



AI-Driven Eco-Resilience: Forging Sustainable Disaster Recovery & Business Continuity in East African RENs

Dr. Stephen K. Wanjau, PhD

**Murang'a University of
Technology
Kenya**

**UbuntuNet
CONNECT 2025**

Harare, Zimbabwe
30 - 31 October 2025

Resilient and
Sustainable Research
& Education Networks
for the Future

Agenda

- ❖ The Stark Reality: A Region at a Digital Crossroads
- ❖ The Problem with Traditional Solutions
- ❖ Our Vision: The AI-Driven Eco-Resilience Framework
 - Pillar 1: Decentralized & Solar-Powered Edge
 - Pillar 2: Distributed Data Sanctuaries
 - Pillar 3: AI-Optimized Failover & Cyber-Resilience
- ❖ The Pilot & Scaling Vision: From MUT to the Region
- ❖ Expected Impact & Benefits
- ❖ The Investment Case: Budget & Partnership
- ❖ Conclusion & Call to Action



The Stark Reality: A Region at a Digital Crossroads

❑ The Infrastructure Gap:

- ✓ 18% of the world's population.
- ✓ <1% of global data center capacity.
- ✓ Heavy reliance on distant, vulnerable infrastructure (e.g., undersea cables).

❑ The Climate Multiplier:

- ✓ Escalating floods, droughts, and seismic activity.
- ✓ These events directly damage infrastructure and cause widespread outages.

❑ The Consequence:

- ✓ **Digital Fragility:** Research, e-learning, and collaboration are constantly at risk.
- ✓ A "**Lost Decade of Development**" is a real possibility if we continue with business-as-usual.



POPULATION



DATA CAPACITY



CLIMATE DISASTERS

The Problem with Traditional Solutions

- ❑ **Cost-Prohibitive:** High-end, centralized DR solutions are unaffordable.
- ❑ **Externally Dependent:** They don't build local capacity or sovereignty.
- ❑ **Contextually Blind:** Fail to address East Africa's unique socio-economic and environmental challenges.
- ❑ **Unsustainable:** Often energy-intensive, contradicting climate goals.

Our Conclusion: We need a new paradigm. Not just resilient, but *eco-resilient*.



Our Proposed Solution: The AI-Driven Eco-Resilience Framework

□ This integrated framework aligns with the World Bank's Green, Resilient, and Inclusive Development (GRID) approach.

- ✓ Decentralized & Solar-Powered Edge Computing
- ✓ Distributed Data Sanctuaries & Mesh Networking
- ✓ AI-Optimized Failover & Cyber-Resilience
- ✓ Community Integration & Indigenous Knowledge



