Regulatory Framework for Mini-Grids in Malawi

1. Introduction

The need for a regulatory framework for mini grids is enhanced by the accelerated use of renewable energy technologies in Malawi. The drivers for the acceleration are diverse and include the following -

1.1 Community driven

Some communities in Malawi developed renewable energy sources for household and community use. Largely, for lighting and light energy uses. This is despite the community groups lacking skills to develop and operate. Consequently, instead of enjoying the services, the consumers have often lost their property due to poor quality of power supply. The Kabvuzi youth group are a typical example.

1.2 Donor Driven

Non-Governmental Organisations (NGOs) and development partners have played a bigger role in developing renewable energy sources for water pumping, lighting and irrigation schemes, among others, to service public institutions like health institutions and schools. The systems have been left to the administration of the institutions to manage, operate and maintain but without the staff having necessary skills to operate and maintain the systems. Most of such systems have not been registered with MERA to monitor and enforce compliance with quality, safety and environmental standards for sustainability with the end result that the majority of the systems have not been sustainable and, hence, short lived.

The exception to this category is the Mulanje Electricity Generation Agency (MEGA), which is duly licensed by MERA.

1.3 Government Policy on Mini Grids and Increased Access to Electricity

Government implemented six (6) Pilot isolated mini grid projects, which were financed through the Local Development Fund. The projects lacked means for sustainability. They had no clear means for generation of revenue to support operations and maintenance requirements. There were not any governance structures. Ownership and organisational

structures, accountability and transparency were not clearly defined resulting in the systems collapsing in a short term. Consequently, the customers complained of poor standards. Hence the need for a regulatory framework for the existing and future developments.

1.4 Energy Policy 2016

The draft energy policy 2016, stipulates increasing renewable energy mix policy from below 10% in the current year to 23% by 2030;

The policy advocates electrification of villages and specifically households, grain mills, and social service facilities in order to increase access to electricity to over 80% of the population of Malawi living in rural areas.

The policy realizes that the impact of the Rural Electrification Levy (REL) on electrification of rural areas has been below expectations. The policy notes that Rural Electrification had targeted mainly grid extensions while renewable energy and mini grids had not been promoted significantly.

The energy policy also advocates the following in the development of renewable energy, among other areas –

a) Supporting small-scale renewable energy initiatives by communities or entrepreneurs. Capacity building, in all areas of renewable energy technologies (RET) of programming, supply and services, as well as in entrepreneurship and management, taking into account gender and social issues;

b) Private sector driven renewable energy technology industry and recognizing the role civil society organisations (CSOs) that are contributing to Government efforts through renewable energy projects;

c) Diversified use of Rural Electrification Levy (REL) to significantly promote development of renewable energy mini grids in support of priority area of rural electrification; and

d) Financing off-grid solutions, from the Rural Electrification Fund, the cost of transformers and associated infrastructure, where it is intended to serve a minimum prescribed number of customers as approved by Government;

e) Use of tariffs that encourage efficient use of electricity, such as Inverted Block Rates, Time of Use (TOU) Tariffs and Dynamic or “Real-time” Pricing; and

f) Introduction of lifeline tariffs to enable low income households access electricity.

Lack of enforcement mechanisms for compliance with standards resulted in the proliferation of poor quality products, which is one of the major barriers to exploitation of renewable energy sources.

2.0 Framework Objective

The mini grid regulatory framework is to provide guidelines for the development and operation of mini grids in Malawi in terms of the following:

a) Terms and conditions for registering or licensing based on whether they are for commercial or private use;

b) The Governance structures to ensure transparency and accountability in the operation of the mini grids;

c) Quality of supply and services standards for development and operation of the mini grids;

d) Key performance indicators;

e) Tariff methodologies and structures for mini grids to ensure sustainability of operations and alignment with policy on subsidies; and

f) Sustainability of mini grid operations when the main grid reaches or extends to the mini-grid supply areas.

