALYSIS.

Presented by:
Sammy Joel Panwal

Key Findings

This study revealed the following findings:

1. Air pollution from generators' emissions is a strong predictor of perceived stress among printing press workers.
2. Reducing air pollution could alleviate stress and improve occupational health.
3. Public health interventions, workplace air quality regulations, and clean energy solutions are critical to mitigate the impact of air pollution on mental and physical health.

Questions From Audience

Q: *What were the cause of the disparity in the findings between male and female?*

A: It could be due to genetic makeup.

Q: *When you say stress level, do you not need to also incorporate noise pollution in this study?*

A: Noise pollution is considered in the full work. Only air pollution is.

Paper 8

MODELLING AND OPTIMIZATION OF HYBRID PHOTOVOLTAIC-WIND TURBINE WITH ENERGY STORAGE SYSTEM FOR AUTONOMOUS ELECTRICITY GENERATION.

Presented by:
Iwundu C.P.

Key Findings

This study aimed to keep the vaccine in remote areas without electricity. The key findings are:

1. Results show that the solar-powered cooler managed to cool the vaccine up to -14.9 oC.
2. Based on the previous challenge of melting, we had consistent temperatures throughout.

Questions From Audience

Q: *What is the cost per kW of the design compared to the grid?*
A: This will be taken into consideration.

Q: *Is the wind turbine going to be installed withing or outside the community?*
A: It will be installed within the community at a height of 50 meters above the buildings in the area.

SESSION 2: WASTE TO ENERGY

Professor Fidelis Abam moderated the sessions and introduced all the presenters.

Paper 1

MICROBIAL FUEL CELL AS A SOURCE OF ENERGY AND BOD REMOVER FROM PETROLEUM WASTEWATER.

Presented by:
Kabo Benedict Jongman

Key Findings

This study aimed to remove Biochemical Oxygen Demand (BOD) from petroleum wastewater and generate energy. The key findings are:

1. A maximum of 92% BOD was removed from the MFC using clay based MFC.
2. A maximum of 250mV was generated.
3. Clay based Microbial Fuel Cells (MFCs) are a lucrative source of green energy and wastewater treatment which leads us to a step closer to ecological sustainability and energy recovery from wastewater.

Questions From Audience

Q: *What influences the performance of the system?*
A: The temperature, PH and amount of inoculation.

Paper 2

BIOELECTRICITY AND BIOHYDROGEN PRODUCTION FROM MIXED BLACKWATER/AGRICULTURAL WASTES.

Presented by:
G. Plason

Key Findings

This study aimed at simultaneously treating blackwater and agricultural wastes while co-producing bioelectricity and biohydrogen. The key findings from this study are as follows:

1. Results show that blackwater can be effectively co-treated with solid agricultural waste in a single piece of equipment.
2. Bioelectricity and clean hydrogen can also be generated from the microbial treatment of these waste streams
3. Both wastes (solid and liquid) can be simultaneously treated and bioelectricity as well as biohydrogen can be produced using one bioreactor.

Paper 3

ENERGY AUDITING FOR UNIVERSITY ENERGY MANAGEMENT: A TOOL FOR ENHANCING SUSTAINABILITY.

Presented by:
John Jeremiah

Key Findings

The primary aim of this review is to explore the role of energy auditing as a critical tool for enhancing energy management and promoting sustainability in universities. The key findings of this study are:

1. Energy audits led to significant improvements in energy efficiency and cost reduction, based on a case study at an engineering college in Kerala.
2. In a seven-story educational building, retrofitting resulted in annual energy savings of 167,873.28 kWh and reduced CO2 emissions.
3. In Toronto, upgrading windows in residential buildings reduced gas consumption by 38%.
4. Upgrading lighting systems from audit recommendations led to an estimated reduction of 116.50 tons of CO2 per year. In the UK, universities avoided 2.21 GtCO2e emissions through efficiency measures.