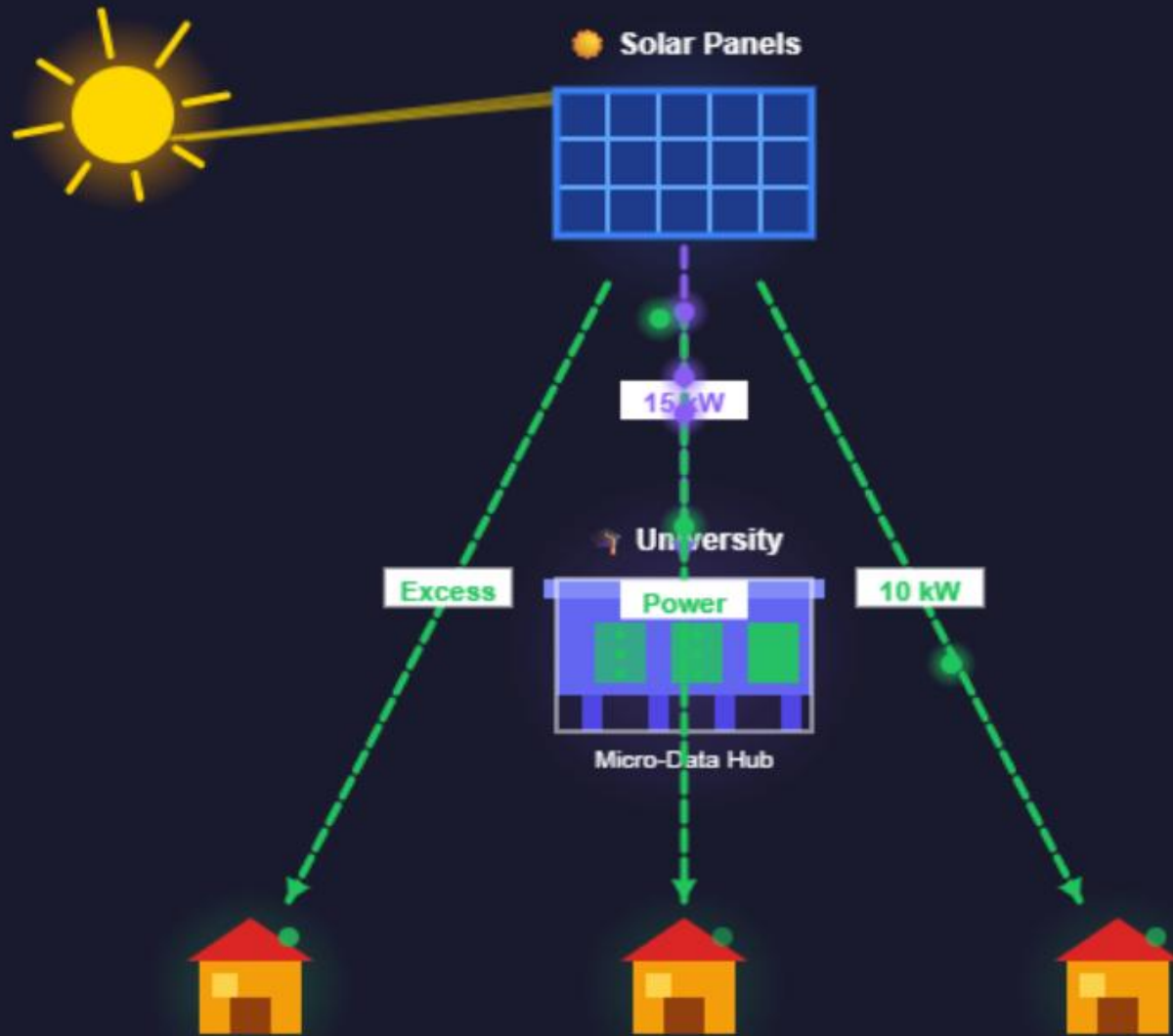
Pillar 1: Decentralized & Solar- Powered Edge

- ❑ **What:** Deploy solar-powered edge nodes with battery backups at universities like MUT.
- ❑ **Why:**
 - **Continuous Power:** Operates during grid failures.
 - **Local Caching:** Critical research data remains accessible during internet outages.
 - **Economic & Environmental Benefit:**
 - ✓ Share excess capacity with communities.
 - ✓ ~70% reduction in carbon footprint.
 - ✓ Creates a revenue stream.



