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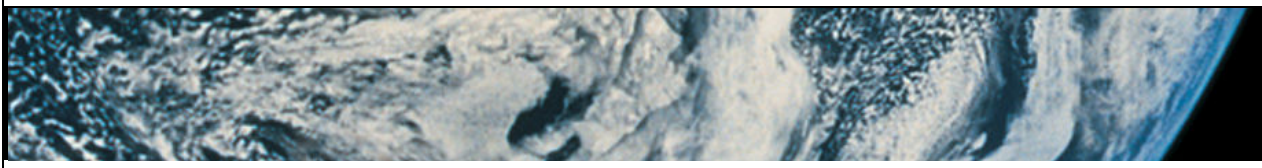
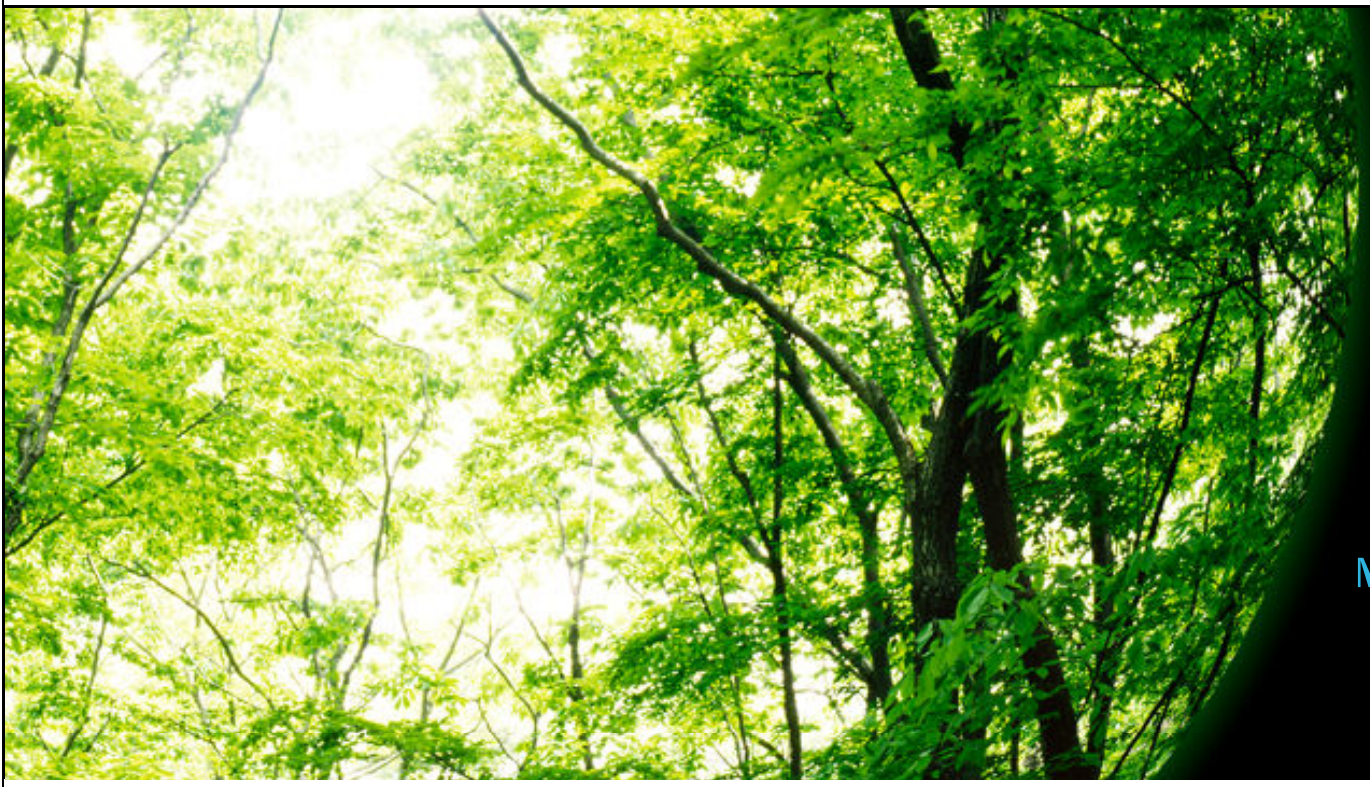


Maizakiah Ayu Abdullah
Engineering Systems and Management,
Masdar Institute of Science and Technology

AN OBJECTIVES ANALYSIS FOR IMPROVED HOLISTIC DESIGN OF A RURAL ELECTRIFICATION SYSTEM



Adrian 'Banie' Lasimbang

Irene Kodoyou

Johan Sipail

TONIBUNG

The community of Buayan Village in Sabah, Malaysia

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AN OBJECTIVES ANALYSIS FOR IMPROVED HOLISTIC DESIGN OF A RURAL ELECTRIFICATION SYSTEM