5 ELECTRIC COOKING DEMONSTRATION

The eCooking demonstration, held during the two-day Africa International Conference on Clean Energy and Energy Storage (AICCEES), showcased the potential of electric cooking technologies for African households with a particular focus on electric pressure cookers (EPCs), as a sustainable, energy-efficient, and practical solution to address the region's cooking energy challenges. The objectives of this exercise were:

1. To understand the challenges with the adoption of electric cooking in Nigeria
2. To promote the health, environmental, and economic benefits of cooking with electricity.
3. To promote awareness of electric cooking.
4. To establish the taste and texture of the meals cooked with an electric pressure cooker.

Key Findings

The eCooking demonstration at AICCEES 2024 highlighted several significant insights into the viability, benefits, and challenges of adopting electric cooking technology, particularly in the African context. These key findings underscore the potential of electric cooking appliances to transform traditional cooking practices while promoting energy efficiency and environmental sustainability. Below are some of the key findings:

1. The electric pressure cooker showcased a substantial reduction in cooking time compared to conventional methods, making it a highly efficient option for busy households Most participants indicated their willingness to adopt electric cooking after watching the cooking demonstration and tasting the food because of the safety, cost effectiveness, and convenience observed during the electric cooking demonstration.
2. Data collected from the smart meters during the demonstration indicates that the electric pressure cooker (EPC) used significantly less energy than traditional cooking methods, such as open fires or gas stoves. This energy efficiency not only reduces household costs but also aligns with the conference's clean energy goals by reducing reliance on fossil fuels. Many participants saw electric cooking

as an affordable, long-term solution for families looking to lower both energy expenses and carbon footprints.

3. General interview and questionnaire responses showed that the taste and texture of the meals cooked with the electric pressure cooker was not different from the taste and texture of the same meals cooked with other cooking technologies. In some cases, respondents mentioned that the meals cooked with the electric pressure cooker even tasted better than the same meals cooked with other cooking technologies. One of the reasons mentioned is that the electric pressure cooker puts the aroma together.
4. The electric pressure cooker showcased a substantial reduction in cooking time compared to conventional methods, making it a highly efficient option for busy households Most participants indicated their willingness to adopt electric cooking after watching the cooking demonstration and tasting the food because of the safety, cost effectiveness, and convenience observed during the electric cooking demonstration.
5. Data collected from the smart meters during the demonstration indicates that the electric pressure cooker (EPC) used significantly less energy than traditional cooking methods, such as open fires or gas stoves. This energy efficiency not only reduces household costs but also aligns with the conference's clean energy goals by reducing reliance on fossil fuels. Many participants saw electric cooking as an affordable, long-term solution for families looking to lower both energy expenses and carbon footprints.
6. General interview and questionnaire responses showed that the taste and texture of the meals cooked with the electric pressure cooker was not different from the taste and texture of the same meals cooked with other cooking technologies. In some cases, respondents mentioned that the meals cooked with the electric pressure cooker even tasted better than the same meals cooked with other cooking technologies. One of the reasons mentioned is that the electric pressure cooker puts the aroma together.

A Staff of Tovero Energy explaining the benefits of cooking with electricity

Key Technology Used

Electric Pressure Cookers, Smart Meters for monitoring energy consumption and efficiency.

Audience Engagement

Questions and comments were entertained by the audience during the e-cooking demonstration. Post e-cooking demonstration survey questions were distributed to the audience to get feedback about their perception concerning cooking with electricity, energy efficiency and possible effects on the taste and texture of the food.

Tea/ Lunch Break

During the lunch break, informal networking was ongoing and key connections between the academia, government and industry were established.

6 PANEL SESSION

Esuuk Ikpokonte, introduced the Panelists and moderated the session.

Topic: Scaling E-Cooking Solutions: Technological Advances, Market Opportunities And Policy Support

Questions From Audience

Q: *What strategy do you recommend for adoption of e-cooking and clean cooking?*
A: Creating awareness and strategise to make the appliance more affordable.

Q: *How do you convince the average person to transition to electric cooking given the frequent power outages in Nigeria?*
A: Start fuel stacking, i.e., having multiple sources of cooking technology in the home; and there are now cooking devices that are battery powered.