Solar-Powered Micro-Data Hub

Sustainable Computing & Community Energy



Solar Generation

25 kW

Data Hub Usage

15 kW

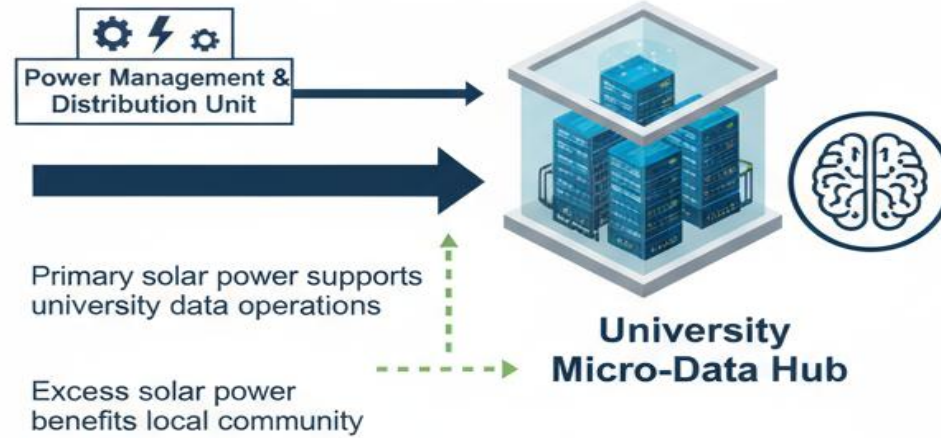
Community Share

10 kW

University Solar-Powered Micro-Data Hub with Community Energy Sharing



University Solar Array



Local Community

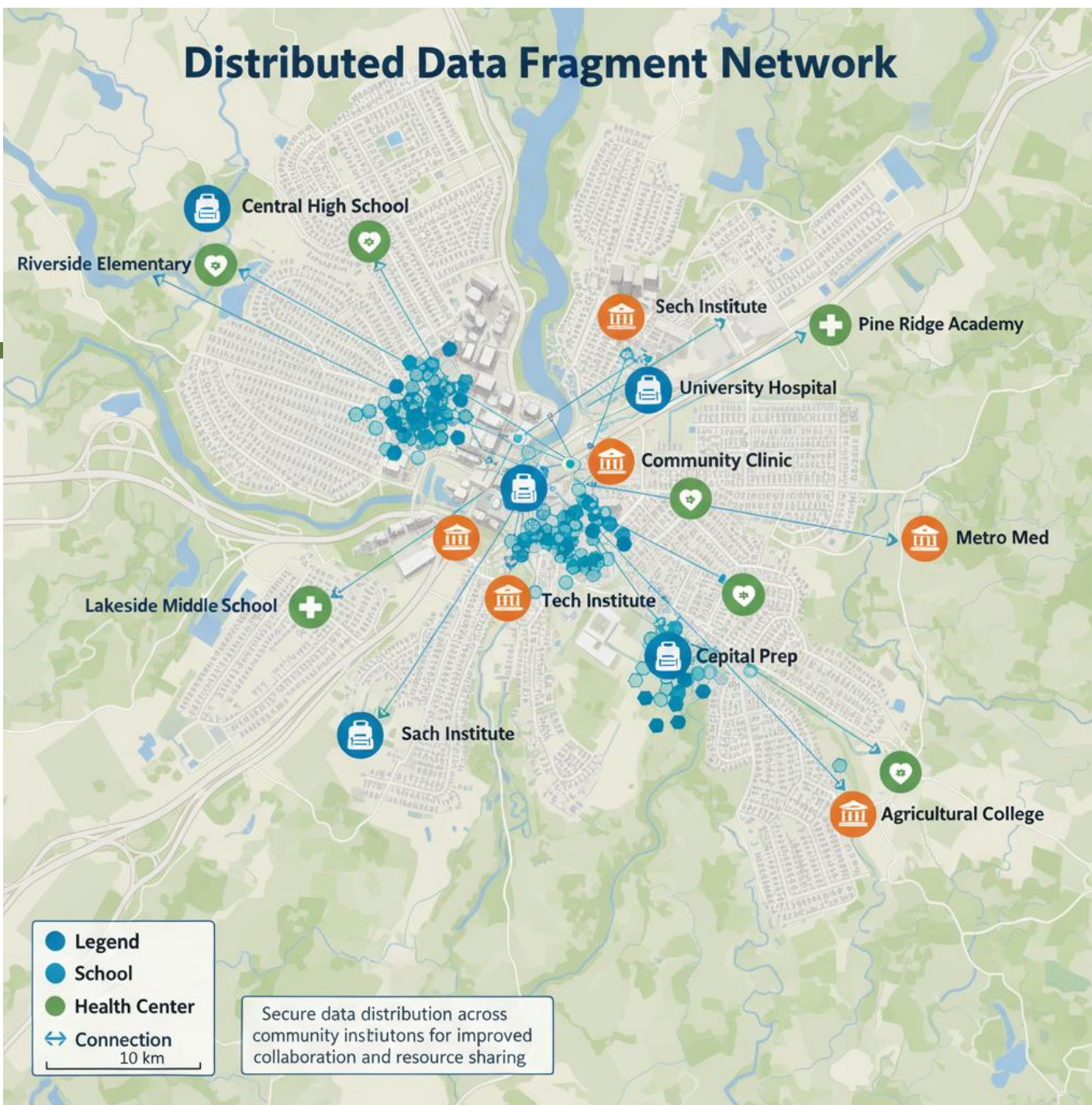


Pillar 2: Distributed Data Sanctuaries

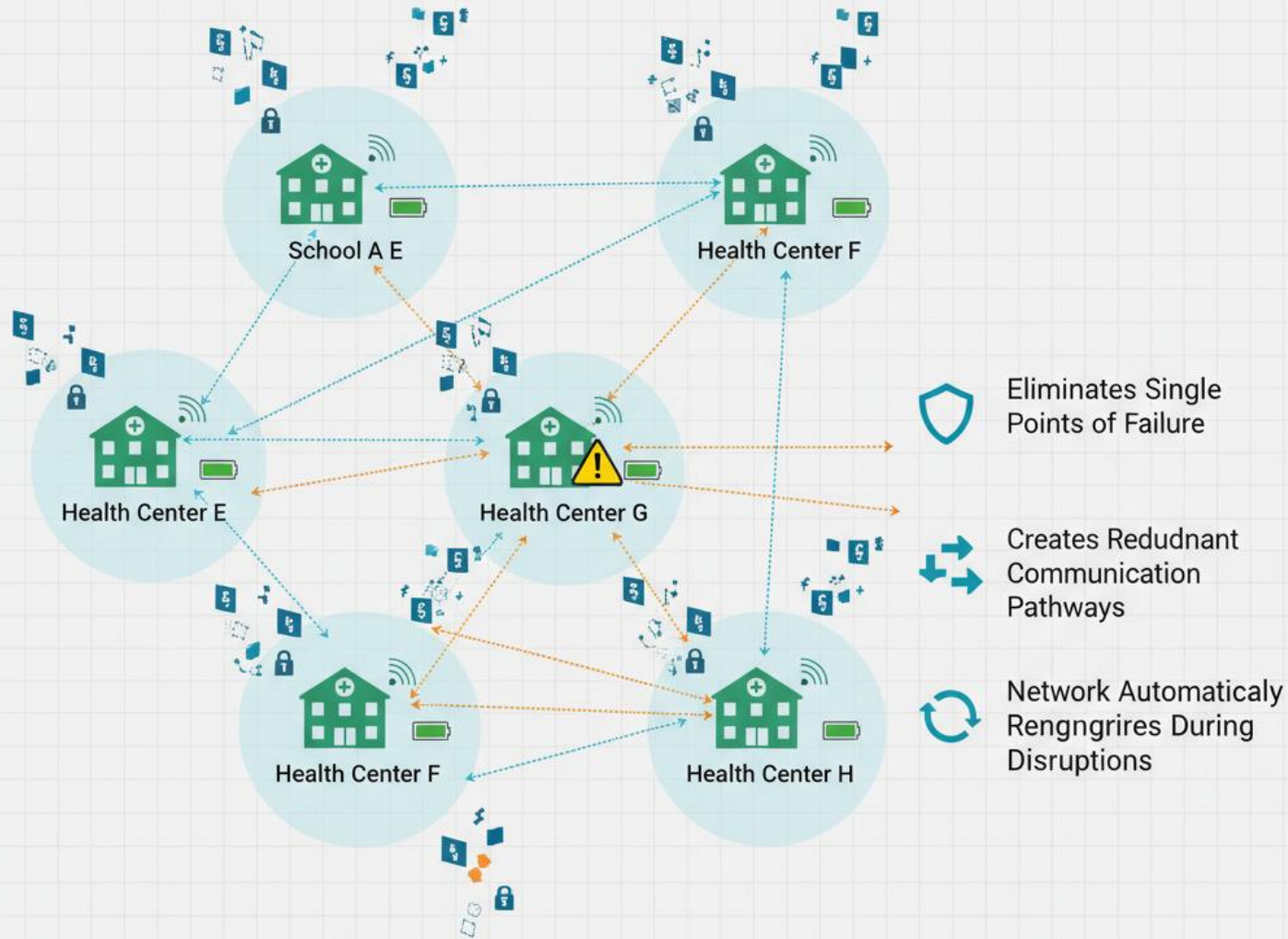
- ❑ **What:** Distribute encrypted data fragments across multiple community nodes (schools, health centers).
- ❑ **Technology:** LoRaWAN for low-power, long-range mesh networking.
- ❑ **Benefit:**
 - *Eliminates Single Points of Failure.*
 - *Creates redundant communication pathways.*
- ❑ **Network automatically reconfigures during disruptions.**



Distributed Data Fragment Network



LoRAWAN Encrypted Data Distribution Network

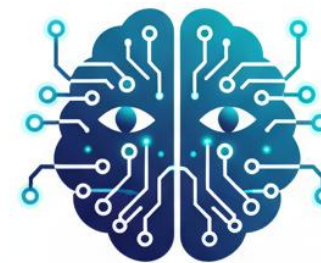


LoRAWAN Specifications:
Range: up to 15 km
Rane: up to 15 km
Power Consumption: very low (μA)

- School Node
- Encryed LoraWAN Link
- Backup LoraWAN Link
- Gateway Coverage
- Disrupted Node

Pillar 3: AI-Optimized Failover & Cyber-Resilience

- ❑ **Predictive Maintenance:** AI forecasts fiber optic cuts & hardware failures (>97% accuracy possible).
 - ❑ **Self-Healing Networks:** AI automatically detects, diagnoses, and reroutes traffic in real-time.
 - ❑ **Digital Twins:** Simulate disaster scenarios (floods, cable cuts) to test strategies risk-free.
 - ❑ **Blockchain Integrity:** Secures data during failovers to prevent corruption.
- **Result:** Near-instant failover, maintained data integrity, rapid cyber-attack recovery.



