PCREEE
Pacific Centre for Renewable Energy and Energy Efficiency
SE4ALL Centre of Excellence to Promote Sustainable Energy Markets, Industries and Innovation

UNIDO
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

GN SEC

Unlocking MG for sustainable development

7.1 Mini-grid installation

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MG in Bolivia by TTA


MG in Ethiopia by TTA

CONTENTS

1. SESSION OBJECTIVES

SESSION OBJECTIVES

i) Discuss key aspects for to consider during the installation phase of mini-grids.

ii) Share relevant experiences during mini-grid installation

2. QUALITY IN MINI-GRID INSTALLATION

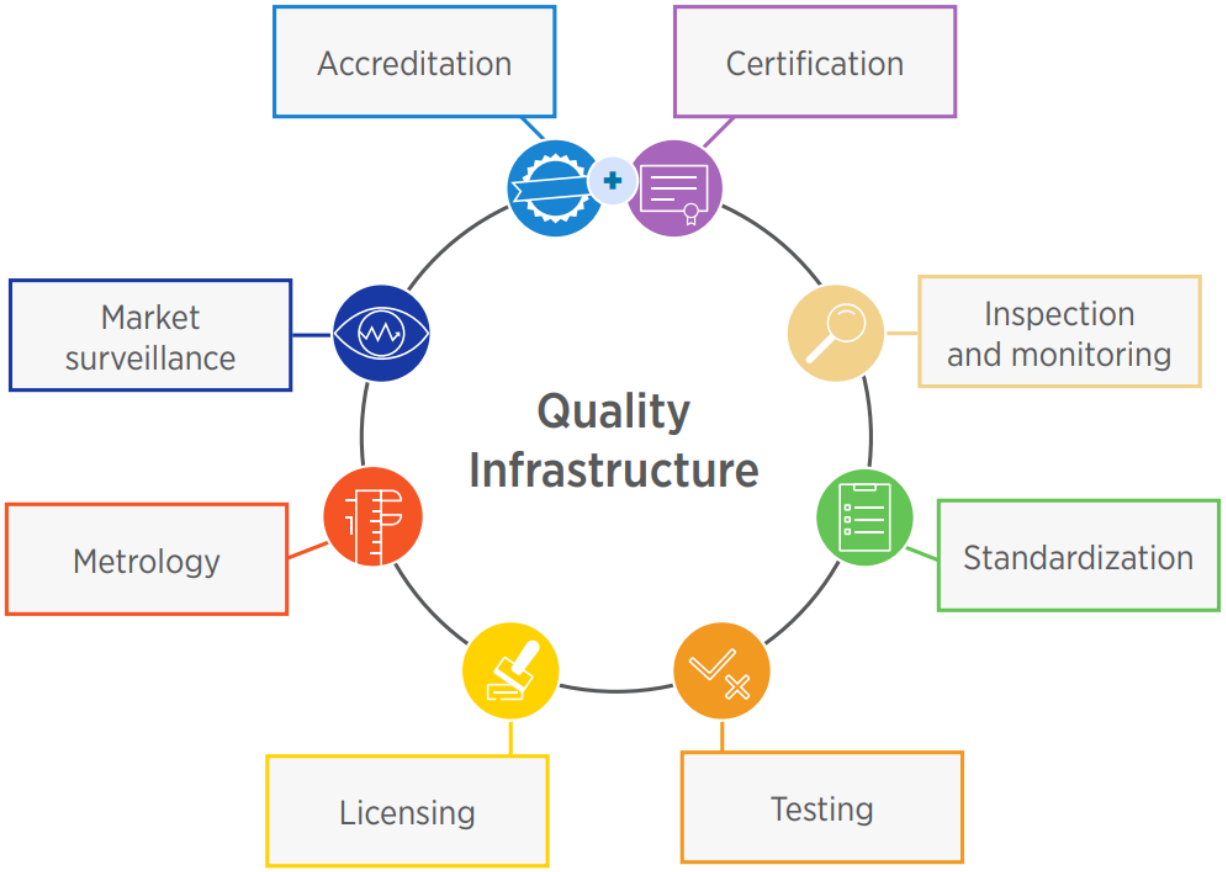
QUALITY INFRASTRUCTURE (QI) IN MINI-GRIDS

With the increasing deployment of mini-grids, it is crucial to look at these systems' performance, durability, and adaptability to new developments.

