# Technical sustainability of mini-grids: findings from a literature review

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# In this presentation

**MINI-GRIDS**

**MEANING OF TECHNICAL SUSTAINABILITY**

**RESEARCH QUESTIONS**

**REVIEW METHODOLOGY**

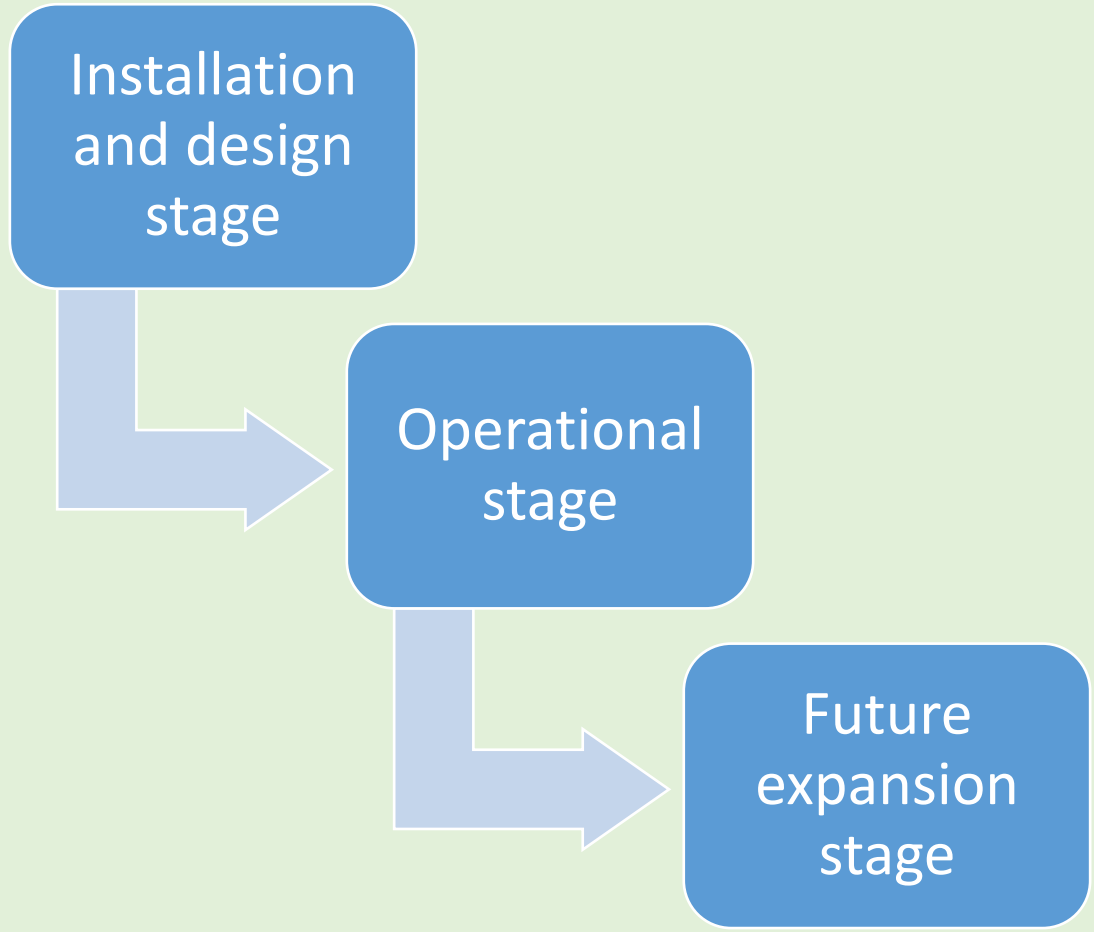
**FINDINGS**

# Mini-grids

- Different definitions
  - A local network:.
  - Local generation/ storage:
  - Local service providers
  - Meeting the needs of local users
- Size
- Technology

# Technical sustainability

- Adequacy: Can the technology provide the service needed at present and in the long-term?
- Availability: Is the resource readily available now and in the long-term?
- Reliability: Is the service reliable and is the quality of supply adequate?
- Safety: Is the supply safe?
- Environmental impact: Is it environmentally benign?
- Economic: Is the technology cost-effective?