AI/ML



Digital Twin



Blockchain

AI-Optimized Failover & Cyber-Resilience

Predictive Maintenance



AI forecasts fiber optic cuts & hardware failures | >97% accuracy

Self-Healing Networks



AI automatically detects, diagnoses, and reroutes traffic in real-time

Digital Twins



Simulate disaster scenarios (floods, floods, cable cuts) to test strategies risk-free

Blockchain Integrity



Secures data during failovers to prevent corruption

RESULTS



Near-instant failover.



Maintained data integrity



Rapid cyber-attack recovery

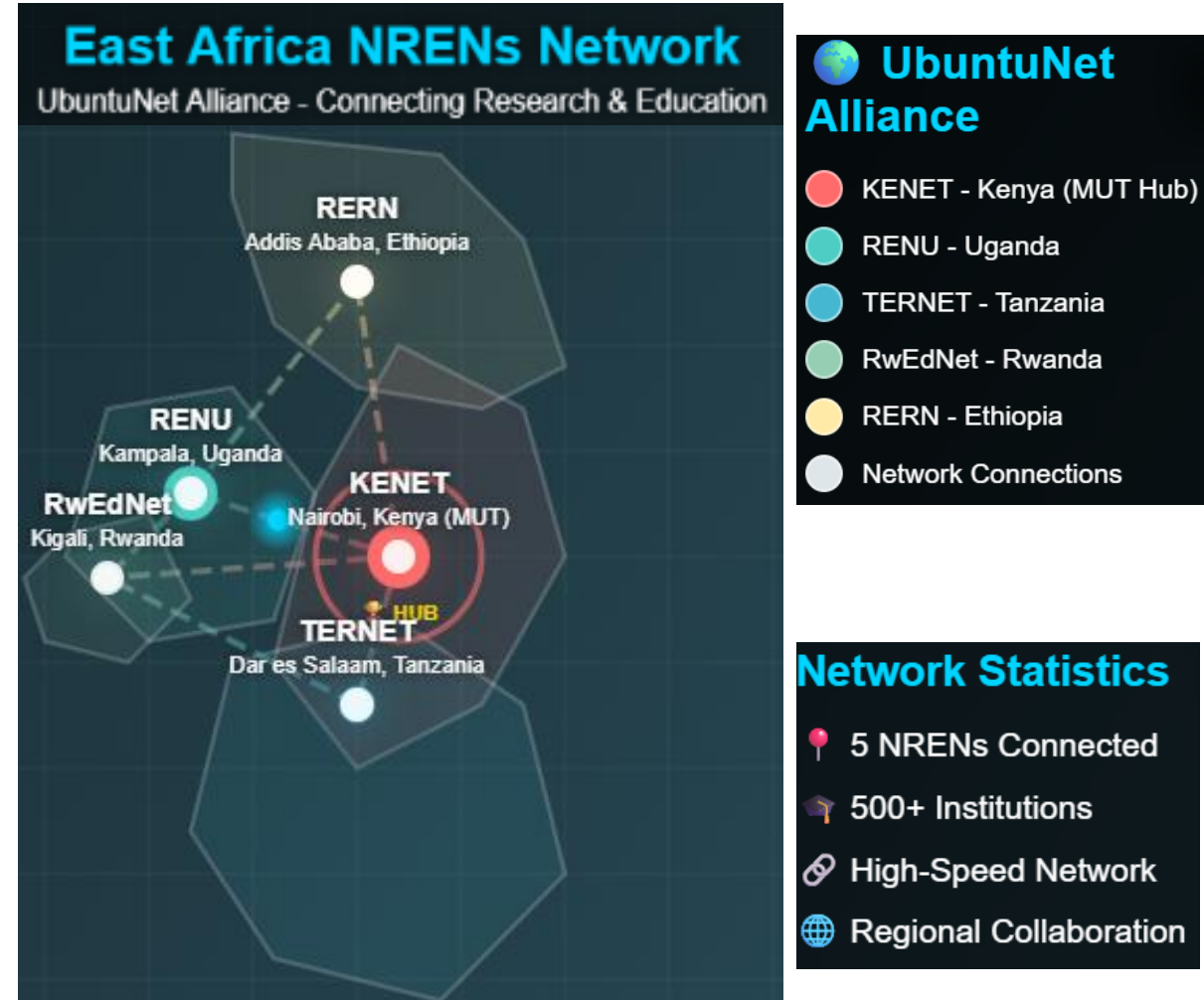
The Pilot & Scaling Vision: From MUT to the Region