Mini-grid systems' sustainable market growth and long-term profitability require quality infrastructure (QI).

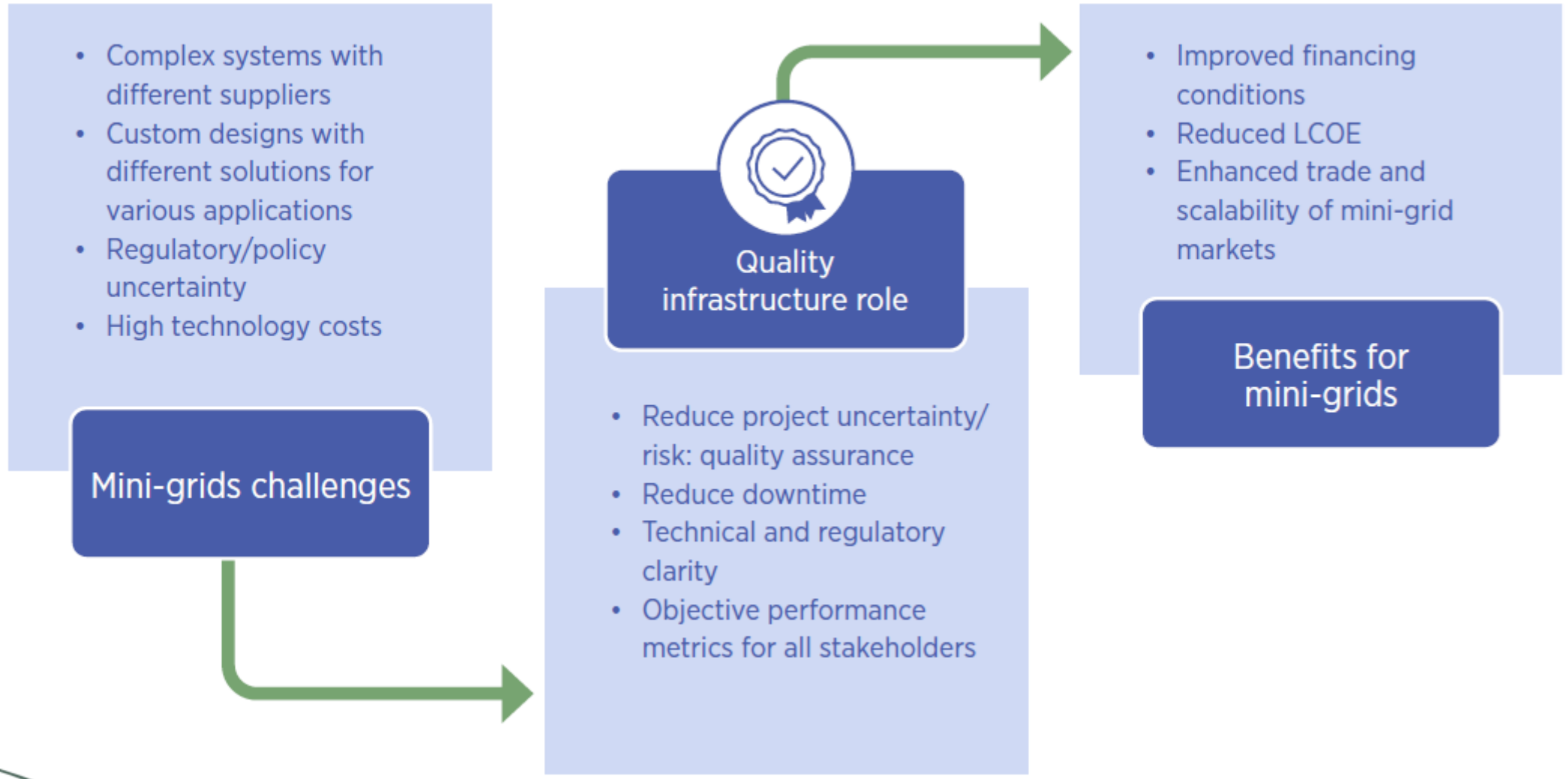
Mini-grids are complex systems with different suppliers, they are developed for different applications, and there is often high regulatory uncertainty regarding their installation and operation.

QI, including comprehensive standards, testing, certification and accreditation, inspection and monitoring, and metrology, **is key to reducing risks**.