3.0 The Legal Framework

The Mini Grid Regulatory Framework has been developed consistent with the above policy direction and legal provisions to guide development of mini grids as follows:

3.1 Energy Regulation By Laws

The Malawi Energy Regulatory Authority (MERA) is mandated to regulate the energy sector and license energy undertakings as defined by the Energy Regulation Act 2004. Energy Regulation By law 42 requires that a licence be issued for renewable energy activities.

Further, that no person shall carry on the business of importing, selling, installation and maintenance of renewable energy technologies without a licence issued to him by the Authority.

3.2 Electricity By laws 2012

3.2.1 By law 44 – Installations Permits

(a) Installers of renewable energy technologies be certified and Issues Electrical Installations Permit;

(b) Renewable energy activities be licensed;

(c) The Authority shall not issue a licence to an applicant for renewable energy technologies unless the Authority has granted to the applicant an electrical installations permit;

3.2.2 By law 55 – Standards and Code of Practice

Every licensee shall comply with and adhere to the standards and specifications for renewable energy technologies approved by the Authority.

3.2.3 By law 56 – Only authorized persons to Install and maintain renewable energy

Every licensee shall comply with and adhere to the applicable provisions in the Electricity By laws in respect of authorized persons or licensees to carry out installations and maintenance of renewable energy technologies installations.

3.3 Rural Electrification Act 2004 and the Electricity Act 2004

The Rural Electrification Act 2004, the Electricity Act 2004 and Electricity (Amendment) Act 2016 provide as follows that -

(a) The Rural Electrification Levy (REL) supports projects with Internal Rate of Return (IRR) of up to 6%. The Electricity (Amendment) Act 2016 allows MERA to specify the rate of return;

(b) Cost reflective tariffs be charged on off-grid/mini grid projects. Section 25 of the Rural Electrification Act 2004 and By-Laws 205(g) and 211 (d) of the Electricity allow MERA to approve tariffs for off-grid electrification which:

- are cost reflective and competitive; and
- do not impede competition in the industry.

Check Section 5.2.6.2 of the National Energy Policy 2003 be reviewed to allow for the charging of different tariffs for off grid electrification as stipulated under

(c) Both generation and distribution licences be issued under the Rural Electrification Act, albeit limited to installed capacity of 5MW.

Recognizing the above limitations in the legal framework, MERA recommended for Government's approval the following amendments to the Rural Electrification Act 2004 and the Electricity Act 2004 that -

- **That Electricity Act 2004** be amended to allow isolated mini grids power systems combining generation and distribution licenses on commercial basis for installations of 5MW or more. That the limitation of 5MW be removed to allow investors and mini grid developments in the rural areas;

4.0 Requirements for Approval of Mini Grid Projects

4.1 Approval and Licensing of Mini Grids

The mini grids shall be developed consistent with the energy policy, energy strategy and Rural Electrification Master Plan provided by the Rural Electrification Management Committee (REMaC). In the absence of the Master Plan, REMaC shall approve the mini grid projects on a case by case basis.

A baseline demand and user surveys shall be conducted, at micro level by project developers. Demand projections (growth factors. Historical or from similar area already electrified) shall be done to assess viability of the project for the life span of the mini grid.

The mini grids shall target customers engaged in economic activities to enhance their viability;

MERA shall license mini grid proposals approved by REMaC. MERA shall consider the following to approve applications for the licensing of mini grid projects:

(a) **Resource Availability** – An assessment confirming sustainability of the energy resource (prime movers including wind, water, solar, geothermal, biogas, etc) under consideration for the economic life time of the project;

(b) **Willingness to Pay (WTP) and Affordability**

Outcomes from a survey of the mini grid concession area to determine operational subsidy to close the gap between affordability and cost recovery, where applicable;

(c) **Financing Options** – to be adequate for project development (in the case of private financing), and for operations and maintenance. Financing options shall consider funding the cost of associated infrastructure to connect the potential customers to facilitate service connections. Subject to Government policy, it may include customer installations to accelerate connections.