Phase 1: Pilot at Murang'a University of Technology (MUT)

- MUT becomes a living lab and a DR hub for its digital library and repositories.

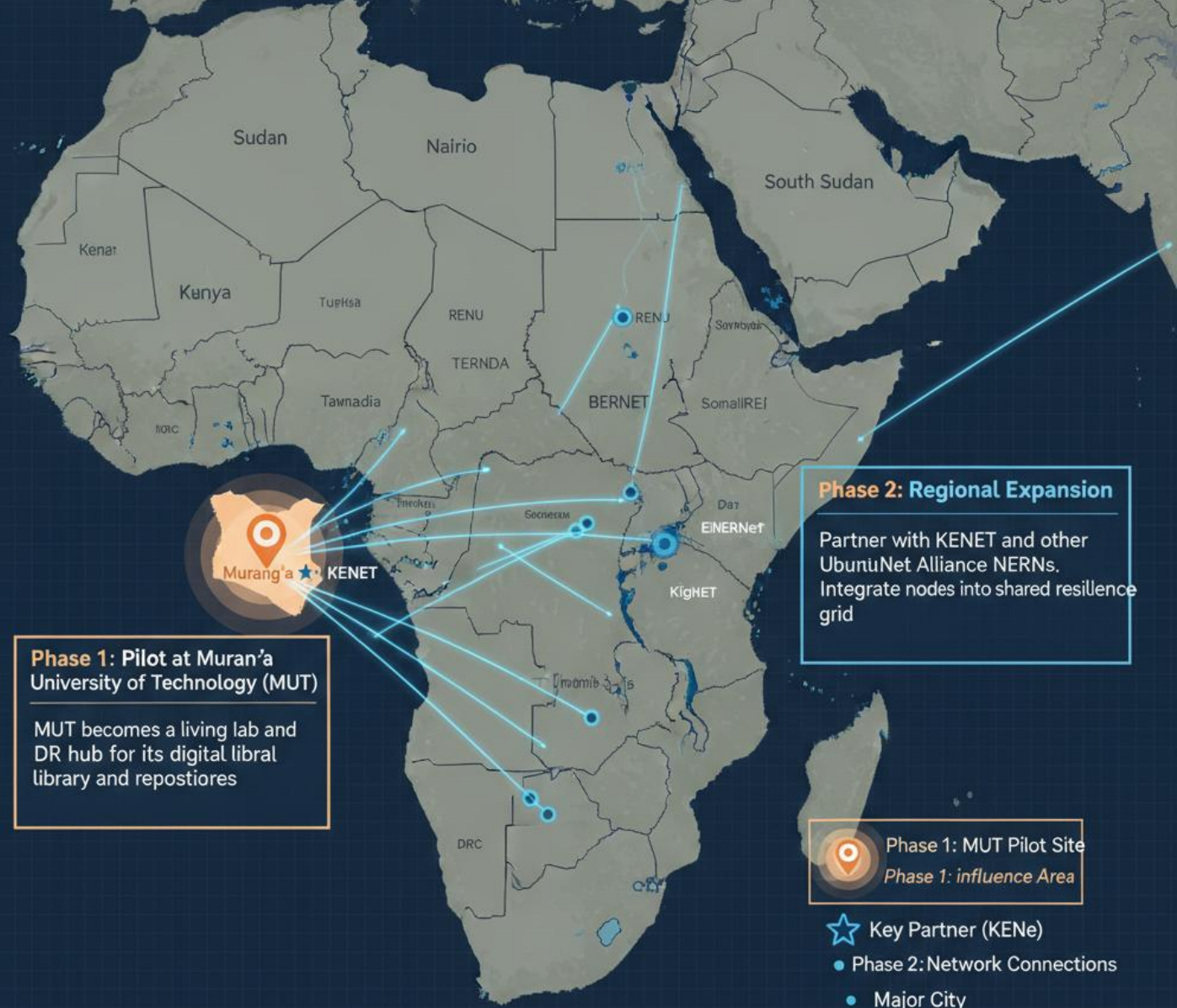
Phase 2: Regional Expansion

- Partner with KENET and other UbuntuNet Alliance NRENs.
- Integrate nodes into a **shared resilience grid**.



