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AFRICA ELECTRICITY SYMPOSIUM 2025

INVESTIGATING THE EFFECTS OF CURRENT TRAVELING WAVES ON 220kV DOUBLE CIRCUIT TRANSMISSION LINE

1. Mr. ROLAND ARYAMANYA
2. Prof. Abubakar Abdulkarim
3. Asso. Prof. Aliyu Nuhu Shuaibu
4. Dr. Ounyesiga Living

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1. Introduction

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Global perspective: Current traveling wave techniques offer a promising alternative to traditional fault location techniques for detecting faults in power transmission systems

Africa: Waves provide crucial information about fault types and locations, enabling faster and more accurate fault detection.

Uganda: This approach is particularly relevant for Uganda's growing high-voltage transmission network, such as the 220kV Kawanda–Masaka line.

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2. Theories

Model	Application
1 Transmission Line Theory	Modeling wave propagation on transmission lines
2 Electromagnetic Wave Theory	Understanding wave generation and travel
3 Fault Location Using TW Theory	Locating faults using wave arrival times
4 Signal Processing Theory	Interpreting waveforms and enhancing fault identification accuracy

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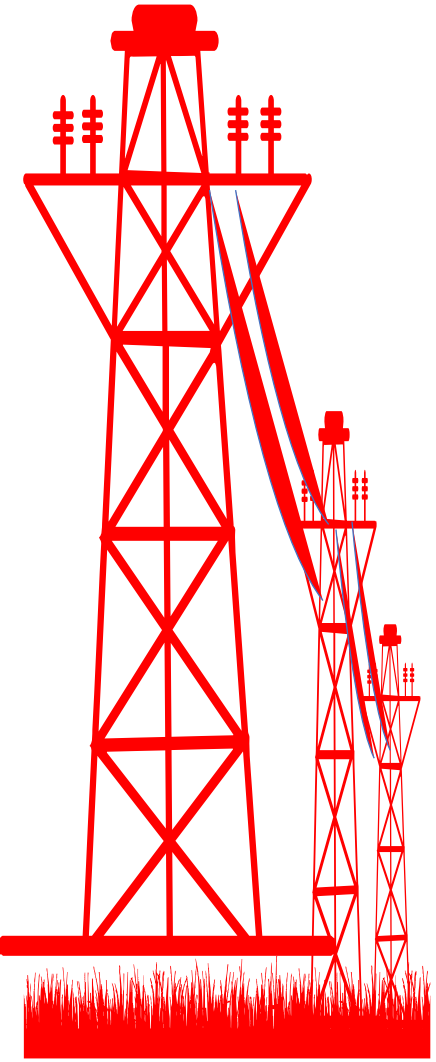
3. Problem statement



- In power transmission there exists faults
- There are challenges of detecting faults with current travelling waves on 220 kV double circuit power transmission lines by investigating their performance and developing mitigation strategies.

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4. Objectives

To study the propagation of current travelling waves on 220kV double circuit transmission line using the Telegrapher's equations.

To investigate the effects of current travelling waves on the transmission lines power transfer capacity and stability by introducing various fault scenarios.

To evaluate the performance of the line with respect to its electrical parameters.

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5. Studies Significance

- Enhances accuracy and efficiency in fault detection.
- Improves system performance, protection, and stability.
- Reduces downtime and boosts grid reliability.
- Supports safer, resilient, and future-ready power systems.