# Research questions

Q1: Do pre-operational choices or considerations affect / hinder technical sustainability of mini-grids? How?

Q2: What are the main technical sustainability issues encountered by mini-grids at the operational stage?

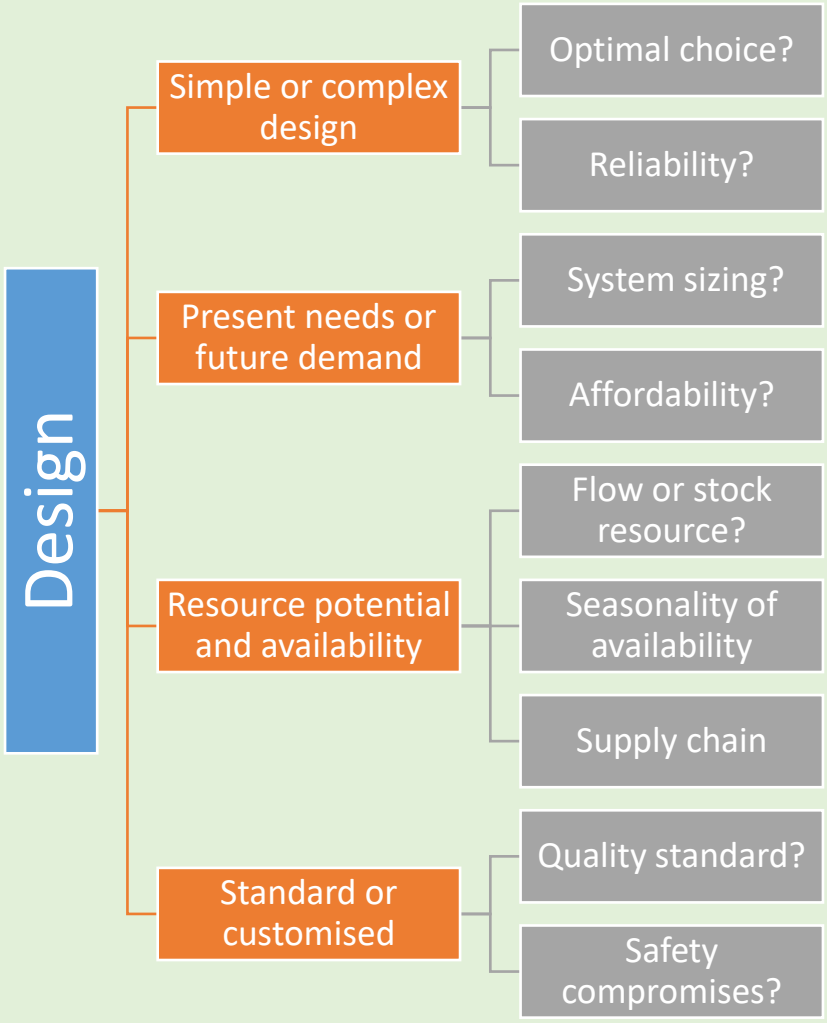
Q3: What sustainability issues do mini-grids face with respect to future expansion?