(d) **Energy Mix** – to be consistent with the medium, to short term and long term renewable energy strategy targets set by Government;

(e) **Isolated Mini Grids** – to be located outside areas earmarked for grid extension to give certainty to investors. Reference shall be made to the Malawi Rural Electrification Program (MAREP) to identify areas earmarked for electrification by grid extension.

4.2 Concession Agreement

Where approved, consistent with the Rural Electrification Act 2004 unless otherwise directed by Government, the developers shall enter into a Concession Agreements (CA) with Government to develop and operate the mini grids. The CA shall be in a format as presented in **Appendix- 1**. Among other areas, the CA shall specify the following:

4.2.1 **A Subsidy Program** – where necessary and to facilitate implementation of the mini grids as follows:

(a) **Capital Subsidy –** The extent of provision of infrastructure. Whether to include or exclude any or all of i) service drop, ii) meter board; and iii) customers' wiring installation);

(b) **Output based Aid** – A subsidy provision with in-built performance incentives. Received only on proof of a tangible output being achieved. Used, for instance, to extend service to new customers, where a fixed subsidy amount is provided for each new customer who is connected and purchases electricity. The subsidy shall be paid only when the connection and its use has been verified.

(c) **Operational subsidy** – Subject to market survey of willingness to pay and affordability, agree on the operational subsidy to close the gap between affordability and cost recovery;

(d) **Pro-poor rates** – through subsidies cross customer categories or price discrimination.

4.2.2 **Targeting Customers** - to t**arget productive use of electricity to p**rovide access to social and administrative institutions; and to customers engaged in economic activities to minimize the gap between affordability and cost reflective tariffs;

4.2.3 **Using Local Resources –** that priority be on using resources and technologies available within the country and local environment;

4.3 Ownership Arrangements

MERA shall consider the following ownership models for eligible applicants for mini grid licences consistent with the energy policies and renewable energy strategy -

(a) **Public – where owned and operated** with Community involvement and participation. Either by a trust or cooperative associations to leverage community and private resources to reduce costs. It could also be owned and operated by a state owned national grid operator;

(b) **Private** – licensed with one or more private owners;

(c) **A Public Provate Partnership** - A special purpose vehicle (SPV) with clear shareholding and risk sharing arrangements; and

(d) **Hybrid System** – where different persons own different components of the mini grid system.

5.0 Grid Connected Mini Grids

The continuity of mini grid business shall be assured through transitional arrangements to be applied in the case where the main grid extends to the mini grid supply area. Grid connection of the mini grid shall be allowed under terms and conditions specified in the Grid Code and as shall be discussed and agreed upon between the mini grid operator, the Single Buyer (SB) and the System Market Operator (SMO).

Where grid connection is not allowed, the SB shall compensate the mini grid operator.

6.0 Tariff Guidelines

6.1 Formulation of End User Tariffs

Compliant with the Rural Electrification Act 2004 and Rural Electrification Regulations 2009, tariffs shall be approved by MERA and shall be set, administered and revised in accordance with the Electricity Act. Cap. 73:01. The tariff setting shall comply with the tariff methodology.

Tariffs shall reflective social economic costs of the selected technologies. **Time of use tariffs (ToU) may be used to cover the high costs of renewable energy technologies in an integrated grid.**

6.2 Composition of Tariffs

Subject to whether the mini grid is connected to the main grid or isolated, mini grid tariffs shall comply with the tariff methodology and standard tariff structure approved by MERA. **Appendix - 2**, refers. In summary, the general tariff structure shall comprise the following components -

6.2.1 Grid Connected Mini Grid Tariffs

6.2.1.1 Tariff Components

(a) Retail tariff to end user customers;

(b) Wholesale tariff from main grid to grid connected mini grid;

(c) Wholesale tariff from the mini grid to the main grid in a Power Purchase Agreement (PPA) format agreed between the mini grid operator and the Single Buyer (SB). The PPA shall comply with a standard format approved by MERA.