East Africa Resilience Network Expansion

UbuntuNet Alliance NREN Integration



Phase 1: Pilot at Murang'a University of Technology (MUT)
MUT becomes a living lab and DR hub for its digital library and repositories

Phase 2: Regional Expansion
Partner with KENET and other UbuntuNet Alliance NRENs. Integrate nodes into shared resilience grid

Phase 1: MUT Pilot Site
Phase 1: influence Area

- ★ Key Partner (KENE)
- Phase 2: Network Connections
- Major City

Expected Impact & Benefits

- ❑ **Operational:** Near-instant failover; uninterrupted e-learning/research.
- ❑ **Economic:** ~50% reduction in recovery costs.



99.9% Uptime

Reliable, continuous service ensuring your systems are always running



Cost Reduction

Optimized solutions that save money while maintaining quality

Expected Impact & Benefits

❑ Social: Enhanced community digital literacy; local skill development.

❑ Environmental: 100% renewable energy usage; net-positive environmental impact.

❑ Strategic: Transforms Disaster Recovery from a cost center into a catalyst for community development.



Community Impact

Building stronger connections and empowering local communities



Environmental Care

Sustainable practices protecting our planet for future generations

The Investment Case: High-Level Budgetary Implications

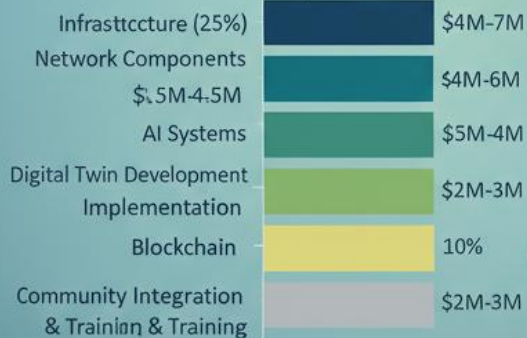
INVESTMENT OVERVIEW AI-Driven Eco-Resilience Framework

A strategic financial commitment for enhanced stability, efficiency, and community-welling.



- Key Value: $\approx 15M$ in 5-year savings, 99.9% Uptime, Carbon Neutrality

BUDGET ALLOCATION BREAKDOWN (25% \$5M-7M)



IMPLEMENTATION PHASES & COSTS



RETURN ON INVESTMENT

Projected Cost Savings



- Reduced Downtime: 90%
- Energy Savings: 40%
- Maintenance Cost Reduction: 30%
- Disaster Recovery Avoidance: \$8M+

KEY BENEFITS WORTH THE INVESTMENT



99.9% Uptime
Improvement Cost
Reduction



30%
Communities
& Training



Carbon-Neutral
& Resilient
Future

*Estimates are high-level and subject to detailed analysis









- ❑ **Note:** These are high-level estimates. A detailed feasibility study will refine these figures.
- ❑ **ROI:** The ROI is not just financial; it's in **sustained education, groundbreaking research, and resilient digital economies.**

AI-Driven Eco-Resilience Framework: Budget Breakdown

Investment for a Sustainable Future

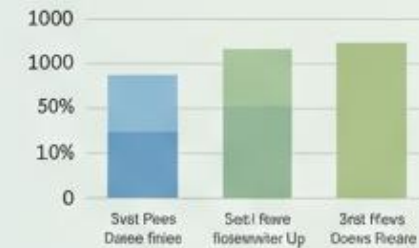
Pilot Phase
(MUT Hub & 5 Nodes)

Regional Scale-Up
(10 Hubs, 50+ Nodes)