SOURCE: IRENA (2020), Quality Infrastructure for Smart Mini-grids

QUALITY INFRASTRUCTURE (QI) IN MINI-GRIDS



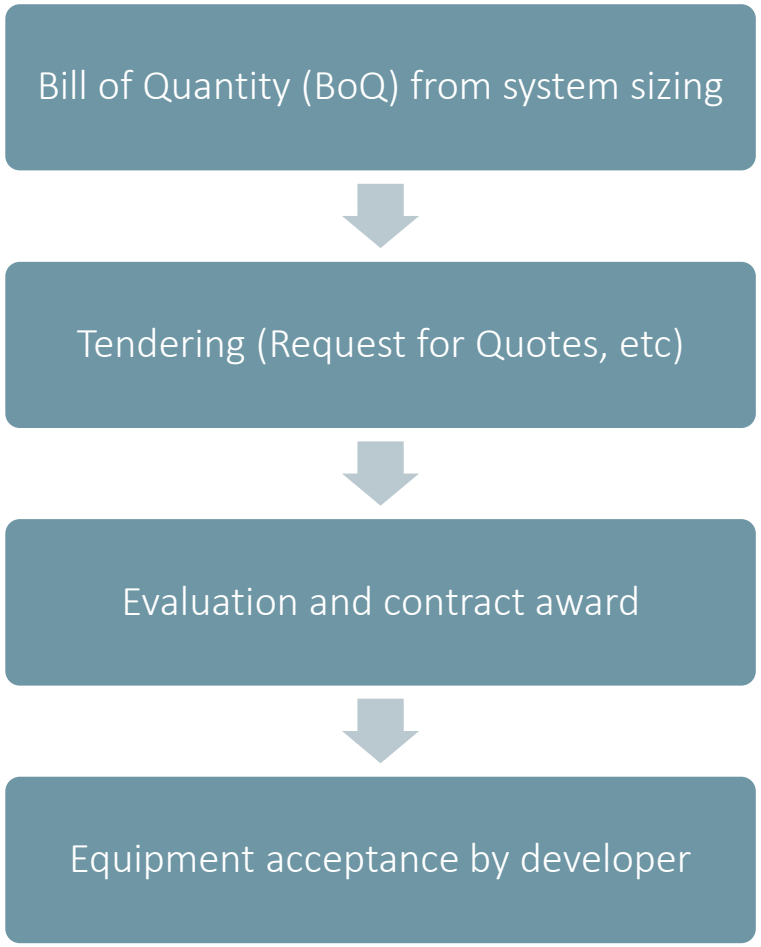
3. MEASURES FOR PROCUREMENT

EQUIPMENT SOURCING

Based on finance and availability, the equipment can be sourced from local or international suppliers.

Engage local suppliers where feasible for balance-of-systems components, for installation flexibility and reduced costs.

Ensure equipment suppliers can service warranties and have quality certifications from recognized bodies.



*Balance-of-system components for solar mini-grids are all components other than solar panels.

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TRANSPORT AND STORAGE

Transport and delivery

- Hire specialized logistics companies to organize international transport of equipment and clearing by customs.
- Site accessibility issues especially during wet/cyclone season should be considered when planning delivery of equipment to site.
- Delivery notes, verification and quality checks should be done at all stages of the logistics process. Each check should be documented properly.

