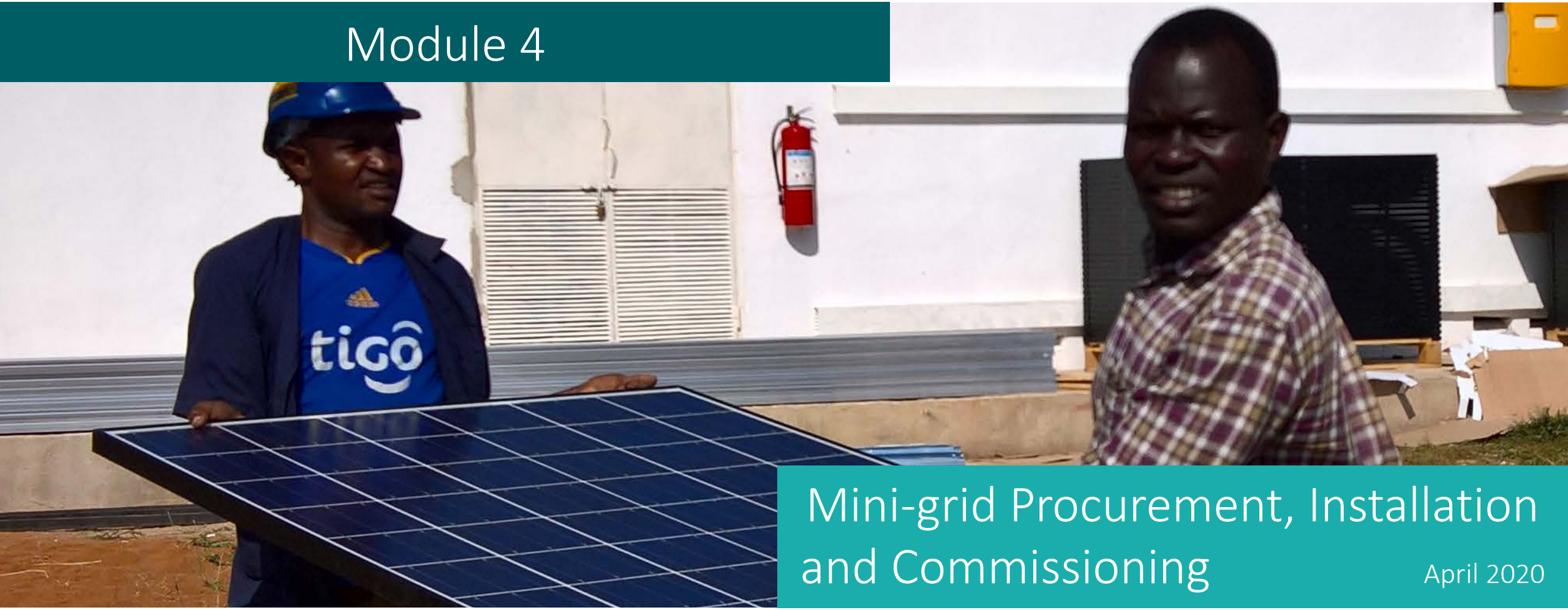
GREEN MINI-GRID HELP DESK

Module 4



Mini-grid Procurement, Installation and Commissioning

April 2020

ENERGY4IMPACT
ACCELERATING ACCESS TO ENERGY

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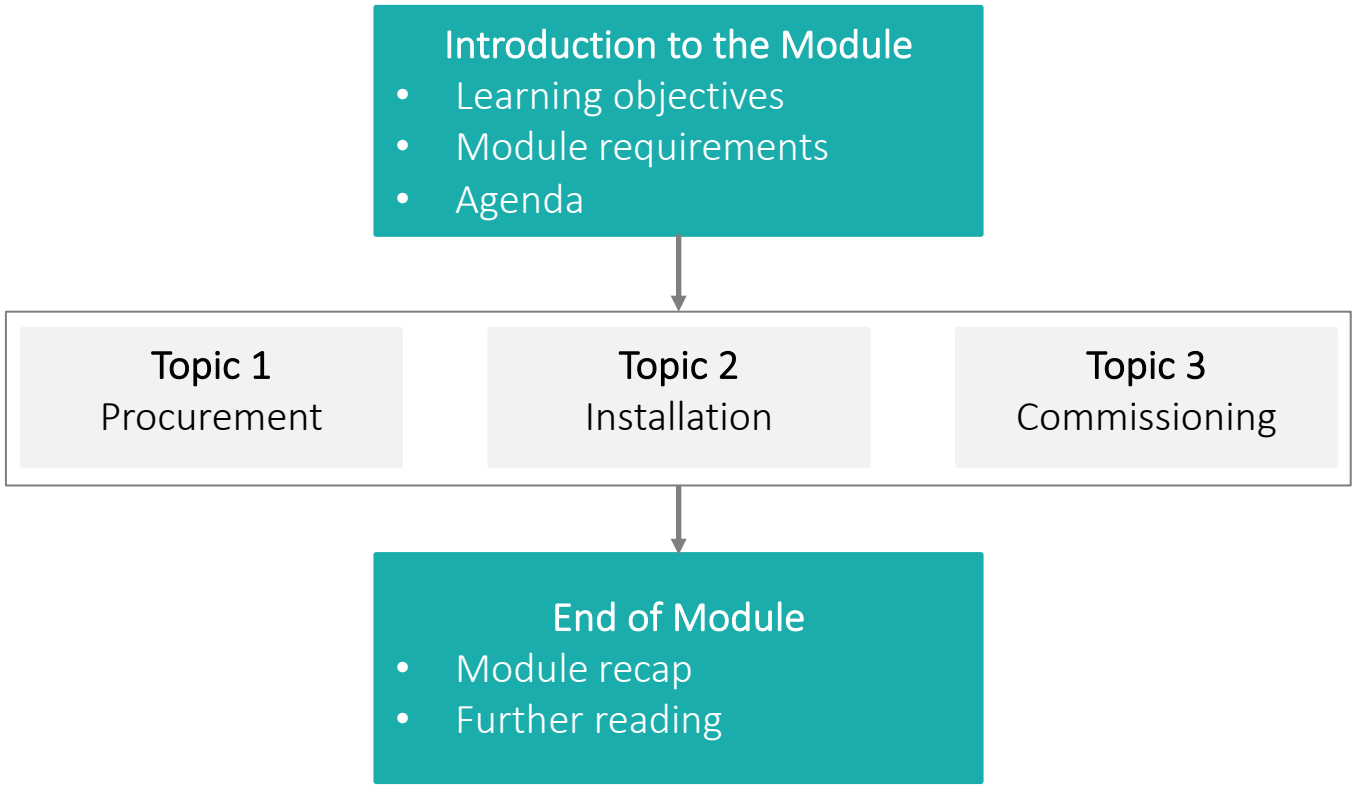
SUSTAINABLE ENERGY FUND FOR AFRICA

Module overview



Objectives & Requirements

Learning Objectives

- Learn best practice on procurement, including equipment sourcing, logistics and customs.
- Learn best practice on installation, including planning and management of interfaces and quality issues.
- Learn best practice on commissioning, including testing and handovers.

Module Requirements

- This module is targeted at mini-grid developers and operators at all stages of development.
- They are expected to have a basic understanding of rural, off-grid energy markets and community dynamics in developing countries.
- No prior technical knowledge of procurement, installation or commissioning is required.

Agenda

1. Procurement
   - Procurement models
   - EPC Contracts
   - Equipment sourcing
   - Transport and Storage
   - Custom, duties and taxes
2. Installation
   - Installation activities
   - Permits and Licensing
   - Site preparation
   - System installation
   - Best practices
   - Standards & regulations
   - Other important considerations
   - Safety, health & environment
3. Commissioning
   - Commissioning overview
   - Commissioning tests
   - Project handover

Overview

- Procurement, installation and commissioning, are usually governed by national and/or international laws, regulations and standards, with procurement occasionally regulated by investors' preferences.
- The most critical role for the developers in the implementation phase is quality assurance. This ensures the objectives of the project are met.
- Developers can undertake these activities on their own or can outsource. If outsourcing, they should retain the supervision and management of the process.