- Introduction
- The Human Development Capability Approach
- Motivation
- Expansion of System Boundary
- Research Objectives
- Case Study
- Objectives Analysis
- Participation in the Design Phase
- Conclusion

AN OBJECTIVES ANALYSIS FOR IMPROVED HOLISTIC DESIGN OF A RURAL ELECTRIFICATION SYSTEM

- **Capabilities** are defined as **opportunities** or the abilities one has to pursue **being or doing** what one **values** (or has reason to value)

> "The purpose of development is to enhance people's capabilities in the present and in the future, in all areas of their life – economic, social, political, and cultural"[1]

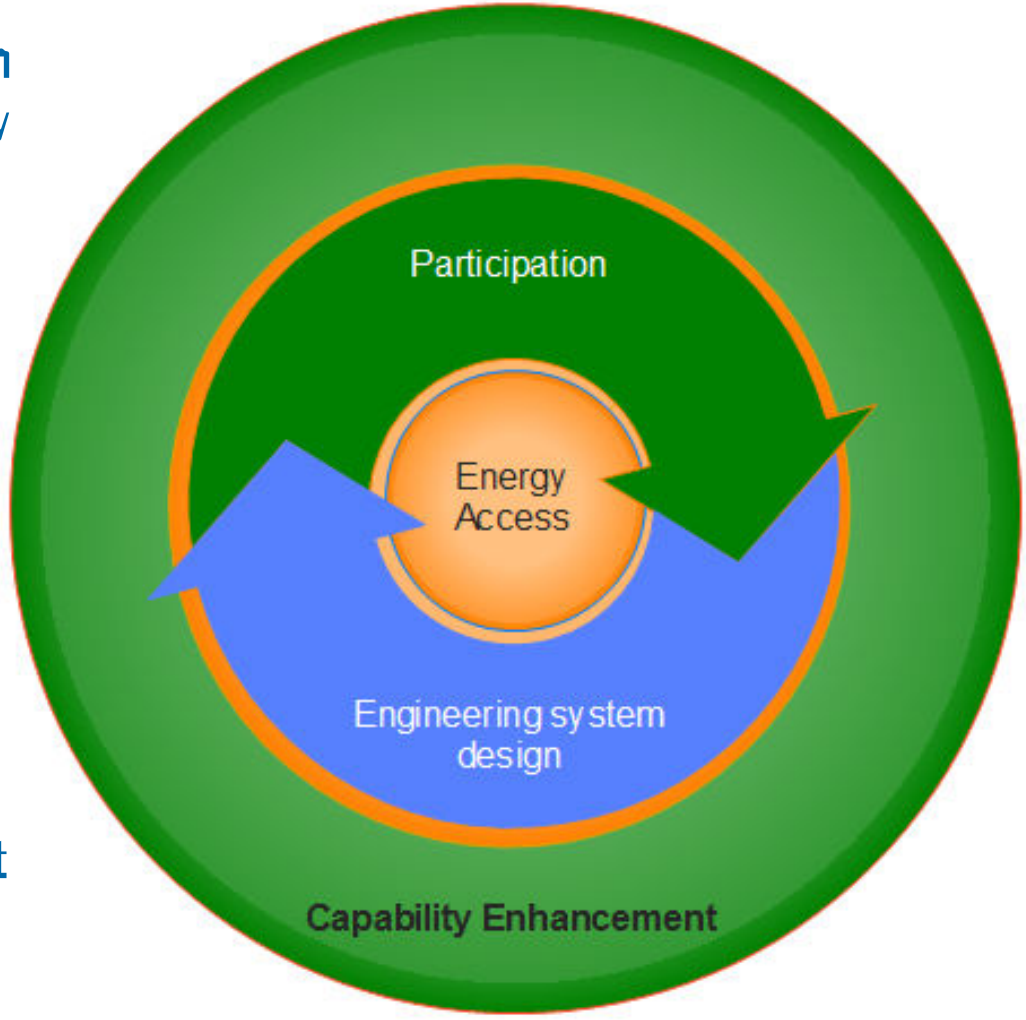
This approach focuses on:

- Expanding and enhancing people's choices
- Creating or ensuring the opportunity to define and practice those choices