Insurance

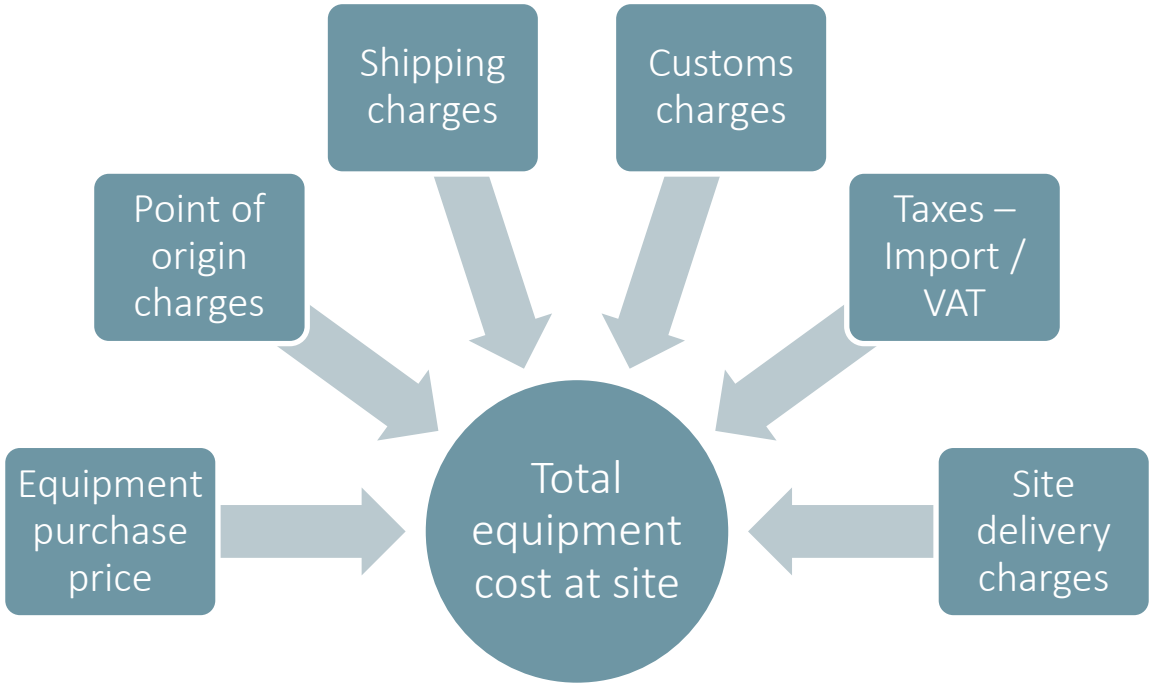
- Insurance for goods during transit is important.
- Most logistics companies offer charges inclusive of insurance. Insurance can be extended post-installation.

Storage

- Use a secure storage location near or at the site. A central warehouse can be considered when building multiple mini-grids.
- A storage inventory should be maintained by the site manager.
- Equipment installation normally begins immediately after delivery so that storage time and costs are minimized.

CUSTOMS, DUTIES AND TAXES

- Check in advance whether import duties and taxes are applicable for specific mini-grid equipment. These rates can change and vary by the country.
- Mini-grids may benefit from exemptions from import duties and taxes especially for solar equipment. However, these exemptions usually need to be obtained before the equipment goes through customs.
- Make sure quotations from suppliers include all relevant costs.



Costs for in-equipment procurement

4. MEASURES DURING INSTALLATION

INSTALLATION ACTIVITIES

Installation involves the following three activities. The developer should lead these even if they are using a contractor for installation:

Planning & scheduling

- Develop S.M.A.R.T. installation schedules that the contractor will follow.
- Constant updating of the schedule aids in managing expectations and control.

Interface management

- Provision and management of all necessary site resources.
- Supervision of works.
- Managing relationships with administration, community, service & material providers and other stakeholders.

Quality management

- Develop and implement tests and checks plan.
- Management of quality assurance function.

S.M.A.R.T. – Specific, Measurable, Achievable, Relevant, Time-bound

PERMITS AND LICENSING

- Permitting and licensing procedures vary depending on plant location and size.
- Permits are required at both national and local level in most countries.
- Typical permits & licenses are shown in the diagram on the right.

Land lease agreement

Agreement to procure/lease land from the landowner (consider plant lifetime)

Land use consent

Local authorities give permits to use land for a specific function

Wayleaves

Agreements on right of way for the distribution network

Building permits

Some countries require a separate permit for the construction works

Environment permits

Environmental impact assessments carried out in feasibility stage are used to obtain permits

Generation license

Developers need to have a license before construction

SITE PREPARATION

Prepare site before installation

- Site fencing and office construction
- Provision of water and power for use
- Preparing necessary access ways (e.g. roads)
- Civil works to prepare the land for construction
- Establishing security systems – CCTV cameras, security guards etc.
- Installation logistics planning for the duration of the installation
- Kick-off meeting with all stakeholders on site
- Preparation of necessary installation tools and equipment

Post-installation environmental reparation activities should also be considered at this stage

SYSTEM INSTALLATION

Generation system

- Powerhouse construction and set up
- Installation of generation Assets.
- Component testing for functionality with accompanying test sheets

Distribution system

- Underground/ overhead/ hybrid setup of distribution grid
- Implementing customer connections
- Component testing of the grid

Metering system

- Meter installation and setup
- Meter system setup
- Meter testing

Data-logging system

- Communications setup for data-logging
- Testing of communication systems and platforms.