Q: *The topic does not suggest the use of multiple sources for cooking in a household, however is it possible to transfer the electric pot to LPG stove to continue cooking when there is power outage?*
A: No, it's not possible

Q: *Considering the initial cost of electric cooking, what strategies can be used to remove the barriers of cost?*

A: There is a correlation between household income and choice of cooking technologies. These strategies could be:

- Leveraging Carbon finance though still lacking in Africa, it is still an option
- Having a payment financing system e.g installment payment structure.
- Government subsidy for clean/electric cooking, although this might not be sustainable.

Q: *What are your thoughts about financial institutions coming into the picture?*

A: Financial institutions will not want to give loans to low-income earners, so that will be a barrier.

Q: *What could be done to stimulate adoption of e-cooking?*

A: Improving grid supply of electricity.

MECS Presentation

Dr Helen Osiolo & Dr. Rihab Khalid made a presentation on what Modern Energy Cooking Services (MECS) have been doing in e-cooking and clean cooking. The highlighted infrastructure limitations, market barriers, data gaps, cultural and behavioral issues, financial barriers and credit constraints as well as lack regulatory framework as barriers to widespread adoption of e-cooking in rural Africa. They urged all to Visit the MECS website for a detailed report with latest details on their e-cooking and clean cooking programs.

7 AWARDS AND RECOGNITION

The presentation of these awards was done by the conference chair, **Professor Roland Uhunmwangho** for the best paper and best presenter.

Best Paper was **Modelling And Optimization Of Hybrid Photovoltaic-Wind Turbine With Energy Storage System For Autonomous Electricity Generation.** The cash reward of **US$ 100** was received **by Iwundu C.P.**

Best Presenter with a cash reward **$100 US Dollars** was given to **Dominic Kata** for his presentation of the paper **The Potential of Geothermal Energy in Decarbonization and Direct Use Applications.**

Leadership Awards

Leadership awards were given in recognition of efforts and contributions towards the success of the conference. The recipients of the distinguished leadership awards were:

1. The Vice Chancellor, University of Port Harcourt, **Professor Onwunari Abraham Georgewill**
2. **Professor Sunday Oyedepo** of Bells University Ota, Ogun State.

The Conference Chair, **Professor Roland Uhunmwangho,** University of Port Harcourt, Rivers State.

Associate Professor Ogheneruona Diemuodeke, University of Port Harcourt

Prof. Fidelis I. Abam, University of Calabar -Cross River State

8 CLOSING REMARKS

On behalf of the convener, **Engr. Anthony Akpasoh** expressed gratitude to the AICCEES organizing team, partners, technical and ICT unit, Ushers/Protocol, Rapporteurs, Legacy TV, African Climate Vanguard and all the international attendees from Kenya, Liberia, Malawi, Botswana, Senegal. He reiterated that **Tovero Energy Ltd** is open to partnerships in the clean energy sector. The speech ended with a prayer for safe return for everyone who attended the conference. Then, a group photograph was taken bringing the 2nd edition of AICCEES to a beautiful end.

9 INSIGHTS AND KEY TAKEAWAYS

1. Waste-to-Energy technologies offer immense potential for waste management and energy generation.
2. Clean Cooking initiatives significantly improve public health and environmental sustainability.
3. Energy Access and Supply remain critical challenges, requiring innovative solutions and collaborative efforts.
4. Renewable Energy Systems are vital for mitigating climate change and ensuring energy security.
5. Waste-to-energy (WTE) Systems not only provide energy but also create job opportunities and generate revenue/ income as consumers can be charged for waste collection and treatment.
6. With Over 600 million people lack electricity, and 970 million lack clean cooking facilities, there's a need to prioritize transition from traditional biomass and other fossil fuels used for cooking. Energy access, electrification, private sector financing, energy for development, and leapfrogging and late-comer advantages can be adequately to tackle this issue.

7. Infrastructure limitations, market barriers, data gaps, cultural and behavioral issues, financial barriers and credit constraints as well as lack regulatory framework as barriers to widespread adoption of e-cooking in rural Africa.