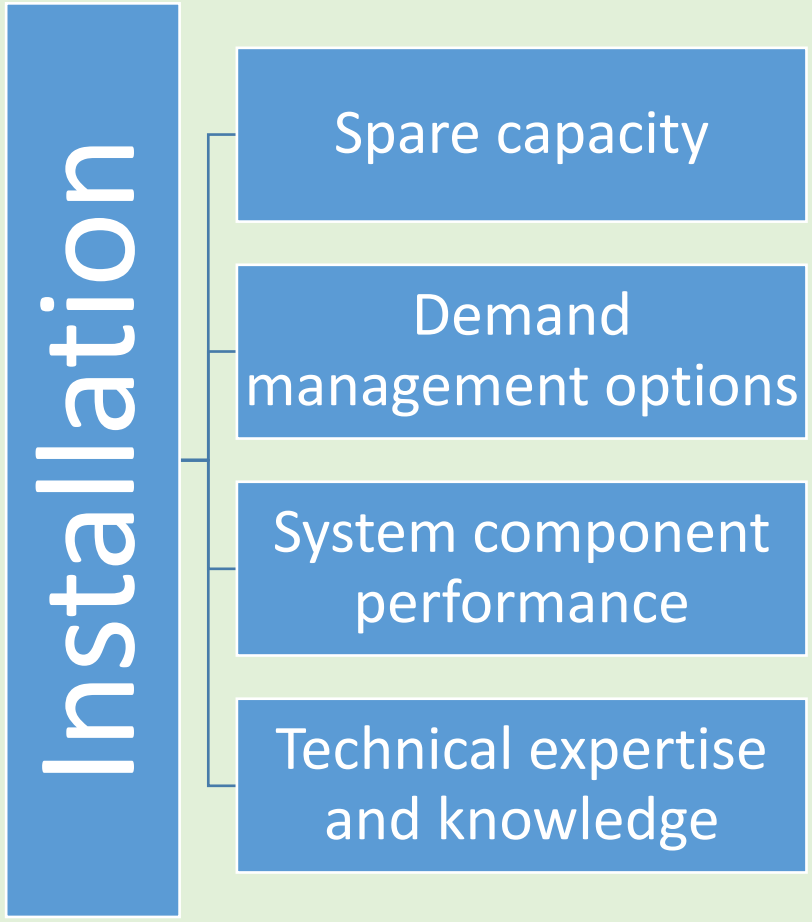
Q4: How is the success or failure of mini-grids linked to their energy resource specificities?

