KeSEBAE NEWS

Newsletter of the Kenya Society of Environmental, Biological and Agricultural Engineers

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DEAR READER

Welcome to KeSEBAE Newsletter.

A fortnightly Newsletter touching on topical issues affecting our environment.

KeSEBAE NEWS is a Newsletter of the Kenya Society of Environmental, Biological and Agricultural Engineers (KeSEBAE)

Inside this Issue!

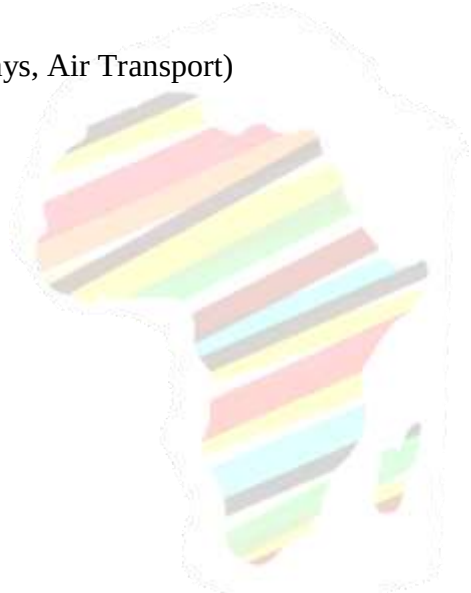
5TH PAN AFRICAN SOCIETY OF AGRICULTURAL ENGINEERING (PASAE) AFROAGENG INTERNATIONAL CONFERENCE – 2023 NAIROBI, KENYA

About the Conference

The annual international conference for 2023, organized by the Kenya Society of Environmental, Biological and Agricultural Engineers (KeSEBAE) in collaboration with the Pan African Society for Agricultural Engineering (PASAE), is set to take place from Wednesday 6th to Friday 8th December 2023. The conference will revolve around the theme of "Engineering Agenda 2063: The Africa We Want."

Sub- Themes

i. Seamless Connections (Roads, Railways, Air Transport)
ii. Energy for Africa
iii. Industrialized Agriculture
iv. Housing
v. Free Trade in Services
vi. Security
vii. Sustainable Environment
viii. Engineering Education and Practice



Paper Submission

The conference avails an international platform for presentation of new advances and findings in diverse engineering fields. We therefore appeal to members to submit their papers. We encourage you to invite colleagues to participate in the conference and submit papers for the Conference Call for Papers.

Please submit your papers to events@kesebae.or.ke.

Key Dates:

Abstract Submission: 11 September 2023

Paper Submission: 10 October 2023

Payment Deadline: 25 October 2023

Registration Details

Members: KES 15,000($150)

Non-Members: KES 20,000($200)

Undergraduate Students: KES 2,000($20)

Field Visit: KES 5,000($50)

Virtual: KES 10,000($100)

Registration Links

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While the current surge in electric vehicle adoption is revolutionizing both passenger and commercial on-road vehicle fleets, a parallel transformation within the off-road equipment sector seems to be lagging behind. This discrepancy arises due to the diverse range of equipment categories and the various ways they are utilized off-road, which necessitates significant research and development efforts to electrify such machinery. Successfully transitioning these types of equipment to electric power can yield numerous advantages, including decreased levels of air and noise pollution, heightened energy efficiency, and improved productivity.

Off-road equipment refer to any non-stationary device, powered by an internal combustion engine or electric motor, used primarily off the highways, to propel, move or draw persons or property including any device propelled, moved or drawn exclusively by human power, and used in, but not limited to the following applications: marine vessels, construction/ farm equipment, locomotives, utility engines and lawn and garden equipment, off-road motorcycles and off-highway vehicles.

Off-road equipment also known as highway equipment is a broad term that is used to explain the machinery which spends most of its time off-road. The type of equipment can range from large trucks used in mining to small agricultural machines, and everything in between. Construction and mining equipment operate in conditions that are hard on the components. Just the nature of the work they do exposes the vehicles to large amounts of contamination and debris that can cause damage especially to the hydraulics and gears which are sensitive to particulate contamination. Continually monitoring the oil condition can prevent unexpected breakdowns. The off-highway and agricultural segment needs specialized expertise to meet new challenges. Be it handling more load or free moving on the roads, the off-highway segment is constantly evolving and onward is geared up to support it with design as well as manufacturing solutions,

Introduction

While the challenges faced by passenger EVs, like limited range and charging infrastructure, have been gradually addressed, a substantial amount of work has been undertaken in electrifying on-road vehicles, ranging from light-duty cars to heavy duty trucks. In contrast, off-road equipment used in construction and agriculture has received less attention despite its potential to reduce air pollution and greenhouse gas emissions, spurred by stringent regulations.