Procurement is the process of purchasing technical equipment and services from an external source.

Installation is the process of constructing a mini-grid, with the procured materials & services.

Commissioning is the process of testing a mini-grid system to verify it functions according to design and specifications.

Procurement Models

There are 2 procurement models that developers can use:

- Tenders for individual components of the mini-grid. The developer then installs and commissions the system themselves.
- Tenders for a turnkey solution where the Engineering, Procurement & Construction (EPC) contractor delivers a fully operational project.

EPC Contracts

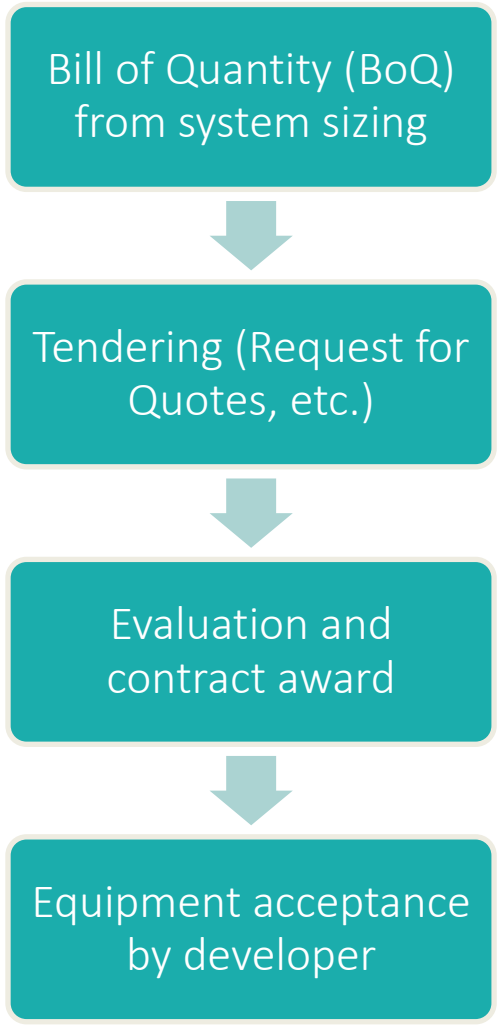
- Contractor commits, through a contract, to deliver the completed plant performing to a guaranteed specification for a guaranteed price by a guaranteed date.
- More expensive, but transfers risks and costs of hiring installation personnel and on-site management to the contractor.

EPC contract checklist

- ✓ Scope of work
- ✓ Payment milestone schedule
- ✓ Provision of defects warranty period
- ✓ Performance testing agreements
- ✓ Provision for obtaining liquidated damages
- ✓ Quality control checks

Equipment Sourcing

- Equipment can be sourced from local or international suppliers based on finance and equipment availability.
- 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 the solar panels

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 seasons 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