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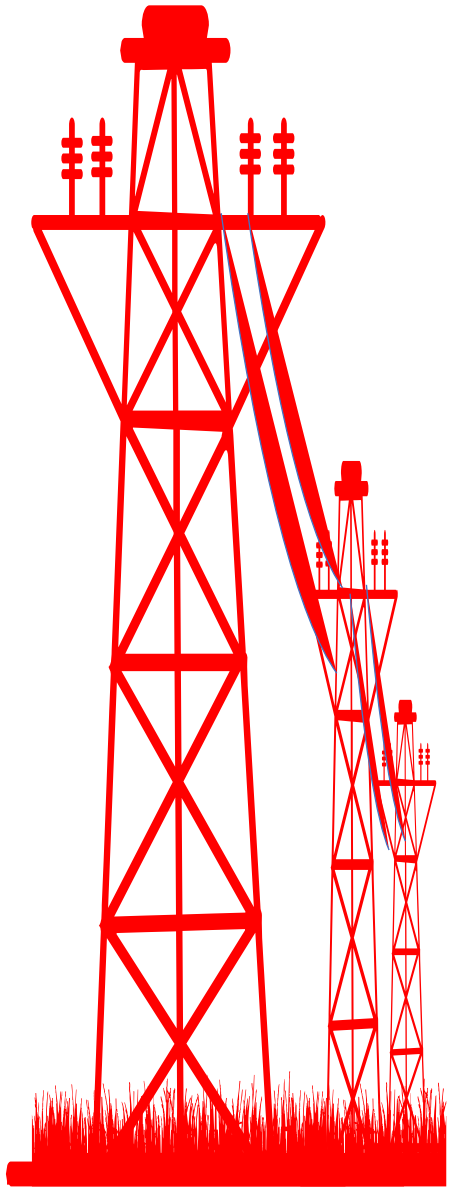
6. Methods



- Mathematical modelling and simulation techniques used to analyze current traveling waves on the Kawanda-Masaka 220 kV double circuit transmission line focusing on fault modeling.

- The model utilizes three-phase configuration parameters and Telegrapher's equations to study wave propagation, reflection, and refraction, capturing voltage and current traveling wave behavior under fault conditions.

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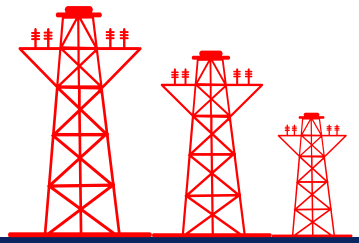
7. Results & Discussion

- The simulation and visualization results analyze the behavior of a 220kV double circuit transmission line under various fault conditions using Python-based models.
- The study began with establishing baseline voltage and current waveforms under steady-state conditions, followed by the introduction of fault types including line-to-ground, line-to-line, double line-to-ground, three-phase, open-circuit, short-circuit, high-impedance, arcing, inter-circuit, and cross-country faults.
- Each fault caused unique disruptions in voltage and current propagation, clearly visualized through simulation outputs



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8. Results & Discussion cont…

- Significant findings include voltage collapse and current spikes during three-phase and short-circuit faults, and total current loss during open-circuit faults.

- The simulation incorporated damping to enhance system stability, effectively reducing oscillations post-fault

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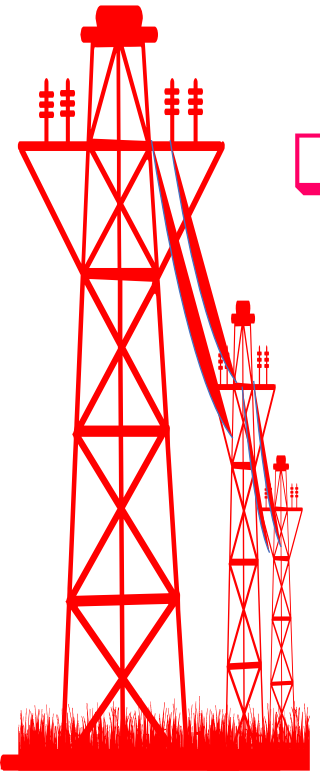
9. Results & Discussion cont…

- Parameters such as characteristic impedance (370.48 Ω) and propagation speed (~1.26×10⁸ m/s) validated the model's accuracy, with error margins kept within 2% after refinement.



- Furthermore, the study highlighted how electrical parameters influence wave behavior and emphasized the role of fault signatures in developing protective systems for transmission lines

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10. Conclusion

- This study analyzed the effects of current traveling waves on the 220kV Kawanda-Masaka double circuit transmission line, revealing that such waves, especially during faults, can destabilize the system and cause equipment damage.
- Through simulations, it identified critical fault scenarios and showed that mitigation techniques like absorbing boundary conditions and damping factors can effectively reduce adverse impacts.
- It recommends further research on multi-circuit systems, environmental variability, and integrating wave protection into grid operations.

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11. References

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www.aes.era.go.ug
symposium@era.go.ug
+256 393 260166