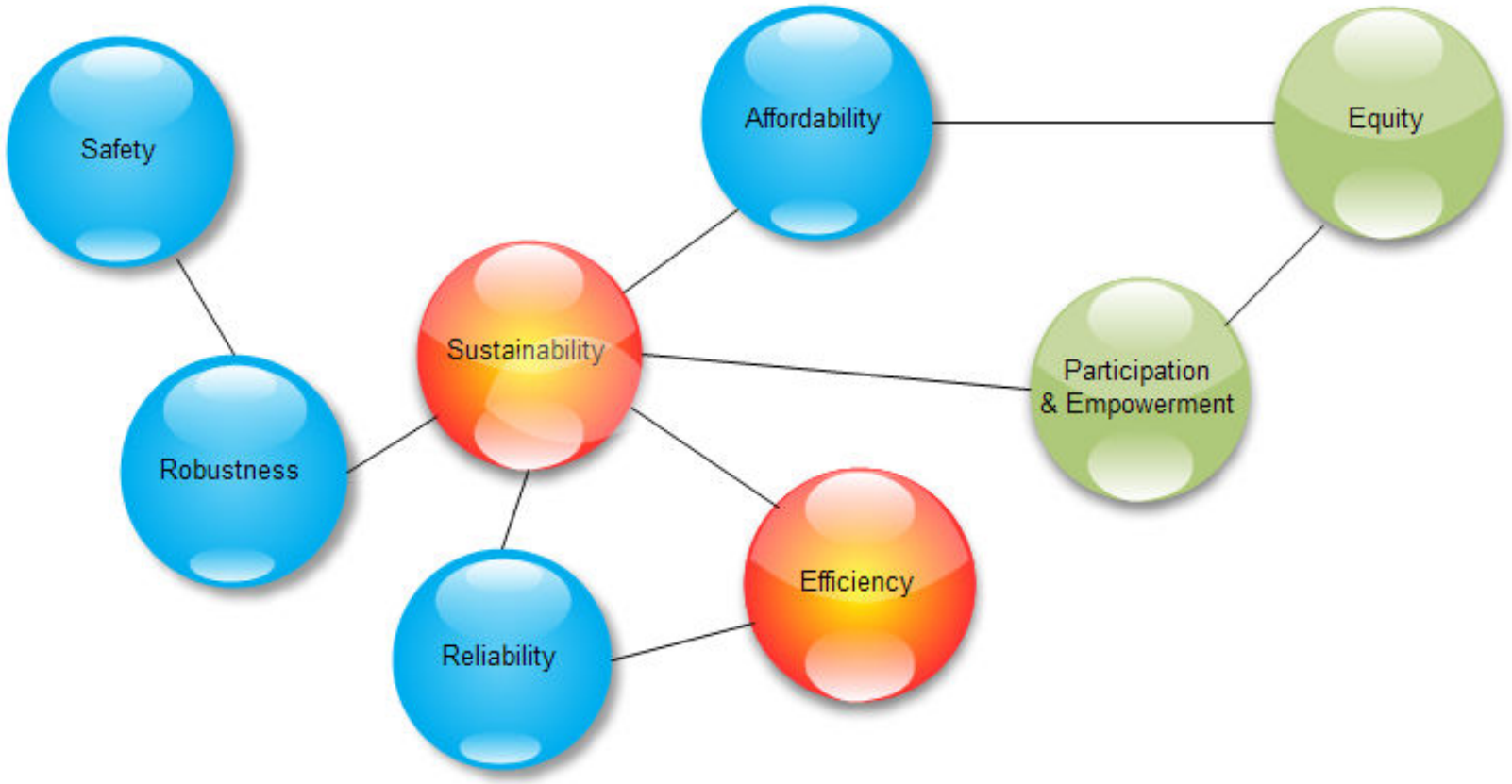
[1] Deneulin, Séverine, and Lila Shahani, *An Introduction to the Human Development and Capability Approach: Freedom and Agency* (Earthscan, 2009)

AN OBJECTIVES ANALYSIS FOR IMPROVED HOLISTIC DESIGN OF A RURAL ELECTRIFICATION SYSTEM

- Enhance **capabilities** of community **through** design, planning and implementing electricity access
- Ensure **participation** of community in their energy access system and this participation needs to be incorporated into the **early stages** of design
- Main motivations:
  - A better understanding of end user requirements
  - Participation as an instrument to achieve high-level goals of capability enhancement



Expand engineering system properties (illities) to include human capability-related properties