Regulations in the United States and the European Union (EU) have prompted off-road equipment manufacturers to explore electrification due to emission reduction demands. The Tier and Stage emission standards in the US and EU, respectively, have become increasingly stringent over time, pushing manufacturers to adopt advanced engine technologies. Electrification approaches such as mid hybridization and battery electrification are now being pursued to meet these demands. California has set an ambitious target of achieving zero-emission heavy duty vehicles by 2045, driving the need for electric heavy-duty machinery development.

Efforts in electrifying off-road construction and agricultural equipment have primarily focused on diesel-electric and hybrid powertrains, with some endeavours towards battery electrification. However, adapting electrification technologies from on-road vehicles to off-road equipment presents challenges due to unique working conditions. Hybrid systems from on-road EVs might not translate directly to hybrid excavators due to varying environments. Furthermore, off-road equipment components must withstand greater impact and vibration compared to their on-road counterparts. Power electronics, for example, need to endure elements like mud and water, while the ruggedness of hydrogen tanks in off-road fuel cell electric vehicles (FCEVs) must ensure integrity even under impact.

Electric Powertrain Architectures in Different Off-Road Equipment Categories

In the realm of general off-road equipment electrification, a range of EV architectures have been explored. For instance, Zhang et al. designed a battery management system (BMS) for a light-duty off-road parallel plug-in hybrid (PHEV) vehicle using fuzzy programming. Parsons et al. presented a series hybrid configuration with hub-mounted electric motors for heavy military vehicles, indicating scalability for potential application in heavy construction

equipment. Transitioning toward battery electric vehicle (BEV) architecture is also considered when battery technology is sufficiently mature and duty cycles align with battery capacity. Baronti et al. developed a BMS for lithium iron phosphate batteries for off-road BEVs, focusing on broader applicability and avoiding bespoke hardware.

Another avenue explored for off-road equipment electrification involves hydrogen fuel cells to power electric drivetrains. Saeks presented an off-road FCEVE configuration using a flywheel energy storage system for energy recovery and acceleration assistance. This system featured four-wheel drive with four motors, adaptive controllers for steering and an emphasis on energy management and acceleration control.

Energy Recovery

In loaders, abrupt stops during operations, such as piling and lifting materials, can generate electricity through regenerative braking. This approach has been implemented in equipment like the John Deere 644K Hybrid Wheel Loader. However, the amount of kinetic energy that can be recovered through regenerative braking in loaders is generally lower compared to on-road vehicles due to greater rolling resistance.

Excavators offer multiple opportunities for energy capture. When lowering the boom, potential energy can be captured and stored for later use. Different studies propose various methods for this purpose. For instance, using an Energy Storage System (ESS) composed of batteries and capacitors, while Ge focus on capturing energy as hydraulic energy. The use of hydraulic systems in conjunction with the electric powertrain is also explored, as hydraulic systems can quickly capture potential energy and then utilize it to generate electricity efficiently.

The concept of capturing energy extends to other aspects of off-road equipment as well. For example, recapturing heat from turbocharged engines to generate electricity is discussed, either through a turbine-generator system or thermoelectric generators. This approach can potentially be applied to any construction or agricultural equipment with turbocharger. Additionally, the adoption of electro-hybrid actuators is proposed as a means to replace hydraulic pipelines with electric wiring, offering increased reliability and the possibility of energy regeneration from hydraulic systems.

Promises and Concerns of Off-Road Equipment Electrification

Electric motors possess superior torque capabilities compared to internal combustion engines, making them well-suited for demanding off-road equipment applications. Electric drivetrains are characterized by fewer moving parts than traditional ICE systems, leading to reduced wear on components and consequently lower maintenance costs. Regenerative braking in electric drivetrains further contributes to decreased wear on mechanical brakes, enhancing their durability. Additionally, this reduction in wear, coupled with decreased fuel consumption, translates to lower overall operating costs.

Electric drivetrains not only improve efficiency, benefiting both hybrid and fully electric setups, but also enable the separation of loads from the ICE in certain vehicles, such as agricultural tractors. Unlike ICEs, electric equipment is not susceptible to power loss at high altitudes due to oxygen limitations. This attribute enhances operational efficiency and reduces fuel expenses, particularly in elevated settings. The diminished need for maintenance translates to reduced downtime, fostering higher levels of productivity.

The flexibility of electric vehicle design is noteworthy, offering increased space utilization and versatile layout options. Electrification introduces operational and economic advantages, such as the capability to operate equipment in proximity to emission-sensitive areas and during noise-restricted hours. This operational flexibility is unattainable with ICE equipment and can heighten productivity in these scenarios. Lower emissions associated with electric vehicles also hold benefits in confined environments like mines, where air quality improvement due to reduced pollution can be significant.

Proposal for Off-Road Equipment Electrification

The studied off-road equipment exhibits diverse work environments and activity requirements, leading to varying duty cycles dictated by different jobsites.