# Review Methodology and scope

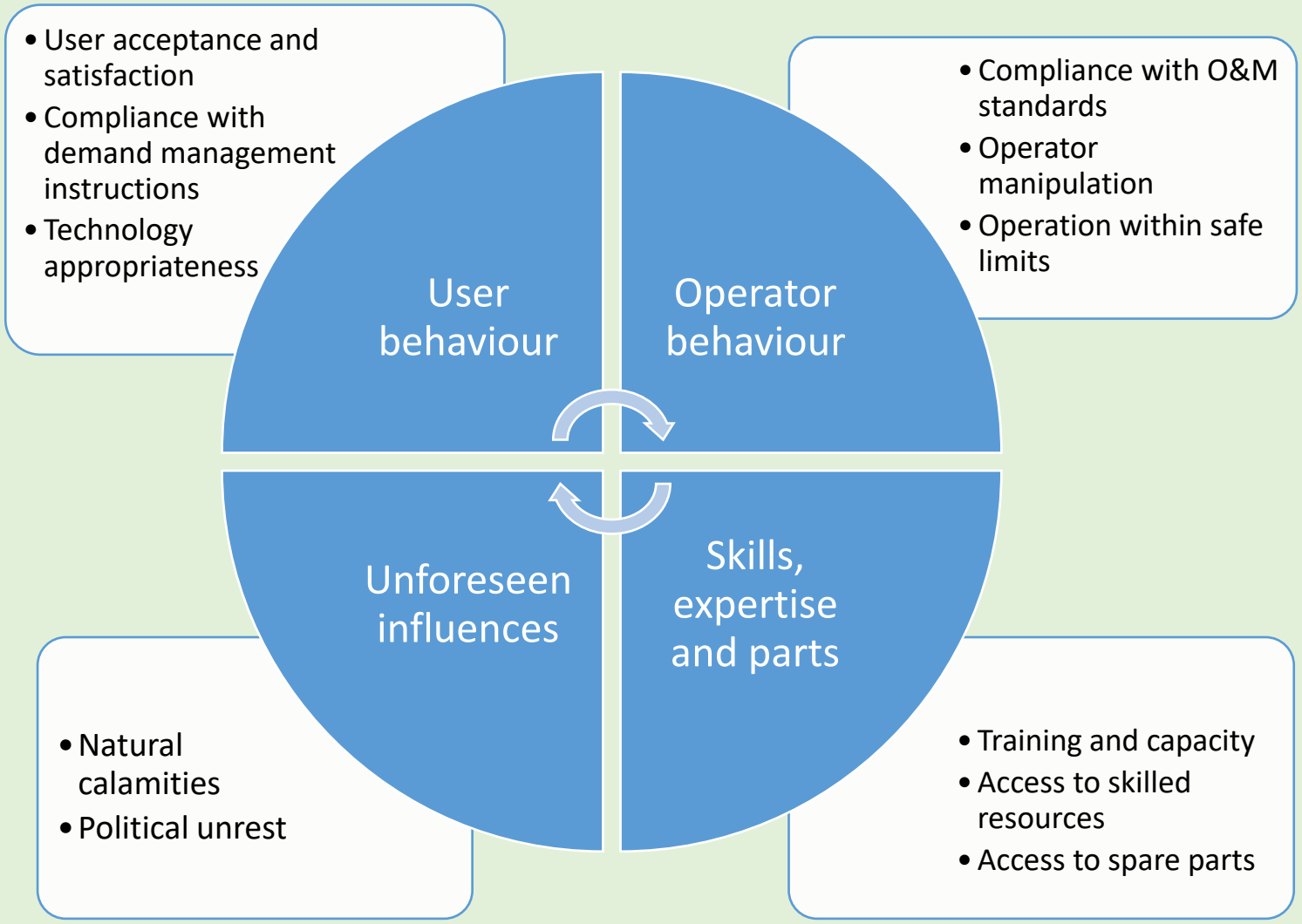
- Methodology
  - Initial database search using pre-defined key words
  - Accessible library databases (Scopus, Springer-Nature, Google Scholar) as well as search engines
  - Relevance check by reviewing abstract and title
  - 84 papers selected for review
  - Analysis using NViVO,
- Scope
  - Publications from 2000 onwards
  - Country coverage – Low and middle-income countries
  - Mini-grid technology: inclusive choice of renewable and non-renewable sources
  - Language: English

# Main findings: Development stage influencers



# Factors affecting the operation stage




Malfunctions in civils works, powerhouse and distribution can all create undesirable power cuts

Presence of strong stakeholders (end-uses) with mechanical and electrical knowledge in the community can attend to operation and maintenance challenges

# Long-term sustainability

overloading of the power plant as demand keeps increasing without supply side improvements, lack of technical expertise to identify and fix problems once they happen

challenges of limited technical and managerial stills, availability of spare parts, uninterrupted supply of feedstock, and genuine technology transfer

grid extensions are a potential threat to solar PV installations

Resource sufficiency

Operability of the installation

Ability to upgrade and expand

Technical skills

Supply chain ecosystem

Grid extension threat

# Effects of resource specificities

## Hydro

- Seasonal availability
- Technology quality issues
- Local skills
- Spare parts issues
- Expansion challenges

## Biomass

- Seasonal supply
- Supply chain challenges
- Technology issues
- Skills and knowledge transfer

## Solar PV

- Day time availability
- Storage needs
- Performance influenced by operating practice
- Easily transferable skills

# Concluding remarks

- Design stage introduces strong path dependence
- Technological alignment with local needs is key to sustainability
- Local skill development and capacity building essential
- Mitigation of possible uncertainties through design and operating practices could improve sustainability
- Scope for further systematic reviews