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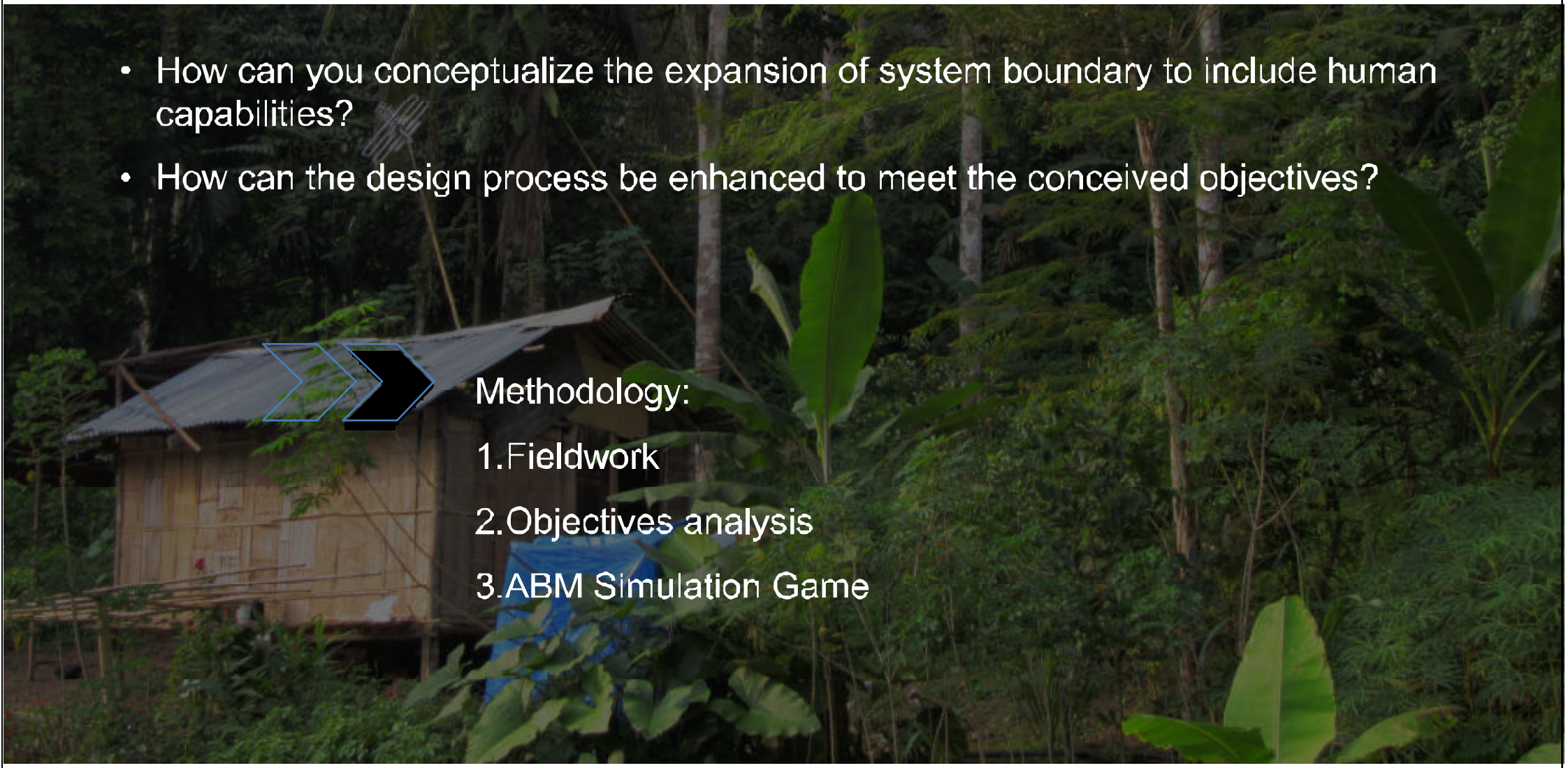
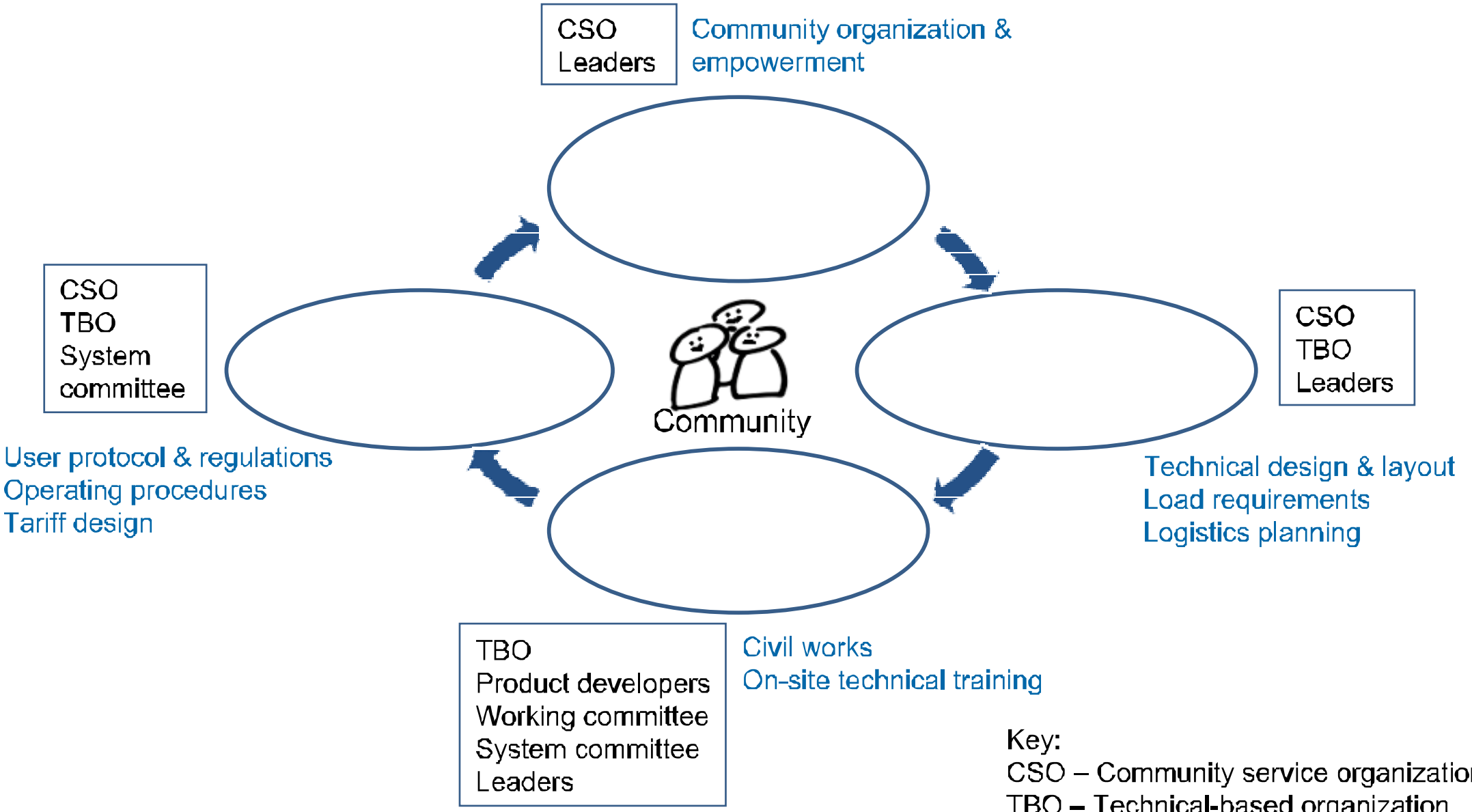