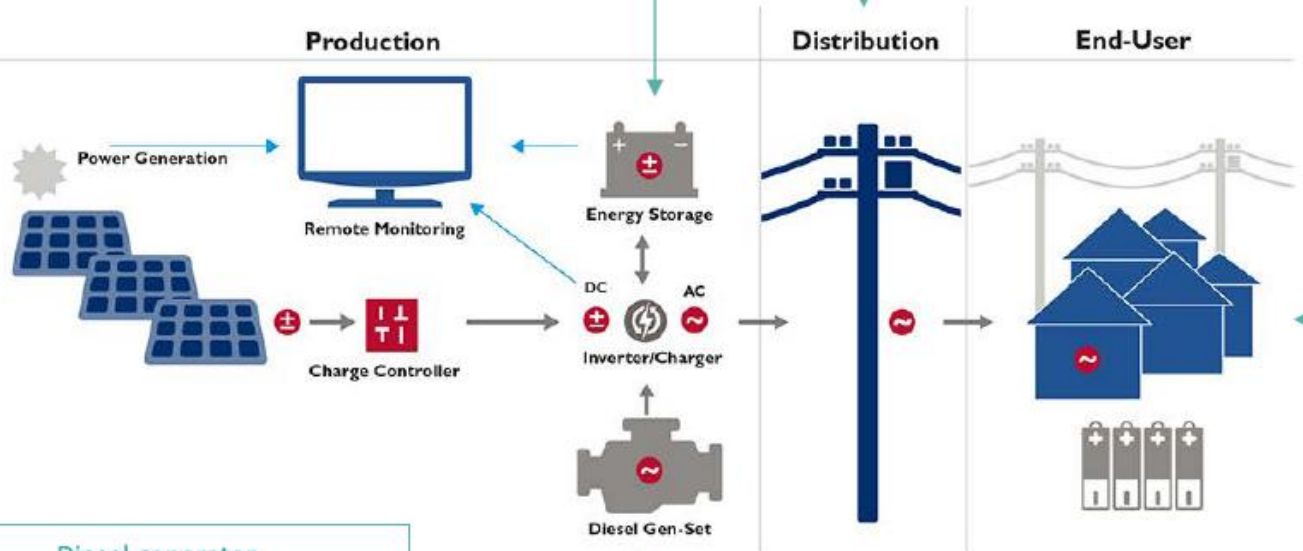
- At all stages, installation should be accompanied by quality checks and equipment tests, and these should be documented and included in the final project report.
- An inventory of all equipment and materials at the site should be maintained by the site manager.
- Design diagrams are used during this installation process. As-built system drawings should be provided after installation works.

INSTALLATION BEST PRACTICES

Storage
- Provide for ventilation to maintain optimum component operation temperature
- Ensure integrity of all connections.

Distribution
- Observe minimum ground clearance for cables from distribution codes.
- Plant poles in stable dry ground.
- Observe spans and sags standards.
- Warning signage on poles and hardware.

Solar panels
- Ensure mounting frame integrity.
- Ensure integrity of all connections.
- Provide for inspection walkways
- Ensure site devoid of shadows

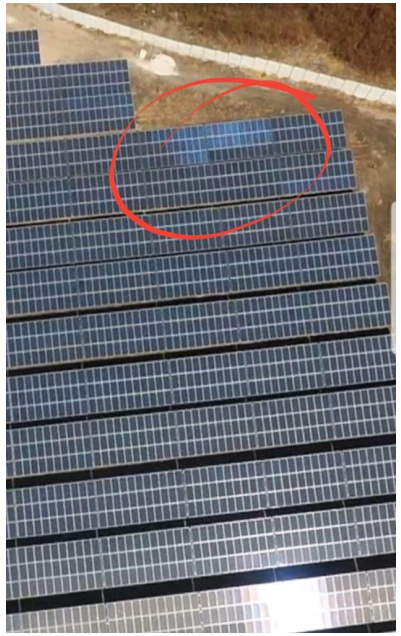


Diesel generator
- Provide for enough ventilation for generator aspiration.
- Provide for maintenance walkways
- Set it on stable platform

End-user
- Use proper hardware for drops.
- Use proper switchgear and grounding.
- Test all connections.
- Ensure proper installation of meters.

