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MINISTRY OF ENERGY AND MINERAL DEVELOPMENT
THE REPUBLIC OF UGANDA

Enhancing Energy Resilience in Higher Education: A Hybrid Solar and Efficiency Case from Uganda.

Vicent Rutagangibwa | Julius Taremwa

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3. Introduction

- **Energy Challenges in African Universities:**
  - African HEIs face unreliable electricity, rising energy costs, and outdated infrastructure(Oliveira & Proença, 2025).
- **Empirical Gaps in Energy Planning:**
  - Few African universities have adopted data-driven energy strategies(Mbumba et al., 2024)
- **Research Contribution:**
  - A context-specific hybrid solar PV model to improve sustainability and institutional resilience.

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4. Problem & Theories (1)

- **Energy Instability Undermines University Operations.**
  - Universities in Africa face frequent power outages, escalating energy costs, and aging infrastructure (Oliveira & Proença, 2025).

- **Current Interventions Lack Empirical and Contextual Depth.**
  - Limited attention to institutional behaviour or policy realities (Lottu et al., 2023; Mbumba et al., 2024)

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5. Problem & Theories (2)

- **Low-Resource Contexts and Feasible Solutions**
  - Many sustainability interventions fail to account for energy complexities in low-resource HEIs(Oliveira & Proença, 2025).
  - Literature often overlooks how energy technologies interact with institutional context (Kammen & Dove, 2022; Munaro & John, 2024):

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6. Methods

- **A mixed-methods energy audit.**
  - Two campuses using instrumentation-based measurements, walkthroughs, and interviews to generate a detailed energy profile.

- **Solar PV feasibility and financial modelling**.
  - Integrated site-specific energy data, meteorological inputs, and economic analysis (NPV, IRR, SPP) to assess the viability of solution.

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7. Results & Discussion (1)

Campus load analysis

- Lighting as the dominant energy consumer.
- Peak demand during midday.
- Low power factor values and voltage instability.