- How can you conceptualize the expansion of system boundary to include human capabilities?
- How can the design process be enhanced to meet the conceived objectives?

Methodology:

1. Fieldwork
2. Objectives analysis
3. ABM Simulation Game

AN OBJECTIVES ANALYSIS FOR IMPROVED HOLISTIC DESIGN OF A RURAL ELECTRIFICATION SYSTEM

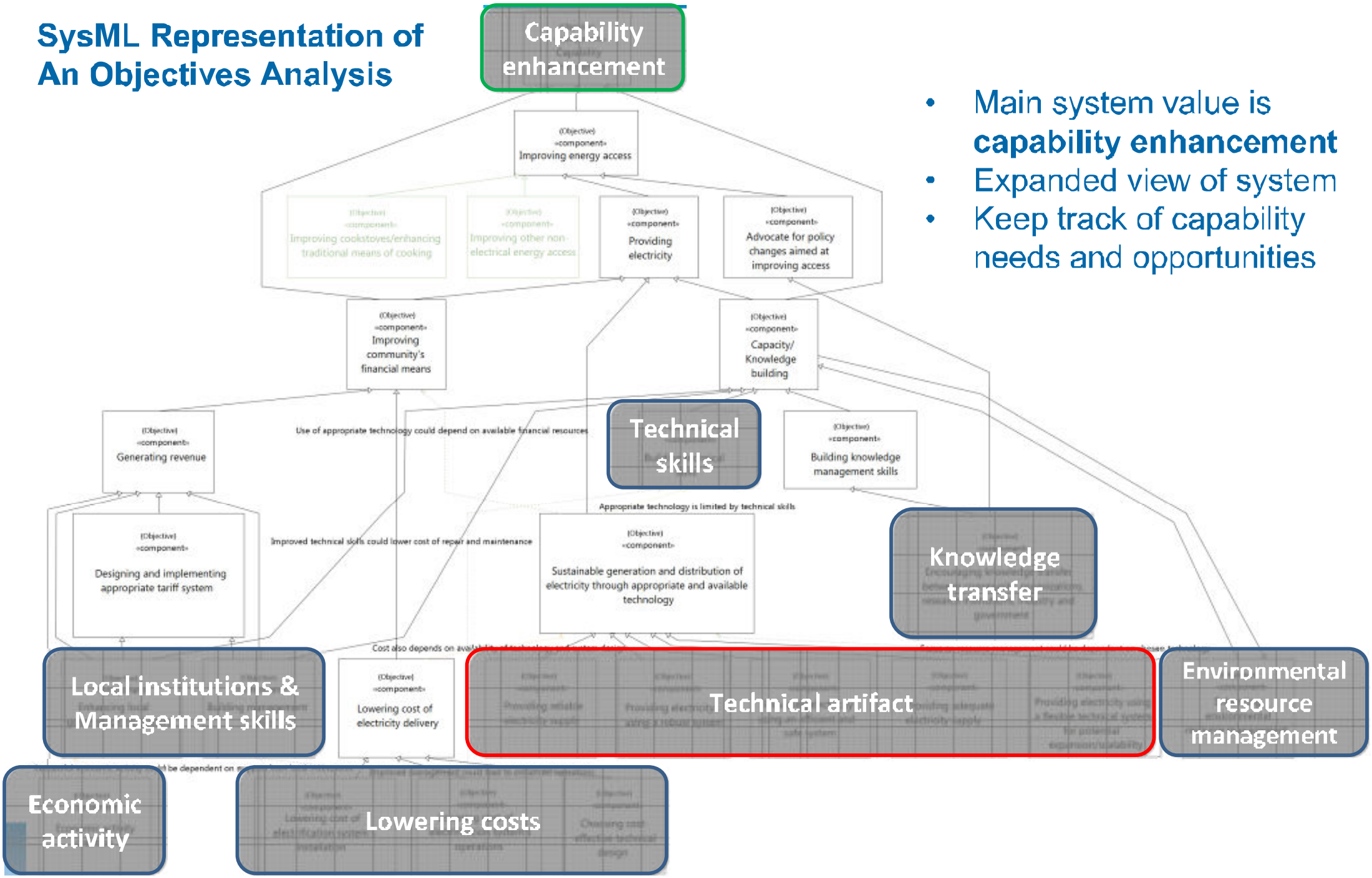


AN OBJECTIVES ANALYSIS FOR IMPROVED HOLISTIC DESIGN OF A RURAL ELECTRIFICATION SYSTEM

- Fieldwork conducted to understand rural, community-based, renewable energy micro-grid
- Used a systems engineering objectives analysis[2] to merge human development theory with engineering design process
  1. Objectives analysis begins with Capability Enhancement as the highest-level system objective
  2. System objectives are decomposed into lower-level objectives
  3. Decomposition stops once verifiable objectives have been revealed. Any further decomposition begins to restrict optimal design options

[2] Buede, Dennis M., *The Engineering Design of Systems: Models and Methods*, Systems Engineering and Management, 2nd edn (John Wiley & Sons, 2009)

SysML Representation of An Objectives Analysis



- Main system value is **capability enhancement**
- Expanded view of system
- Keep track of capability needs and opportunities