Source: Green Mini-grid Help desk, African Development Bank.

INSTALLATION BAD PRACTICES



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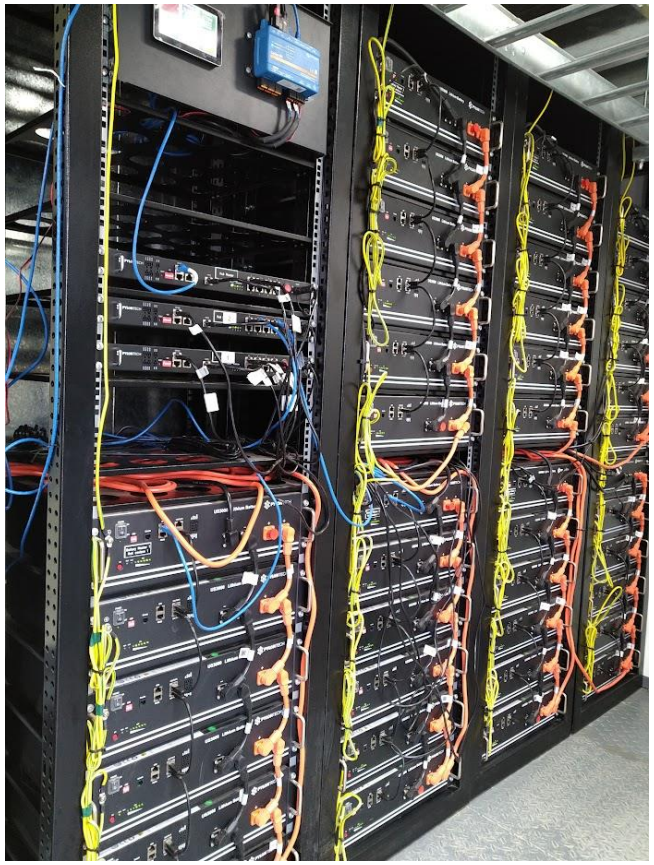

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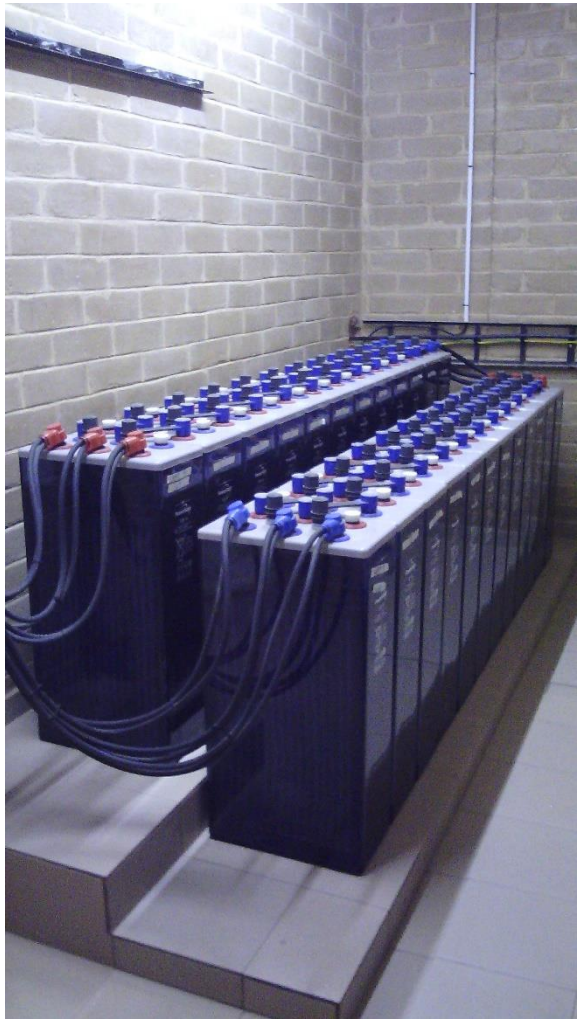
INSTALLATION BEST PRACTICES