A PPA format for variable renewable energy resources of wind and solar solar shall comply with a specific standard format, also, approve by MERA. **Appendix-3** refers.

(d) Feed in Tariffs (FIT)s shall apply consistent with the feed in tariff policy, where applicable;

(e) Energy Banking – where parties agree, alternatively, that amount of energy consumed by the mini grid be netted off with the energy sent out to the main grid and reconciliation done after an agreed period;

6.2.1.2 Take or Pay Terms for the Tariffs

In either case, whether PPA or energy banking arrangements, the tariffs shall be on a Take or Pay basis unless otherwise provided by the CA.

6.2.2 Retail Tariff for Isolated Mini Grids

End user tariffs for both isolated and grid connected mini grids shall comply with the requirements of the tariff methodology and shall comprise fixed and variable charges.

Innovative tariff formats shall be considered for approval by MERA. Where, for instance, load limiters are used and where customers opt to be interrupted under conditions of system disturbances to stabilize system operation and to be switched off under a load shedding program to match demand and supply.

7.0 Light Handed Regulation

7.1 General Consideration

Caution shall be taken to void over-regulation of mini grids to the extent of destroying their commercial viability. Amount of information requested and number of reviews and approval steps for the purposes of regulating tariffs and quality standards shall deliberately be reduced.

7.2 Tariff Consideration

Tariffs for community owned isolated mini grids, shall best be left to be decided by the beneficiaries themselves. The approach is believed to yield tariff levels that are within the range of affordability and willingness to pay of the beneficiaries.

The regulator shall verify the adequacy of the tariffs to cover operations and maintenance of the mini grid to ensure sustainability. An attempt shall be made to set the tariffs higher than required to provide for accumulation of adequate funds for system maintenance during major equipment failure and system breakdowns.

8.0 System Design

The designs shall consider sustainability of the system during the life time of the mini grid.
The following factors shall be considered:

8.1 Technology Choice

A least cost technology mix for maximum stakeholder value. Technology options shall be based on what is locally available and may include any or a hybrid system of the variable technologies of wind and solar; energy storage; or main grid back up.

8.2 Market Needs and Demand Management

The capacity for the mini grid shall be adequate to meet the needs of different types and number of expected beneficiaries. A baseline demand and user surveys shall be undertaken and projections done based on population growth and growth factors derived from historical figures or from similar area already electrified.

8.3 Customer Management System

Customer installations shall allow two way communication to reduce operational costs. The design shall consider using smart phones for real time network information and communication. The following smart grid technological developments shall be considered for use along with mobile internet banking, where practical for -

(a) Meter reading, billing and revenue collection;
(b) Monitoring and regulating consumption;
(c) Balancing demand and supply;
(d) Automatic customer service data collection, analysis and reporting; and
(e) Time of use tariff.

Energy efficiency measures including load limiters and DSM shall be used and loss reduction measures applied accordingly.

Aggregation of rural services shall be used as far as will be practical to reduce upfront cost for equipment and systems installations. The provision of smart grid technologies shall, for instance, endeavour to combine, other rural services including water supply, communications, financial services, consumer electronics, sales and services.

8.4 Sustainability of the Mini Grid

A feasibility study shall be conducted for each project to ascertain the adequacy of the supply chain in the long term.

8.5 Grid Connection

Connection of the mini grid to the main grid shall be allowed in the case where the main grid extends to cover the supply area of the min grid to provide for continuity of the mini grid business. The Single Buyer, shall be obliged to compensate the mini grid owner as soon as the main grid extends to the mini grid supply area, in the case where grid connection is not considered.

8.6 Min Grid Technical Requirements

8.6.1 The min grid shall comply with the following technical requirements:

(a) The connection code;
(b) Network Code of the Grid Code;
(c) Metering Code for the Grid Code; and
(d) Distribution Code.