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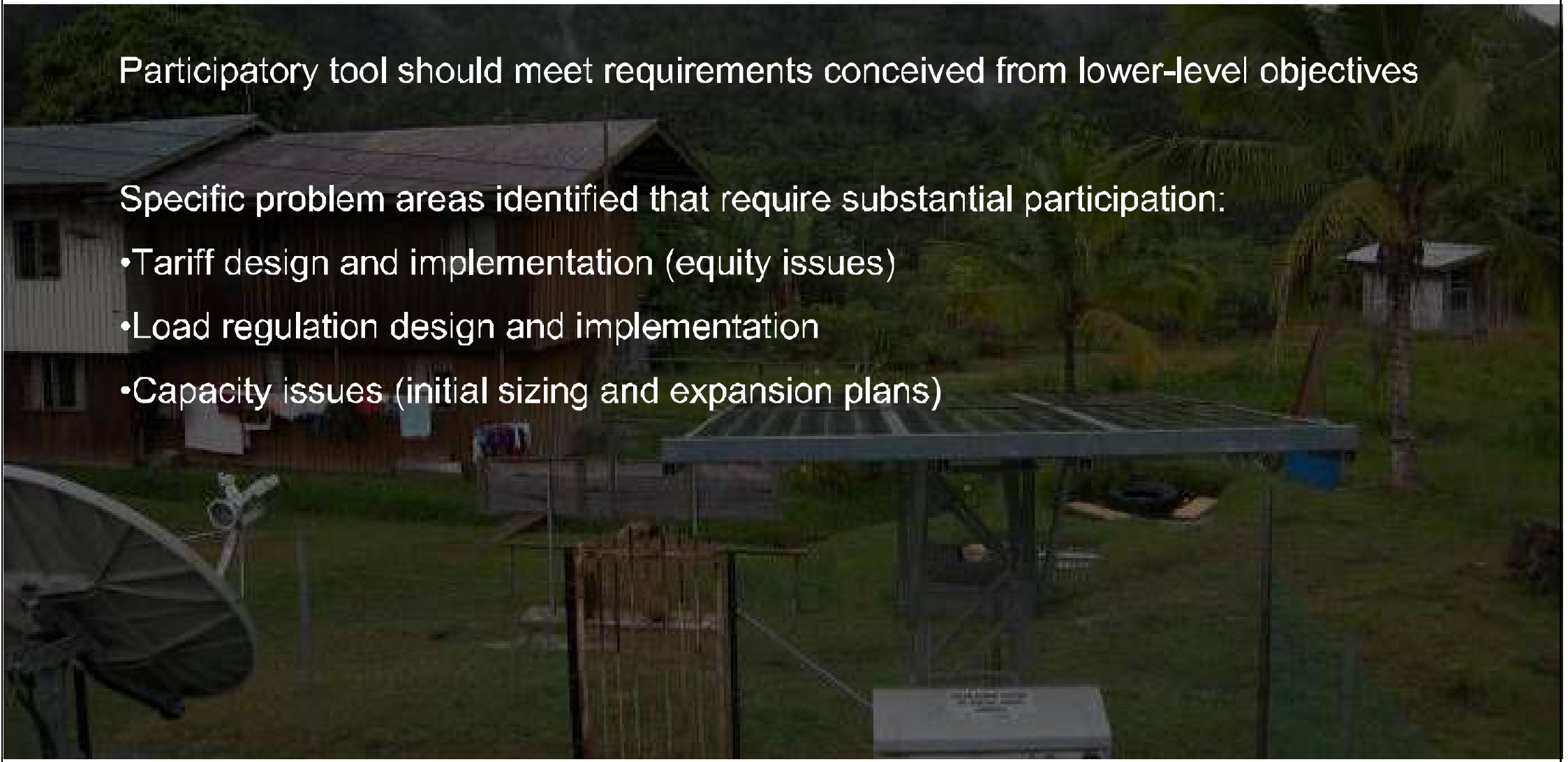
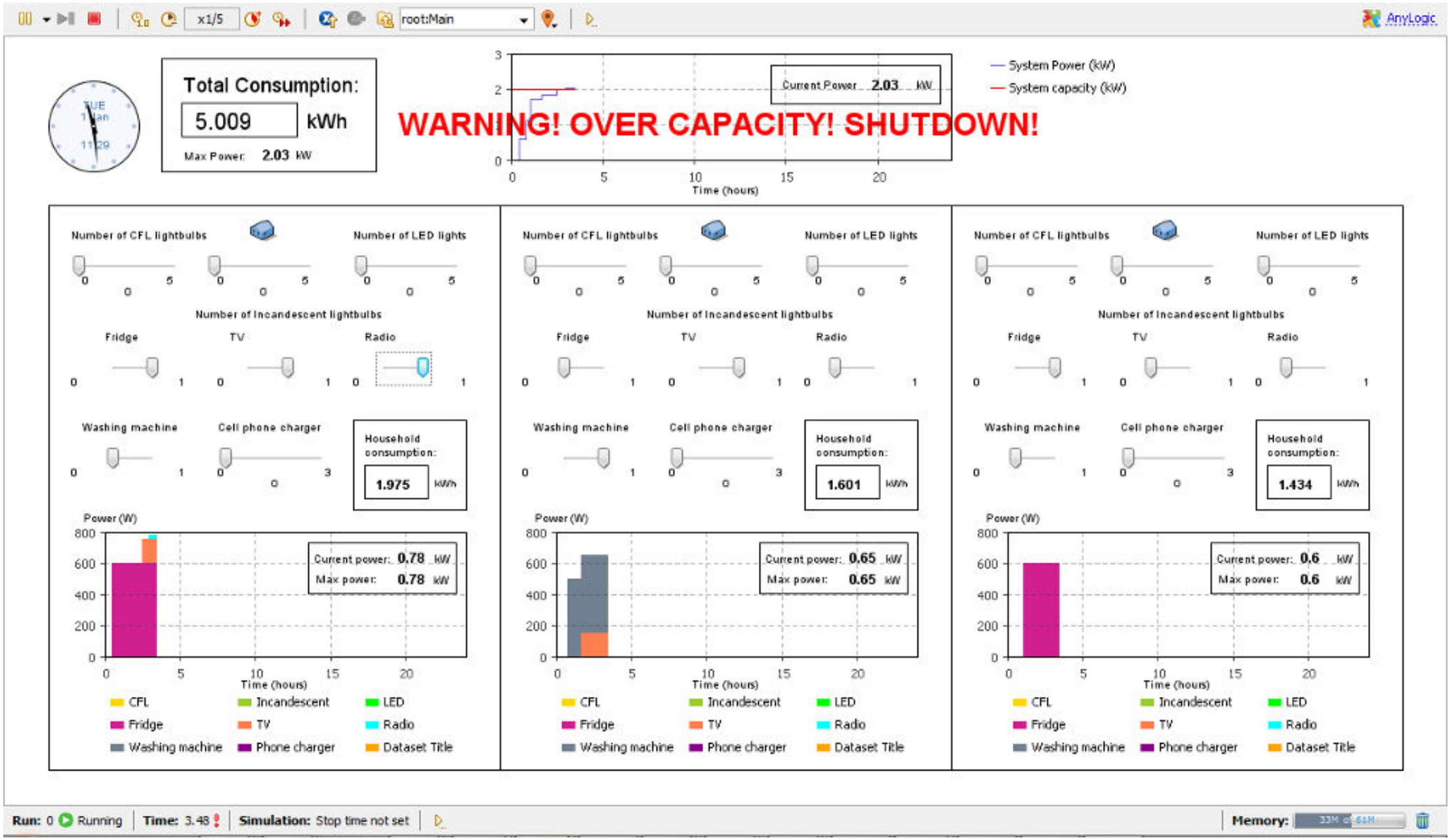


