Swarm-E

NEWSLETTER

Issue 4

From Modelling to Real-World Deployment

Entering the deployment phase

SWARM-E project has successfully transitioned from **conceptual design and data collection** into a phase of **validated system modelling, site readiness, and implementation planning**.

The project has built a uniquely robust evidence base—combining **high-resolution field data, advanced modelling tools, and socio-economic insights**—to ensure that upcoming pilot deployments are technically sound, financially viable, and socially inclusive.

The next phase will mark a major step forward: **bringing SWARM grids to life in real communities.**

Data-driven system design: a unique evidence base

A defining achievement of SWARM-E is the depth and quality of its empirical data collection, which underpins all technical and business decisions.

Extensive Field Data Collection

Across Rwanda and Tanzania, the project collected and validated:

- Data from 600+ households, MSMEs, and public institutions
- Detailed insights on:
    - Energy consumption patterns
    - Income levels and expenditure
    - Willingness to pay
    - Productive use activities

This dataset goes far beyond typical mini-grid planning inputs, enabling granular system optimisation.

Behavioural load modelling

Using the **RAMP (Remote Area Multi-energy systems load Profiles)** tool, SWARM-E developed:

- High-resolution bottom-up demand profiles
- Time-of-use patterns reflecting real behaviour
- Scenario-based demand projections

In addition:

- Energy personas and clustering models were created
- These allow system configurations to be tailored to specific user archetypes, rather than generic averages

Result: **Highly realistic demand modelling**, reducing investment risk and improving system sizing accuracy.

SWARM grid architecture: integrated and flexible

The project has fully defined and validated the SWARM grid concept, which integrates multiple components into a single system:

Core Components

- AC mini-grid infrastructure
- Solar PV generation
- Battery energy storage
- Smart metering and control systems

Innovative Layer: P2P Energy Trading

A key differentiator is the inclusion of:

- **Peer-to-peer (P2P) energy trading mechanisms**
- Enabling:
    - Local energy markets
    - Increased system efficiency
    - User empowerment

Sector coupling

SWARM grids are designed to go beyond electrification:

- Water (pumping, purification, kiosks)
- Agriculture (irrigation, processing)
- Cooling (cold storage for food/medicine)
- Mobility (e-mobility solutions)
- Clean cooking (including hydrogen pathways)

Result: A **multi-service energy ecosystem**, not just a mini-grid.

Pilot sites: from selection to readiness

All pilot sites have now been:

- **Selected**
- **Surveyed**

● **Technically and socio-economically characterised**

What This Includes

● Load demand assessments
● Resource availability (solar, water, etc.)
● Infrastructure mapping
● Community structure analysis
● Productive use potential

A **control site** has also been defined to support comparative analysis.

Key Outcome

Each site now has:

● A **tailored system design**
● A **preliminary deployment plan**
● Defined **use-case portfolios**

This ensures that deployment is **context-specific rather than one-size-fits-all**.

Productive use of energy (PUE): unlocking local economies

A major focus of SWARM-E is ensuring that energy access translates into **economic development.**

Identified PUE Applications

The project has assessed and modelled multiple applications:

- Water kiosks and purification systems
- Milling and agro-processing
- Refrigeration and cold storage

- Small-scale commercial activities
- E-mobility solutions
- Hydrogen-based applications for clean cooking

Integrated Planning

Each PUE is:

- Linked to **local demand and economic context**
- Integrated into system sizing and revenue modelling

Result: Energy systems that **generate income, not just provide access.**

Business models and financial engineering

SWARM-E has developed **comprehensive financial models** to ensure long-term sustainability.

Key Elements

- CAPEX and OPEX modelling for hybrid systems
- Tariff structures aligned with:
    - Affordability
    - Willingness to pay
- Revenue projections from:
    - Household consumption
    - PUE services

Investment Readiness

The project also:

- Evaluates **bankability**
- Identifies **investment gaps and financing strategies**

Outcome: A framework for **scalable and replicable business models.**

Community engagement and governance

SWARM-E places strong emphasis on **local ownership and inclusivity.**

Progress Achieved

- Stakeholder mapping completed for all sites
- Community engagement strategies implemented
- Workshops conducted with:
    - Local authorities
    - Entrepreneurs
    - End-users

Governance structures

The project is developing:

- Community-level governance models
- Mechanisms for:
    - Participation
    - Decision-making
    - Conflict resolution

This ensures that SWARM grids are **socially embedded and accepted**.

Regulatory and policy frameworks

Operating in two national contexts, SWARM-E has conducted:

- **Regulatory mapping in Rwanda and Tanzania**
- Identification of:
    - Barriers to P2P trading
    - Licensing constraints
    - Tariff regulations

Policy Engagement

Operating in two national contexts, SWARM-E has conducted:

- Dialogue with national stakeholders
- Contribution to discussions on:
    - Mini-grid frameworks
    - Clean cooking strategies

Result: Clear pathways for **compliant and scalable deployment.**

Dissemination and outreach

SWARM-E has exceeded expectations in communication and outreach.

Key Figures

- **25+ events** (target significantly exceeded)
- Workshops and stakeholder events in Africa
- Strong digital growth:
    - Website traffic
    - Social media engagement

Strategic Positioning

- Active role in WEFE Cluster discussions
- Collaboration with sister projects (e.g. SUNNY)
- Contribution to EU-Africa energy dialogue

The project is now recognised as a **reference initiative in decentralised energy systems**.

Scientific and technical outputs

SWARM-E is contributing to advancing knowledge in:

- Hybrid decentralised systems
- Behavioural energy modelling
- Energy-access-driven development

Publications

- Two scientific papers under preparation/review
- Additional outputs planned in upcoming phases

Challenges and mitigation

While progress is strong, some challenges have emerged:

- Regulatory delays
- Logistical constraints in pilot regions
- Coordination complexities across sites

Response

- Adaptive planning
- Strengthened local engagement
- Adjusted timelines

All pilot sites remain on track for **deployment readiness by Month 24**.

What Comes Next

The next 6 months will focus on:

- System installation and commissioning
- Integration of PUE services
- Testing of P2P trading mechanisms
- Monitoring socio-economic impacts

This phase will transform SWARM-E from a **design framework into a living system.**

The bigger picture

SWARM-E is building a **replicable blueprint** for:

- Decentralised electrification
- Rural economic development
- Climate-resilient infrastructure

By combining:

- Technology
- Community engagement
- Financial viability

...the project is paving the way for **scalable energy ecosystems across Sub-Saharan Africa**.

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