(e) **Operation and Maintenance** – The min grid shall have a comprehensive and clear operation and maintenance scheme;

(f) **Ability for parallel and island modes** - The mini grid shall be designed to applicable standards for easy integration into the main grid without any technical constraints during the time when main grid covers supply area of the min grid;

8.6.2 Key Performance Indicators (KPIs) - The regulator shall monitor and enforce compliance with agreed key performance indicators (KPIs), which shall include but not limited to the following:

8.6.2.1 Reliability and security of supply - The design may include the following to enhance reliability and security of supply -

(a) Energy banking;
(b) Energy storage;
(c) Back up systems; and
(d) Design for minimum system losses;
(e) System adequacy to meet demand and customers' needs. To check and avoid over-designing; and
(f) Affordability by the target market. Evaluated from Willingness to Pay (WTP) and affordability survey results.

8.6.2.2 Compliance with Electricity By laws on the following:

(a) **Stability** of system voltages and frequency;
(b) Planned and forced outages;
(c) **Times to respond and resolve -** complaints, faults and request for general information;

(d) **Customer Service Standards** – that benchmarks be set through consultative processes and to include at least as follows:

i. Reporting requirements including on KPIs;
ii. System Availability – for both the distribution network and generation as a percentage of total hours in a year;
iii. Access by distance to call centres; and
iv. Call centre performance on -

- Quotation days;
- Connections days;
- New connections;

- Faults clearance, duration to clear; and
- Number and duration of faults per customer.

Need for more literature review – reference to guidelines developed under AFUR and IRENA -

9.0 Standards Compliance

Mini grids shall be developed in compliance with Malawi Standards on quality for rural electrification and mini grids development, systems and service delivery provided in **Appendix – 4**.

All equipment used in the development and for operation of the mini grids shall comply with the Malawi Standards and be certified by the Malawi Bureau of Standards.

10.0 Licensing Requirements for Mini Grids

10.1 Licensing Threshold

All mini grids with generation and or distribution capacity of 50kW or more developed for commercial purposes shall be licensed. Only one licence shall be issued for combined activities of generation, distribution and retailing.

Mini grids of less than 50 kilowatts shall not be licensed provided that, where such type of mini grids are developed for public use, they shall be registered to monitor compliance with quality of service, safety and environmental protection standards.

All mini grids of 50 kilowatts or more developed for private use, shall be registered for records and to monitor compliance with safety and environmental protection standards.

10.2 Licensing Terms and Conditions

The following terms and conditions shall form pre-requisites for licensing of mini grids:

(a) **Permits and certificates -** for sustainable use of resources including: approved Environmental Management Plans (EMPs), Water Rights and local authorities approvals on usage of land and forests;

(b) **Business registration** in Malawi - compliance with registration requirements including: tax remittance, ownership and authorized operators, among others;

(c) **Work place registration** for safety of people and equipment; and

(d) **Application Requirements** – any person applying for a licence or registration for operation of mini grids, shall duly fill and submit to MERA application form provided in **Appendix – 5**.

Appendix - 4

Mini Grids Development and Operation Standards

MERA developed through the Malawi Bureau of Standards (MBS) standards for the development and operation of Renewable Energy Mini Grids as follows:

Selection and Design

MS IEC 889 – The design, system Selection on whether to go for grid extension, mini-grid or individualized energy system; and methodological approach for developing operating and maintaining min-grids shall be in accordance with the **MS IEC 889**. Key areas required by the standard for consideration shall include as follows -

Selection and Design

- Provision for integration into the grid;
- A robust technical and economic modelling (using appropriate computer software tools);
- A socio-economic impact assessment of the resource and tariffing; and
- Required long term supporting mechanisms.

Peace-meal solutions, which fail to meet people's expectation should be avoided. Systems should be adequate to satisfy demand of the area within its mandate. Modular development could be considered, where experiencing capital financing constraints. Optionally, government co-financing should be considered in case of the financial constraints.