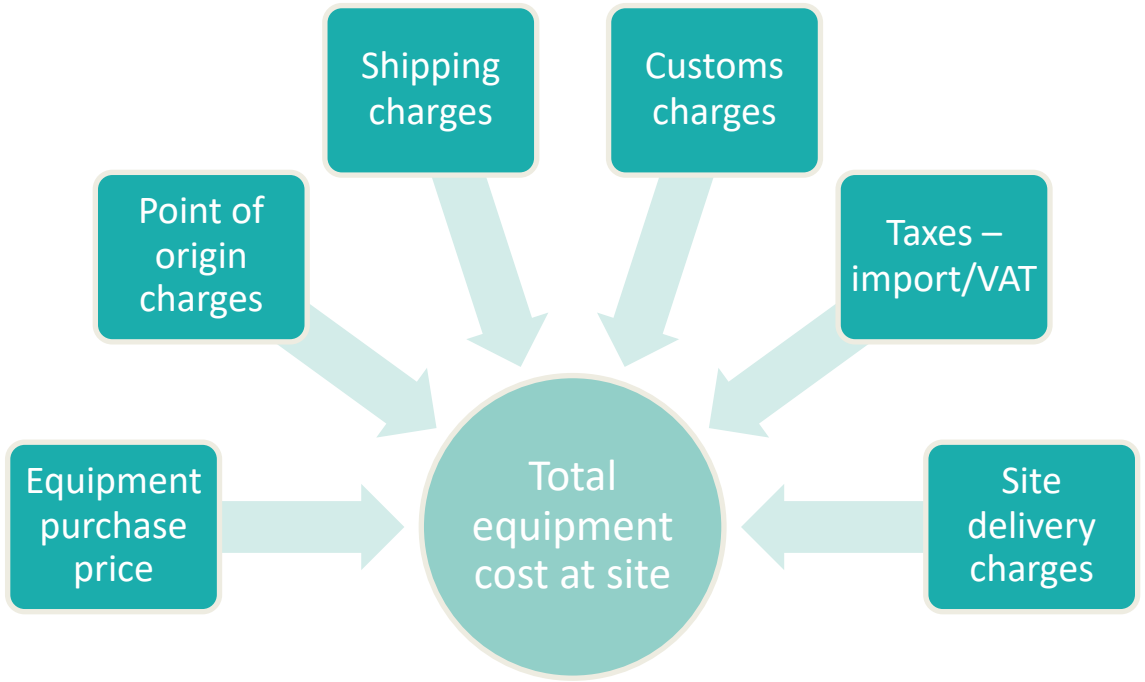
- Insurance for goods during transit is important.
- Most logistics companies offer charges inclusive of insurance. Insurance can be extended post-installation.

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.

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 a tests and checks plan.
- Management of quality assurance function.

S.M.A.R.T. – **S**pecific, **M**easurable, **A**chievable, **R**elevant, **T**ime-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 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.

Solar panel installation. Source: Gorja Development Solutions Ltd.

System Installation

Generation system

- Power room 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

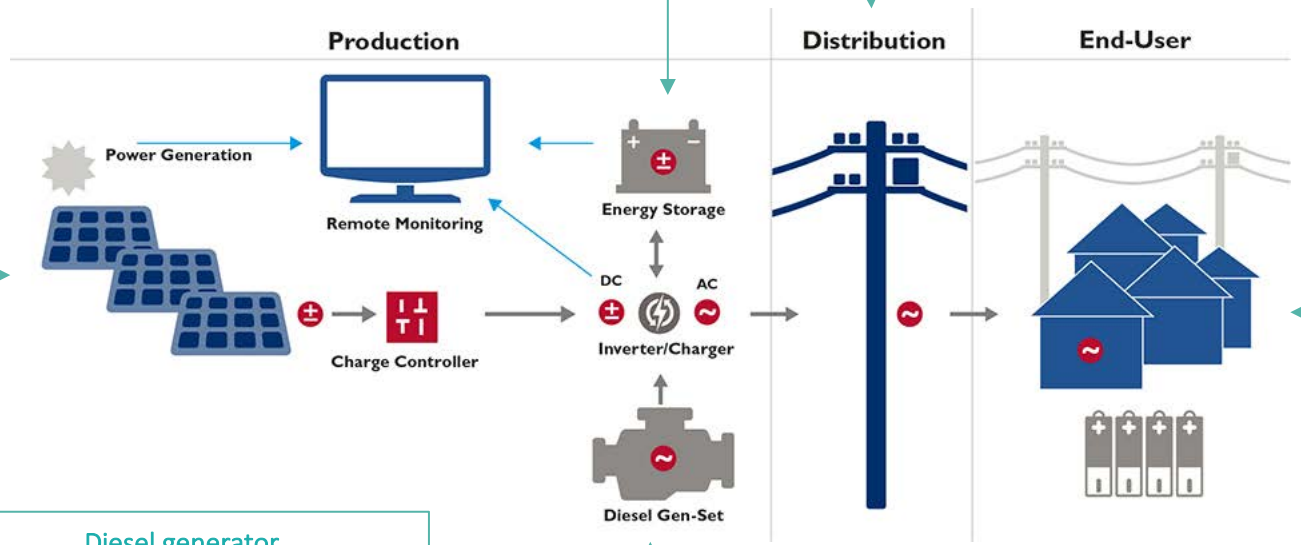
- At all stages, installation should be accompanied by quality checks and equipment tests and these should be documented and included in the final project report.
- An inventory of all equipment and materials at site should be maintained by the site manager.
- Design diagrams are used during this installation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