Consequently, it is not possible to provide a single optimal electrification recommendation applicable to all off-road equipment due to this variability. Equipment within the same category might benefit from different technologies based on their specific intended uses and operating conditions. While this section outlines general possibilities for overcoming current limitations in off-road equipment electrification, the effective application of these techniques can differ for each use case.

Construction and agricultural equipment often have extended service lives, and retrofitting existing vehicles with electric powertrains emerges as a plausible solution to maximize their utility. Retrofitting could involve utilizing range extenders as on-board generators, with existing Tier 4 diesel engines functioning within optimal regions to maximize efficiency and minimize emissions while using their remaining lifecycle.

To operate plug-in hybrid electric (PHEV) or battery electric (BEV) equipment, on-site charging facilities are necessary. Leveraging renewable energy sources (RES) such as solar or wind power to charge these vehicles is proposed. Methods like solar or wind power to charge these vehicles is proposed. Methods like solar-powered charging stations for light agricultural vehicles can be scaled up for heavy-duty agricultural equipment, with wind power offering another viable option. Employing solar photovoltaic systems for EV charging is a well-receiving concept. Studies have explored various configurations, including PV-fed EV charging stations with connections to the grid, intermediate energy storage systems (ESS), and dedicated fuel-cell generators. Charging stations equipped with ESS and hydrogen generation mechanisms can serve a range of electric vehicle types while utilizing electricity generated from RES.

Smart charging systems with vehicle-to-grid (V2G) capabilities, as proposed by Kam et al., could support energy-independent, self-sustaining small agricultural farms. Second-life batteries (SLBs) can be repurposed as ESS in charging stations to reduce costs, and utilizing SLBs from off-road equipment can yield long-term efficiency and cost benefits. Proper placement of charging stations and the use of mobile chargers powered by mobile ESS can address scenarios where equipment cannot return to central charging points.

References

Zhang, W.; Wang, J.; Du, S.; Ma, H.; Zhao, W.; Li, H.; (2019). Energy management strategies for hybrid construction machinery: Evolution, classification, comparison and future trends. Energies 2019, 12, 2024.

Parsons, M.B.; Mepsted, G.O.; (2014). Development of off-road hybrid-electric powertrains and review of emerging battery chemistries. In Proceedings of the 5th IET Hybrid and Electric Vehicles Conference (HEVC 2014), London, UK, 5–6 November 2014; pp. 1–7.


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16th - 18th October 2023
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Call for Papers

To the Next Editions of the JEAE

JEAE

Journal of Engineering in Agriculture and the Environment

The Journal of Engineering in Agriculture and the Environment (JEAE) is a Publication of the Kenya Society of Environmental, Biological and Agricultural Engineers (KeSEBAE) through which researchers in the fields of Environment, Agriculture and related fields share research information and findings with their peers from around the globe.

The JEAE Editorial Board wishes to invite interested researchers with complete work in any relevant topic, to submit their papers for publication in the next editions of the Journal.

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d. Deals with theoretical, practical and adoptable innovations applicable to engineering and technology in agriculture, the environment and biological systems
e. Have a 150 to250 words abstract, preceding the main body of the article
f. The abstract should be followed by the list of 4 to 8 "Key Words"
g. Manuscript should be single-spaced, under 4,000 words (approximately equivalent to 5-6 pages of A4-size paper)
h. Should be submitted in both MS word (2010 or later versions) and pdf formats (i.e., authors submit the abstract and key words in MS Word and pdf after which author uploads the entire manuscript in MS word and pdf)
i. Are supported by authentic sources, references or bibliography

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CALL FOR ARTICLES TO KeSEBAE NEWS

KeSEBAE NEWS Editorial wishes to call for topical articles for publication in future editions of KeSEBAE NEWS.

Please transmit the same to the **Editor: Ezekiel Oranga** via Email: info@kesebae.or.ke

NOTE: A payment will be made to the author of each selected article

CALL FOR MEMBERSHIP

Be a KeSEBAE Member:

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Membership Category	Annual Subscription (KES)	Admission Fees (KES)	Reinstatement Fees (KES)
Fellow	5,000	1,000	2,000
Member	2,000	1,000	2,000
Ass.Member	1,000	1,000	2,000
Aff.Member	500	1,000	2,000
Student	300	100	-

Membership Renewal

Members of all grades are requested to renew their **2022 membership as follows.**

Membership Category	*Annual Subscription Fee (KES)*
Fellow	**5,000**
Member	**2,000**
Ass. Member	**1,000**
Aff. Member	**500**
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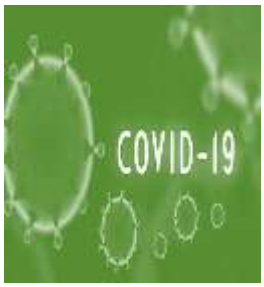

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