10 RECOMMENDATIONS FOR FUTURE ACTION

1. Development and implementation of national clean energy strategies.
2. Increased investment in clean energy research and development.
3. Strengthen global partnerships for clean energy cooperation.
4. Support capacity building and technology transfer.
5. Stimulated Political will.
6. The benefits of waste to Energy are quite enormous but can only be adequately harnessed with a robust plan for waste management, qualified professionals and collaboration between the relevant stakeholders and developed nations to enable cross-sharing of knowledge and expertise.

11 CONCLUSION

The Africa Conference on Clean Energy and Energy Storage (AICCEES) brought together experts, policymakers, and innovators to explore transformative clean energy solutions for a sustainable future. Over two days, attendees, speakers and invited guests engaged in thought-provoking discussions, sharing knowledge and experiences on:

1. Waste-to-Energy
2. Clean Cooking
3. Energy Access and Supply
4. Renewable Energy Systems
5. Mini grids Systems and Hydropower development
6. Energy Efficiency and Smart Systems
7. Hydrogen Development

Conference Impacts

This conference:

1. Fostered meaningful connections among stakeholders, facilitating future collaborations.
2. Identified knowledge gaps and research priorities in clean energy
3. Informed policy and decision-making processes through expert insights.
4. Showcased innovative technologies and business models driving clean energy adoption.

Final Thoughts

AICCEES underscored the urgency of transitioning to clean energy systems. To achieve this:

1. Scale up Waste-to-Energy and Clean Cooking initiatives.
2. Enhance energy access and supply through decentralized renewable energy solutions.
3. Promote policy frameworks supporting clean energy development.
4. Foster international cooperation to address global energy challenges.

The clean energy revolution demands collective action, innovation, and commitment. This conference has ignited a spark, and we anticipate the transformative impact of our collective efforts.

12 ACKNOWLEDGEMENT

The AICCEES Conference Committee would like to express its sincere gratitude to the following individuals and organizations for their invaluable contributions to the success of the conference:

Conference Chairs

Professor Roland Uhunmwangho
Conference Chair
Former Dean, Faculty of Engineering, University of Port Harcourt

Professor Sunday Oyedepo
Conference Co-Chair
Faculty of Engineering, Bells University of Technology, Ogun State, Nigeria.

Dr. Ogheneruona Diemuodeke
Conference Co-Chair
Director of Energy Technology Institute, University of Port Harcourt, Rivers State, Nigeria.

Professor Fidelis Abam
Conference Co-Chair
Faculty of Engineering and Technology, University of Calabar, Cross River State, Nigeria.

Scientific Committee Members

S/N	NAME	AFFILIATION
1.	Dr. Celestine Ebieto	University of Port Harcourt
2.	Professor Tunde Bello-Ochende	University of Cape Town, South Africa
3.	Dr. Joseph Dirisu Osekhoghene	Covenant University, Ogun State.

4.	Dr. Ibrahim Muritala	Founding Member, CODAHEA (Consortium for the Development and Advancement of Hydrogen in Africa).
5.	Dr. Kehinde Ogunsola- Sali	Matheko International Limited/ Center for Petroleum, Energy Economics and Law University of Ibadan.
6.	Dr. Shoeb Syed	Head of Department, Mechanical Engineering. Department, PNG University of Technology Lae Papua, Equatorial Guinea.
7.	Professor Okedu Kenneth Eloghene	University of Port Harcourt
8.	Professor Howard Njoku	University of Nigeria, Nsukka.
9.	Dr. Tarek Safwat Kabel	University of Sadat City, Egypt
10.	Dr. Olusanya O. Omolara	Bells University, Ogun State.
11.	Dr. Oyebanji A. Joseph	Bells University, Ogun State.
12.	Dr. Mercy Ogbonnaya	University of Lagos.
13.	Dr. Ajibola Akinyemi	Bells University, Ogun State.
14.	Dr. Kishor Deshmukh	Amrut Vahini College of Engineering, Sangamner, India
15.	Dr. Adeleke Tunde	Bells University, Ogun State.
16.	Dr. Nwaokocha Collins	Olabisi Onabanjo University, Ago-Iwoye, Ogun State.

Organizing Committee

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