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MDPI

Artificial Intelligence, Digital Twins, and Data-Driven Decision Support for Urban Energy Management in Zambian Cities

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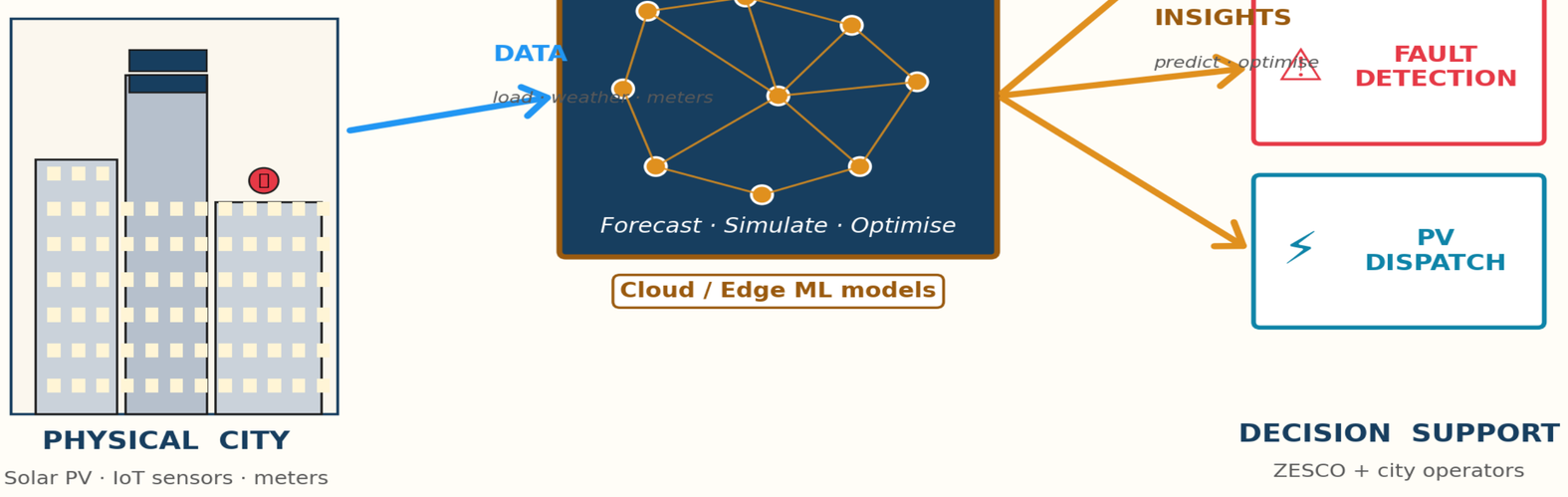
AI + Digital Twin for Urban Energy — Lusaka

Sense → Model → Predict → Decide

20 hrs
Daily outages (Lusaka, 2023/24)



1,000 MW
Solar PV target by 2025

Smarter dispatch & demand-side management for a hydropower-stressed grid

Lake Kariba drought 2023/24 — 80% generation drop, up to 20 h Lusaka outages

1 · INTRODUCTION & AIM

> Only **43%** of Zambians on the grid (urban 67% · rural 14.5%)

> 80% of electricity from hydropower → **climate-vulnerable**

> Lake Kariba drought 2023/24 → **80% generation drop, 20-h Lusaka outages**

> National Digital Transformation Strategy 2023–27 + Vision 2030 → **enabling AI / digital-twin foundation**

AIM How can AI, digital twins and data-driven decision support be feasibly implemented for urban energy management in Zambian cities?

2 · METHOD

1. Literature review
AI in smart energy systems · digital twins · Sub-Saharan smart-city projects

2. Document review
National Energy Policy · Digital Transformation Strategy · IRP & regulations

3. Case studies
Kenya renewable mix · Rwanda smart-grid pilots · Zambia Smart-Village project

4. Thematic synthesis
Tech readiness · regulation · skills · finance — focus on digital twins for ZESCO grid & ML for solar irradiance

3 · KEY RESULTS

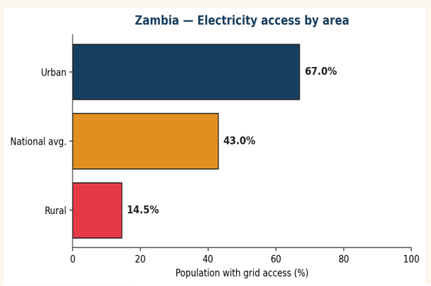
> ML load forecasting → **technically viable** for short-horizon dispatch

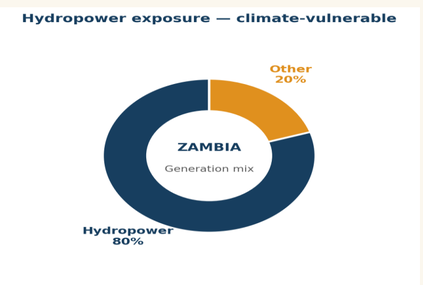
> Digital twin → **fault analysis · loss quantification · grid simulation** without physical intervention

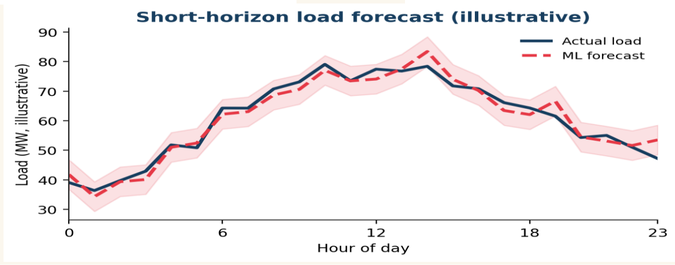
> Solar irradiance ML supports **1,000 MW PV target by 2025** — addresses intermittency

> Barriers: **low peri-urban internet, skills gap, finance** (smart-meter rollout)

> UNDP **Timbuktoo AI Compute Nodes** → sovereign, renewable-powered AI cloud for Africa







4 · CONCLUSION & TAKE-HOME MESSAGE

Take-home **AI, digital twins and decision-support can modernise ZESCO and Zambian urban energy — within today's infrastructure constraints.**

1. Pilot digital twin on a Lusaka distribution feeder 2. Train ML on local load + solar data 3. Build technical capacity in ZESCO + municipalities 4. Modernise data-privacy & P2P-trading regulation 5. Mobilise blended finance for smart-meter rollout

5 · DISCUSS · SCAN · CONNECT

Talk to us → *which AI lever should Zambia pull first?*

[1] Digital-twin pilot for ZESCO feeder
[2] ML solar-irradiance forecasting node
[3] Smart-meter rollout in Lusaka
[4] AI/data skills programme (TEVET + university)
[5] Data-privacy & P2P-trading regulation

Scan → conference page

6 · REFERENCES, ACKNOWLEDGEMENTS

Selected references
[1] Govt. of Zambia. National Digital Transformation Strategy (2023–27).
[2] Govt. of Zambia. Vision 2030.
[3] ZESCO. Integrated Resource Plan (latest).
[4] IEA. Africa Energy Outlook (2024).
[5] UNDP. Timbuktoo AI Compute Nodes (2024).

Acknowledgements
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