SDG BLOCKCHAIN ACCELERATOR

Prototype (PoC) Report

1. Project Information

- **Project Name:** AegisGrid: using blockchain to address Tanzania's electricity losses
- **Challenge & UNDP Office:** UNDP Tanzania – Frequent energy theft, poor billing transparency, and limited integration of renewable energy into national utility systems
- **Document Version:** 1

2. Project Overview

Background: TANESCO, Tanzania's national electricity utility, faces over 14% losses from meter tampering, billing errors, low consumer trust, and lack of real-time monitoring. Its centralized billing system is vulnerable to manipulation, affecting revenue and planning.

The **proposed solution** is to use blockchain with smart meters or mobile billing to securely record consumption data, reduce fraud, and boost trust. This could also enable future innovations like peer-to-peer energy trading and integration with decentralized renewables

3. Repository Structure

```
/prototype
  /scripts        → Database scripts for initial DB
  /src
    /api          → Endpoint to interact with frontend
    /blockchain   → Blockfrost API client for Cardano blockchain interactions
    /database     → Basic database connection and table mapping.
    /services     → Consumption-related business logic and database operations.
    /tokens       → Wallet operations for Cardano tokenization. Orchestration of
energy reading tokenization.
    /utils   Date and time utility functions.
```

4. Build Instructions

Frontend (React)

```
# Install dependencies
npm install

# Build production code
npm run build
```

Backend (Python)

```
# Install UV
pip install uv

# UV Synchronization
uv sync

# Install required components
uv pip install -e .

# Create configuration file from template and edit
cp .env.example .env
vi .env

# Startup Uvicorn (set host and port as prefer)
uvicorn src.main:app --host 0.0.0.0 --port 7778
```

5. Test Instructions

No automated tests were implemented as part of this PoC

6. Deployment Instructions

```
python scripts/tokenize_cli.py setup
```

7. Testnet / Emulator Results

All Cardano Preview transactions can be found in wallet
addr_test1vz3dfpcaxs384dtgvm6r7rgww3ypq9mu6sat363mhuha4qgugf5vu

8. Dependencies & Environment

- *Python 3.10 – Core language used for scripts, orchestration, and application logic.*
- *Uvicorn 0.24.0 – ASGI server for running the API.*
- *PyCardano – Library for building, signing, and submitting Cardano transactions.*

- *Blockfrost API (via BlockFrostChainContext) – Interface for blockchain queries and transaction submission.*
- *Cardano-node (Preview Testnet) – Provides network connectivity and transaction propagation.*
- *Logging (Python standard library) – Used for monitoring, debugging, and audit trails.*
- *PostgreSQL – Database for storing readings and tokenization records.*

9. Demo / Walkthrough

- https://www.youtube.com/watch?v=SjiWvvYmXAs

10. Remaining Issues / Next Steps

Analyze generation of data

The next step in expanding the analysis is to integrate generation data alongside consumption data to create a full view of the energy flow. This requires consolidating data sources from production sites, consumption points, and transmission infrastructure into a unified model. By mapping generation outputs against consumption patterns, we can identify imbalances and trace where losses may be occurring, whether in transmission, distribution, or at the point of use. This approach will also involve developing metrics to quantify inefficiencies and applying analytics or visualization tools to highlight critical loss areas. Once this framework is established, it will enable targeted interventions to reduce waste, optimize operations, and improve overall system reliability.

Expand to other electricity consumers

Expand the prototype beyond its initial scope by incorporating additional categories of electricity consumers, enabling a more representative and realistic picture of demand. In parallel, the minimum viable product (MVP) should be designed to scale up and integrate the full ecosystem of the country's electricity sector—covering all registered generators, transmission infrastructure, and consumer groups. This broader integration will provide a comprehensive baseline for system-wide analysis, ensuring that both supply and demand dynamics are accurately captured. By doing so, the MVP will not only validate the prototype's approach but also lay the foundation for more advanced features such as predictive modeling, optimization of energy flows, and policy or investment scenario testing.