Standards & Regulations

- Installers and supervisors need to have necessary licenses and permits to install the power systems.
- Some countries have their own standards and regulations while some have adopted international/regional ones.
- Must conform to all relevant standards and regulations.

Regulations

- Licenses to install or supervise power plants
- Environmental and OSH regulations

Standards

- Local and international guidelines on installation
- E.g. IEC standards

Guidelines

- National distribution codes

Other Considerations

- Involvement of local labour in less technical tasks is advised to ensure local community support and reduce costs.
- Specialized installation tools and local-language instruction manuals for installation of the equipment should be available and used accordingly.
- Installation notes and pictures should be taken for reporting purposes.
- Follow local cultural practices to ensure good relations with local employees and community at large.

Source: African Development Bank

Occupational Safety & Health (OSH)

- OSH aims to protect workers and local community from harm during the mini-grid 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.

Duties of the developer

- Provision of necessary resources to the site manager for OSH.
- Supervision of personnel to ensure adherence to safety regulations.

Duties of the site manager/EPC contractor

- Provision of protective equipment (PPE) for everyone accessing the site.
- Risk management to identify and mitigate potential hazards.
- Managing and ensuring health for all stakeholders.
- Providing general and task specific safety training for all persons accessing the site
- Reporting on any accidents and/or incidents.

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 summarise the day's tasks and associated risks.

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

Example of an OSH risk register.

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.

* EHS – Environment, Health & Safety

Tasks to develop strong EHS* risk management:

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

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

- 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 mini-grid 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 (1)

- Testing protocols for all components should be used as the basis for testing processes. These protocols are supplied in equipment manuals.
- Relevant specialized tools and testing equipment should be used during this process and all results documented.
- Comparison of results against design simulation results should be done and any variations explained.
- For solar PV plants, the performance ratio (PR) is determined at this point and set as baseline plant value against which future performance will be compared against:

$$\text{PR} = \frac{\text{Actual power plant output}}{\text{Nominal (designed) plant output}}$$

Completing commissioning tests. Source: ADB

Commissioning Tests (2)

Commissioning tests for mini-grid plants

Test	Details
Combined power output test	Tested with resistive electric heater loads equal to the combined power output required (e.g 50 watts [W] per connected household for 1 hour.)
Solar PV SC (for solar PV plants)	Testing solar power production under full sun.
Distribution system	Testing distribution system operating all loads while measuring the voltage at the furthest points of each distribution branch.
Metering system	Testing the meters for proper measurement of energy/power and payment processing.
Data-logging system	Observing the operation of the data-logging service by retrieving and reviewing a few hours of data.
Insulation Resistance Test	Verifying the electrical continuity of the conductor and the integrity of its insulation.
Control/automation testing	Starting/stopping the system to test operation and emergency shutdowns.
Battery testing	Observing and recording the charging and discharging cycles in the first week of operations noting the voltage, charge time, state of charge and amp-hours.

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 under-performance

Source: GIZ

Module Recap

- Developers can procure equipment in 2 ways: tenders for individual components or tenders for turnkey solutions.
- Ensure relevant warranties and certifications are in place.
- Keep clear records and take out insurance for transportation and storage of equipment.
- Be aware of applicable customs procedures, duties, and taxes
- Developers should follow 3 steps in installation: planning & scheduling, interface management, and quality management.
- Prepare site before installation starts.
- Follow best practices for installation and adhere to regulations & standards.
- Have a robust management plan for environment, health and safety risks.
- A mini-grid should only be commissioned when it is structurally & electrically safe, can operate as designed, and is robust enough to operate for its intended lifetime.

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