Methodological Approach and Tools for Development of Rural Electrification Systems

The MS 889-2: 2011 **sets out the necessary data that should be collected for understanding the project environment, undertaking techno-economic feasibility study for the isolated mini-grid, and undertaking financial analysis for the isolated mini-grid.** The standard also discusses possible electrification systems architecture that can be used.

Computer packages may be used for energy resource assessment, and energy systems performance modelling, which include WAsP, WRAMS, Meso Map and True Wind Solutions, among others.

Energy systems performance modelling and simulation computer packages including: HOMER, Hybrid2, PVSYST and Wattsun, among others may also be used.

Project Development and Management for rural electrification systems

In line with the MS 889-3: 2011 the following roles and responsibilities shall be involved in the implementation of renewable rural power systems:

a. Project developer;
b. Engineering consultant;
c. Main contractor;
d. Subcontractor;
e. System operator;
f. Maintenance contractor;
g. Training provider; and
h. End-user/customer.

Contractual commitments and relevant tests shall be conducted to ensure quality assurance and environmental management techniques such as recycling of rural power systems products.

The equipment used shall be compliant with relevant IEC standards. Either, IEC approval certificates should be requested from manufacturers or equipment certification tests listed in the MS 889-3 (Table 2) and as described in MS 889-5 and MS 889-6 shall be performed.

Verification of equipment technical specifications (generally known as identification file) should be conducted and discrepancies recorded. The supplier shall give written justification of the discrepancies and outline remedial measures.

System Selection and Design

In line with MS 889-4: 2011 the fooling shall be achieved and complied with by an energy production and distribution system in relation to the user needs:

a. Technical factors;

b. Economic factors;

c. Site characteristics;

d. Regulations;

e. Energy management rules;

f. Project development documentation;

g. Commitments to supply;

h. Characteristics of proposed equipment; and

i. Data acquisition rules for system management ;

System User Interface

the designing of interface equipment within the user's installation and connecting to the mini-grid shall in compliance with MS 889-9-3: 2011 consider as follows:

a. Electrical characteristics;

b. Functional description;

c. Design and erection;

d. Information to be given and marking; and

e. Verification and acceptance

User Installation

User installations, particularly of single phase with power requirements of up to 500 VA in a decentralised rural electrification system shall in compliance with MS 889-9-4: 2011 include as follows:

a. Protection against electric shock;

b. Protection against overcurrent;

c. Protection against effect of lighting; and

d. Selection and erection of electrical equipment with regards to:

(f) Wiring, allowable voltage drops, and connections;

(g) Selection of wiring systems in relation to external influences;

(h) Specific rules to wiring buried in earth;

(i) Circuits identification;

(j) Isolation and switching;

(k) Pre-commissioning checks;

Household Lighting Equipment

The recommended tests shall be conducted in compliance with MS 889-12-1

a. To identify potentially acceptable lamps;

b. Electrical tests;

c. Luminous efficacy test; and

d. Assessment of performance and manufacturer specification.

System Components

The Standard applies to generators, distribution lines, user interface, system protection and user protection mechanisms that should be embedded in mini-grid power systems;

Q-1 Compliance with Quality Standards

Various procedures and tests shall be conducted to certify PV systems and/or PV system components. First and foremost visual inspection shall be done to establish the integrity of any supplied equipment.

The following standards shall apply:

MS ICE 61215 - modules- Design Qualification and Approval;
MS 695 - MS 695:2004 - Battery based PV Systems – Specifications;

MS 710: 2005 - General requirements for Secondary Cells and Batteries;

MS 696: 2004- Battery Based Solar PV – Code of Practice
MS IEC 61400; and MS 696

The above standards provide guidelines for compliance with quality assurance of mini-grids equipment. The standards provide areas for visual inspection that shall be used in assessing compliance with quality of renewable energy technology products. **Appendix 1** refers.