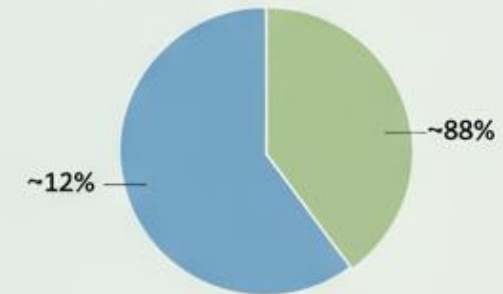
| Budget Components | | Pilot Phase (\$) | Regional Scale-Up (\$) | Justification |
|---|--------------------------------|---|--|--|
|  | Solar Edge Nodes & Micro-Grids | 250,000 | Solar panels, batteries, edge servers, installation | 2,000,000-3,000,000 installation |
|  | Mesh Networking (LoRAWAN) |  | Gateways, nodes deployment | 1,000,000 |
|  | AI/ML & Digital Twin Platform | 150,000 |  | Software licenses, development |
|  | Capacity Building & Training | 500,000 | Curriculum development, community programs | Curriculum development, community programs |
|  | Project Management & M&E |  | Ensures delivery, monitoring and reporting | Ensures delivery, monitoring and reporting |

TOTAL ESTIMATE ~600,000

Component Cost Comparison

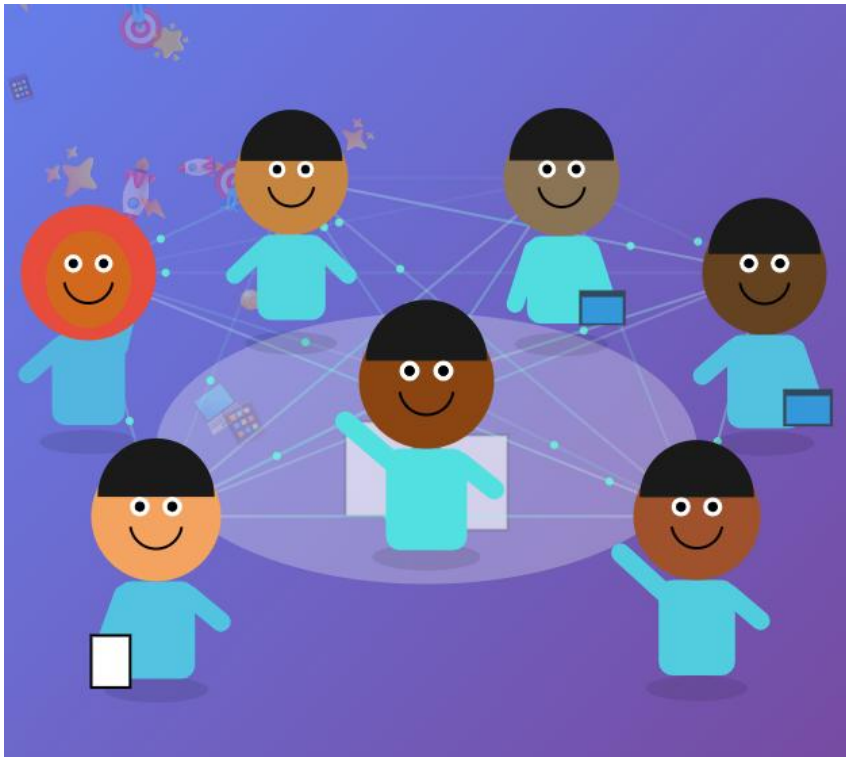


Component Cost Comparison



Phase Cost Distribution

A Call for Partnership & Investment



- ❑ This is not just a technical project; it's a strategic investment in East Africa's future.
- ❑ **We seek for partners who believe in this vision:**
 - **Financiers & Impact Investors:** For blended finance models (grants, equity, debt).
 - **Technology Partners:** For in-kind support and expertise.
 - **Government & Policy Makers:** To create an enabling environment and co-invest.
 - **Regional NRENs (KENET, UbuntuNet):** For collaboration and scaling.
- ❑ **Our Offer:** A scalable, replicable blueprint for resilient and eco-friendly RENS across developing regions.

Conclusion & Call to Action

- ❑ The Challenge is immense, but so is our opportunity to leapfrog to a sustainable and resilient digital future.
- ❑ Our AI-Driven Eco-Resilience Framework provides a concrete, holistic pathway.
- ❑ The pilot at MUT is ready to serve as **proof-of-concept** and a beacon for the region.

"Let us not just recover from disasters; let us build systems so intelligent and so rooted in our communities and environment that they anticipate and adapt to them. Let us invest not just in infrastructure, but in a resilient digital future for East Africa."



Let us Build This Future Together.

Thank you

Dr. Stephen Kahara Wanjau, PhD

+254 740910882

skahara@mut.ac.ke

steve.kahara@gmail.com

**UbuntuNet
CONNECT 2025**

Harare, Zimbabwe
30 - 31 October 2025

Resilient and
Sustainable Research
& Education Networks
for the Future