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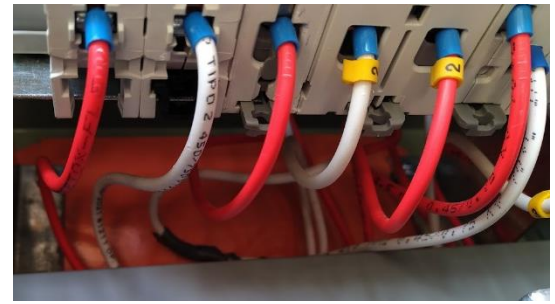
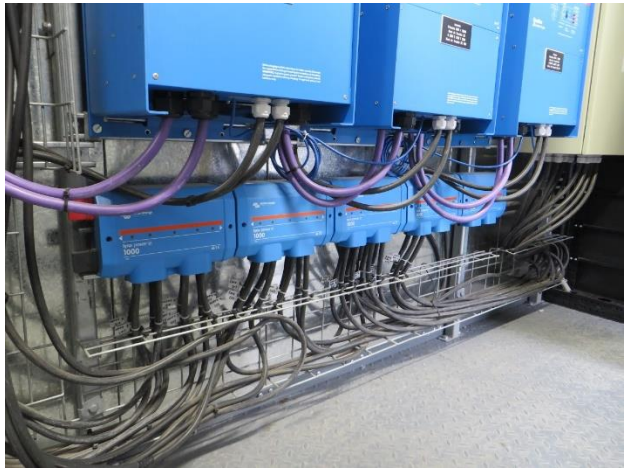
INSTALLATION BAD/BEST PRACTICES











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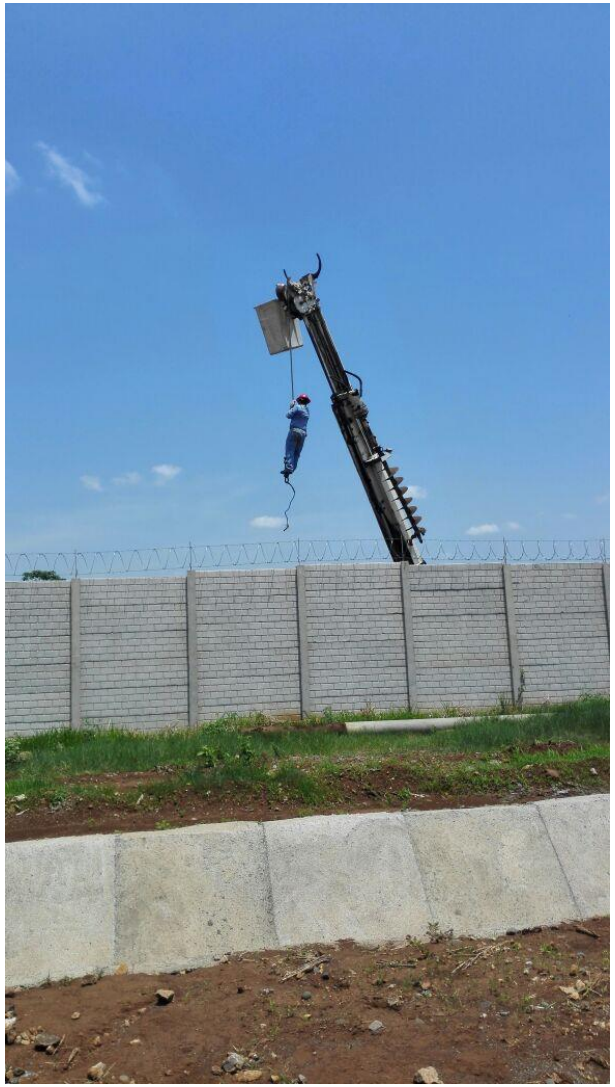
OCCUPATIONAL SAFETY & HEALTH (OSH)

- OSH aims to protect workers and local community from harm during the minigrid installation e.g death and injury (safety) or diseases and illnesses (health).
- Developer should oversee health and safety of the project work force. Financial and reputational risks for not complying with OSH legislation are significant.
- Developer must ensure there are clear guidelines and manuals for internal company processes.



RISK MANAGEMENT

- Develop register for all risks that may lead to harm on site. This should be updated regularly and be accessible for review by all persons at the site.
- Introduce daily toolbox talks to summarize the day's tasks and associated risks.