Q-2 Structural Requirements for Mini-grid Systems

Support structures for PV panels and wind turbines shall be designed to stand both dead loads and dynamic loads arising from –
the weight of solar panels and rails holding the panels for the PV system; from parked-turbine weight and the supporting tower for the wind turbine; and
the Dynamic loads from wind and precipitation for the PV system; and from wind, precipitation, and rotating turbine for the wind power systems, respectively.

6.1 Mounting of PV Panels

The strength design of PV panel mounting structures shall be guided by the metrics shown in
Table 1with reference to **Figure 1** of **Appendix 2**.

Table 1 Guiding metrics for solar panels support structure design

Dimension of PV panel (m), L*x* B *x* T; and mass, m		Distance between horizontal rails (m) based on length of PV panels, and distance between mounting holes	

Number of PV panels to be installed		Distance between PV panels	At least 0.05 m
Tilt of the PV panels in degrees		Wind speed of the location	
Precipitation of the location		Soil bearing capacity of the location	

6.1.1 Analysis of Mounting Structures for PV Panels

The PV panel structural analysis shall consider the following:

- Weight of rails
- Weight of solar panels
- Wind load - Whether the wind hits the array from the front or back of the solar panel, it would cause a velocity force given by $F_w = 0.5*\rho_a*A_a*v^2$ Where F_w is force in N caused by the wind; ρ_a is the density of air in kg/m^3; A_a is the cross section area, in m^2, perpendicular to the wind direction; and v is the wind speed in m/s.
- Rainfall loads

The following forces and bending moments shall be calculated to determine the amount of excavations and concrete in the foundation to support the expected loads in worst case scenarios.

- Forces that may act on the horizontal rail supporting the PV panels;
- Shear force and bending moment diagram;
- Forces that may act on the vertical rails; and
- Shear force and bending moment diagram.

5.1 Mounting of Wind Turbines

The design for wind turbine support structure shall be based on the parameters shown in **Table 2**.

Table 2 Guiding parameters for wind turbine structural support

Turbine blade diameter		Survival wind speed	
Swept area		Cutout wind speed	
Mass of nacelle and turbine		Hum height	

IEC 61400-2:2006 requires that, where wind turbines have a swept area of more $2m^2$, the support structure shall be specified and supplied as part of the wind turbine. The manufacturer shall also specify the foundation requirements and all specifications for support structure shall be in accordance with expected gust loads.

Three types of support structures can be considered for wind turbines: lattice tower, free standing monopole tower, guyed pole towers, and hydraulic towers. Towers shall be selected with consideration of ease of installation, maintenance and availability of expertise and construction equipment.

In compliance to IEC 61400-2:2006 for the tower installations, the wind turbine supplier shall, further, provide the following details:

- details on the mechanical turbine/tower connection;
- details on the electrical turbine/tower connection;
- minimum blade/tower clearance;
- maximum allowable tower top deflection; and
- maximum tower top loads including to access such as for maintenance.

Structural strength should be observed in the design and implementation of mini-grids power systems

Performance monitoring and evaluation for mini-grids

The following parameters for measuring the performance of mini-grids power systems including associated instrumentation shall be adhered to. Standards for benchmarking the performance of mini-grids power systems shall apply.

Costing, economic, and financial viability for mini-grids

The costing, economic and financial viability of mini-grids shall be in a way that a breakeven tariff is achieved. The standards requires as follows that –

MS 889-1: 2011 - General Introduction to Rural Electrification – that decisions, whether or not to electrify a location using an isolated mini-grid system shall be based on realistic discounted cash flow analysis and taking into account sociological and cultural aspects of the concerned location;

Also, that advantages and disadvantages of an isolated min-grid shall be analysed relative to individually powered users.