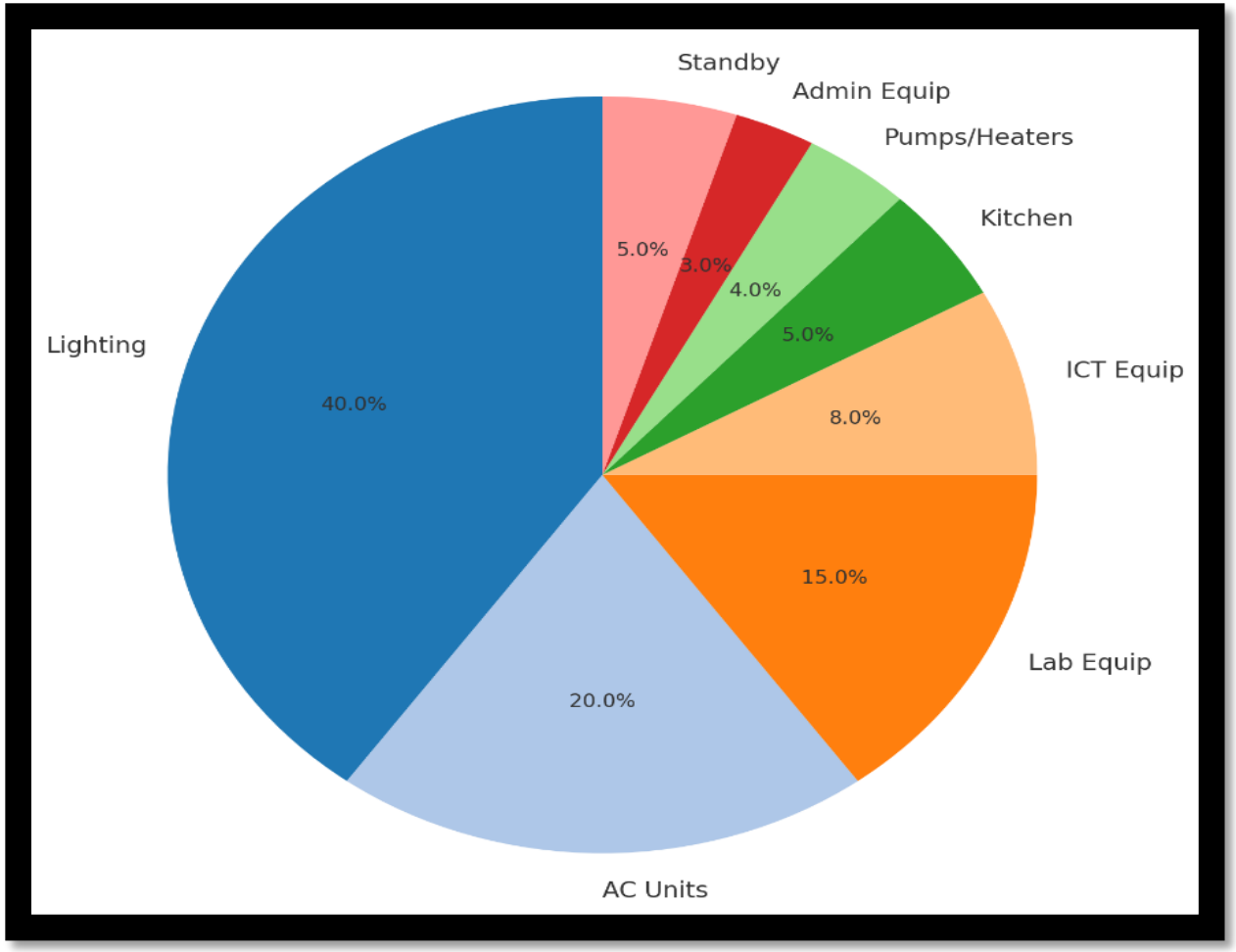

Figure: Load Distribution by Category

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8. Results & Discussion (2)

- **Energy conservation potential is high:**
  - LED retrofits projected to cut lighting consumption by 30 to 40 percent.
  - HVAC scheduling and upgrades offering additional load reduction.
- **A modular 200-kW solar PV system.**
  - Projected to offset 30 percent of baseline demand.

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9. Results & Discussion (3)

- **Financial modelling**
  - 7–8 years payback period, with positive NPV and an IRR above 12 percent.

- **Sensitivity analysis**
  - The model's resilience to variations in energy prices and consumption growth

  - Supporting its replicability and scalability for similar institutions across sub-Saharan Africa.

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10. Results & Discussion (4)

- **Institutional leadership** must actively prioritise sustainable energy planning.

- The importance of **enabling policies and green financing mechanisms** to facilitate long-term energy investments *(Budu et al., 2025)*.

- **Policy frameworks** can facilitate the adoption and scaling of sustainable solutions.

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11. Recommendations

- **Implement Efficiency First**
  - Retrofit outdated lighting and HVAC systems to reduce baseline demand.
- **Phase the Solar PV Rollout**
  - Start with a 200-kW rooftop system and scale incrementally based on performance monitoring and available funds.
- **Improve Power Quality**
  - Invest in power factor correction and harmonic filtering to stabilize supply and reduce utility penalties
- **Promote Behavioural Change**
  - Launch energy awareness campaigns among students and staff, and integrate sustainability themes into teaching and operations

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12. References

1. Budu, R., & Ofori, A. (2025). Green culture and digital transformation in African HEIs. *Journal of Environmental Policy*, 10(2), 45–61.

2. Ishak, M. H., Sipan, I., Sapri, M., Mar Iman, A. H., & Martin, D. (2016). Estimating potential saving with energy consumption behaviour model in higher education institutions. *Sustainable Environment Research*, 26(6), 275–283. https://doi.org/10.1016/j.serj.2016.04.017

3. Mbumba, J., & Chisoma, L. (2024). Evaluation of off-grid PV projects in education institutions. *Energy for Sustainable Development*, 64, 88–96.

4. Munaro, B. H., & John, M. (2024). Sustainable campus operations in African higher education institutions. *Renewable & Sustainable Energy Reviews*, 152, 111625.

5. Oliveira, M. R., & Proença, L. M. (2025). Energy efficiency in higher education institutions: Challenges and best practices. *Journal of Sustainable Development*.

6. Soares, N., et al. (2018). Energy retrofits and economic modeling in institutional settings. *Sustainable Cities and Society*, 42, 230–238.

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