Participatory tool should meet requirements conceived from lower-level objectives

Specific problem areas identified that require substantial participation:

- Tariff design and implementation (equity issues)
- Load regulation design and implementation
- Capacity issues (initial sizing and expansion plans)

ABM Simulation Game



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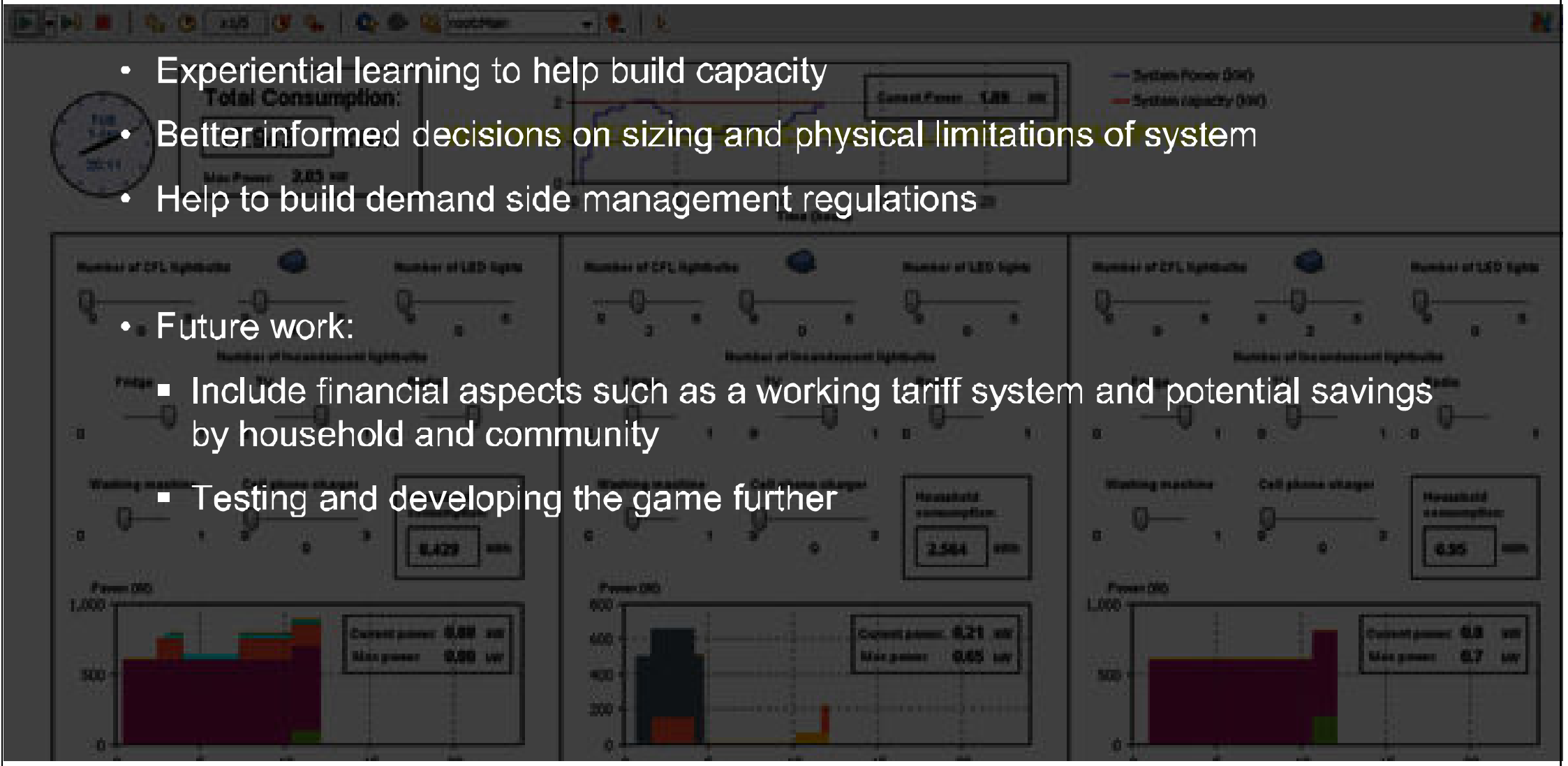

- Experiential learning to help build capacity
- Better informed decisions on sizing and physical limitations of system
- Help to build demand side management regulations
- Future work:
  - Include financial aspects such as a working tariff system and potential savings by household and community
  - Testing and developing the game further

AN OBJECTIVES ANALYSIS FOR IMPROVED HOLISTIC DESIGN OF A RURAL ELECTRIFICATION SYSTEM

- There is a need to incorporate social science perspectives into engineering system approaches. The Capability Approach provides one framework
- The process of planning and delivering energy can also be used as an enabler in delivering human development impacts
- An explicit objectives analysis is useful in providing a representation of an expanded view of a rural electrification system
- Community participation as a means and an ends to capability enhancement