Example of an OSH risk register

Identified risk	Possible causes	Possible effects	Mitigation	Risk rating
Electric shock	Touching bare electrical cables	Injury or death	Avoid having bare cables without labels	4/5
Fatal cuts	Moving components e.g. fans, turbines	Cuts or death	Safety warnings and lock-outs	1/5
Poisonous fumes	Batteries releasing fumes	Suffocation, poisoning, illness	Proper ventilation, correct PPE and warning signs	1/5
Fire hazards	Diesel generator fires	Burns or death	Designated personnel and fire extinguishers	2/5

ENVIRONMENTAL MANAGEMENT

- Most governments and many financiers require an Environmental Impact Assessment (EIA) to be completed before construction begins.
- It is important to adhere to the Environment Management Plan developed during the EIA.
- This highlights the main environmental risks and mitigation measures that need to be addressed during installation.
- All packaging and other waste material must be disposed in an environmentally friendly way and meet the conditions specified in the EIA.

Tasks to develop strong Environment, Health & Safety (EHS) risk management:

- Involve EHS professionals
- Identify EHS project hazards and associated risks
- Define the likelihood & magnitude of EHS risks
- Implement & prioritize risk management strategies in working areas
- Favor strategies that eliminate the cause of a hazard
- Develop processes and prepare workers and nearby communities to respond to accidents
- Monitor ongoing EHS performance

5. MEASURES DURING COMMISSIONING

COMMISSIONING OVERVIEW

Commissioning should ensure

- The power plant is structurally and electrically safe
- The power plant is sufficiently robust to operate for the specified lifetime
- The power plant operates in line with pre-determined design parameters and functionalities

Physical and technical tests need to be carried out on the mini-grid by either an independent party or a combination of the installer and the client (i.e. the minigrid developer) working together.

All these tests should be carried out in line with the applicable national and international standards and guidelines.

Final payments to the EPC contractor are made after successful commissioning.

COMMISSIONING TESTS

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DC INSTALLATION CHECKING

- Procedure 01 - Structure checking
- Procedure 02 - Buried wires pipes checking
- Procedure 03 - Sealing and external status of switchboards and electrical wires checking.
- Procedure 04 - Electrical connections review in string boxes.
- Procedure 05 - PV modules inspection
- Procedure 06 –Open Circuit voltage of strings checking.
- Procedure 07 - Curves v-i measurement.
- Procedure 08 - Insulation measure of DC cables.
- Procedure 09 – Earth resistance measurement.
- Procedure 10 - Thermographic study of hot spots on modules
- Procedure 11 - Thermographic study of hot spots on electrical equipment.
- Procedure 12 - Voltage drop in DC lines measurement

AC INSTALLATION CHECKING

- Procedure 13 - Inverter review.
- Procedure 14 - Voltage drop measure of AC line
- Procedure 15 - Inverter operation checking
- Procedure 16 - Energy meters Performance testing
- Procedure 17 - Insulation measure of AC cables
- Procedure 18 - Test shot of leakage protection

HV INSTALLATION CHECKING

- Procedure 19 - Remove tension in MT and put in downloaded the transformer.
- Procedure 20 - Review of the power transformer.
- Procedure 21 - Review of MT cabine.
- Procedure 22 - Test and measurement of earth resistance transformer.
- Procedure 23 - Earth resistance measure of transformer neutral.
- Procedure 24 - MT wiring status check
- Procedure 25 - Review power evacuation infrastructure

INFRASTRUCTURES CHECKING

- Procedure 26 - Checking infrastructure monitoring and control system
- Procedure 27 - Checking weather station infrastructure
- Procedure 28 - Review and verification of the electrical infrastructure of auxiliary services
- Procedure 29 - Checking prefabricated infrastructure centers
- Procedure 30- Checking the control center

HANDOVER TO MINI-GRID OPERATOR

- The handover from contractor to client is the point at which the client has verified that the mini-grid system has been installed and commissioned properly. It usually triggers a payment to the contractor and transfer of liabilities to the client.
- Handover documentation usually includes:
  - as-built electrical, mechanical and structural diagrams,
  - system login credentials,
  - manuals,
  - project reports,
  - distribution network details,
  - test sheets etc.
- The EPC contractor should provide an O&M manual for future maintenance works.
- It is common for installers to provide a workmanship warranty for a period of not less than 24 months. The process for resolving problems during this period is defined in the main supplier contract e.g time to resolve problems, criteria for system underperformance

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Vinaka!

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