Salient Compliant Issues – Check Lists for Various Technologies

Appendix – Guidelines for Visual Inspection of Renewable Energy Equipment

A visual inspection for qualifying a PV module involves asking the following questions:

DESCRIPTIVE	RESPONSE	COMMENT

	Yes	No	
PV technology type –mono-crystalline or poly-crystalline			
PV Panel equipped with sealable waterproof junction box			
PV panel has bypass diode			
PV panel framed with aluminium frame super straight structure			
PV panel has mounting holes and grounding hole			
Label presence			
INFORMATION ON LABEL			
Manufacturer's address			
Model number			
Serial number			
Ratings: Wp, Imp, Vmp, Isc, Voc, at STC			
STC information indicated: Irradiance, and Temperature			
Rated capacity with an indication discharge rate			
Country of origin			
Date of manufacture (month and year)			
10 years minimum warranty period			

A visual inspection for qualifying a battery involves asking the following questions:

PARAMETER PROVIDED?	**RESPONSE**		**COMMENT**
	Yes	**No**	
Rated capacity with indications of several discharge rates (at least C/20 discharge rate)			
Cycle life at several depth of discharge (at least 30% depth of discharge)			
Self discharge rate per month			
Maximum charging voltage (cycling and floating)			
Final Voltage			

Terminal are bolt-nut			
Label presence			
INFORMATION ON LABEL			
Manufacturer's name and address			
Model number			
Serial number			
Rated voltage			
Rated capacity with an indication discharge rate			
Country of origin			
Date of manufacture (month and year)			
1 year minimum warranty period			

A visual inspection for qualifying an inverter involves asking the following questions:

DESCRIPTIVE	**RESPONSE**		**COMMENT**
	Yes	**No**	
Efficiency is in excess of 85 % at above 50% load output			
Has maximum surge current capacity in one minute or equivalent short period indicated			
Surge current capacity: minimum of 200% of the continuous rating for one minute			
Has reverse polarity protection			
Has short circuit protection			
Continuous output capacity indicated			
Type of waveform indicated			
Output waveform is pure sine wave			
Has low voltage shutdown capability			
Low voltage shutdown voltage indicated			
Kind of protections indicated (short circuit, overload, low voltage shutdown, reverse polarity protection etc.)			
Label presence			
INFORMATION ON LABEL			
Manufacturer's name and address			
Model number			
Serial number			
Ratings: Continuous operating power, maximum operating power in one minute			

Country of origin			
Date of manufacture (month and year)			
1 year minimum warranty period			

A visual inspection for qualifying a charge regulator/ charge controller involves asking the following questions:

DESCRIPTIVE	**RESPONSE**		**COMMENT**
	Yes	**No**	
Charging control mechanism is PWM			
Indications: Charging status, battery status(low voltage, low voltage disconnect etc)			
Set point voltages: LVD, LVR, HVD, HVR meet battery specification			
Has equalisation capability			
Has short circuit protection			
Has reverse polarity protection			
Has reverse current leakage protection from battery to modules			
Has surge protection			
Has self consumption below 100mA or below 1% of the rated capacity whichever is lower			
Label presence			
Voltage drop within charge regulator (PV to battery) not exceeding 0.5 V			
Charge control algorithm provided			
Value of temperature compensation			
Temperature compensation -18 to -30 mW/°C			
Suitable battery information			
INFORMATION ON LABEL			
Manufacturer's name and address			
Model number			
Serial number			
Country of origin			
Date of manufacture (month and year)			
2 years minimum warranty period			

The project implementer, based on advice of the project engineering consultant, may determine whether or not to accept a certain supplied product if some samples fail the initial visual inspection.

4.1 MS IEC 61400- Wind Turbine Design Requirements

A visual inspection for qualifying a wind turbine involves asking the following questions:

INFORMATION ON LABEL			
	Yes	No	Comment

Manufacturer's name and address			
Model number			
Serial number			
Country of origin			
Date of manufacture (month and year)			
Rated power indicated			
Reference wind speed provided			
Hub height operating speed range provided			
Operating ambient temperature range provided			
IEC wind turbine class			
Rated voltage at the wind turbine terminals provided			
Frequency at the wind turbine terminals or frequency range in the case that the nominal variation is greater than 2%			

Appendix 2

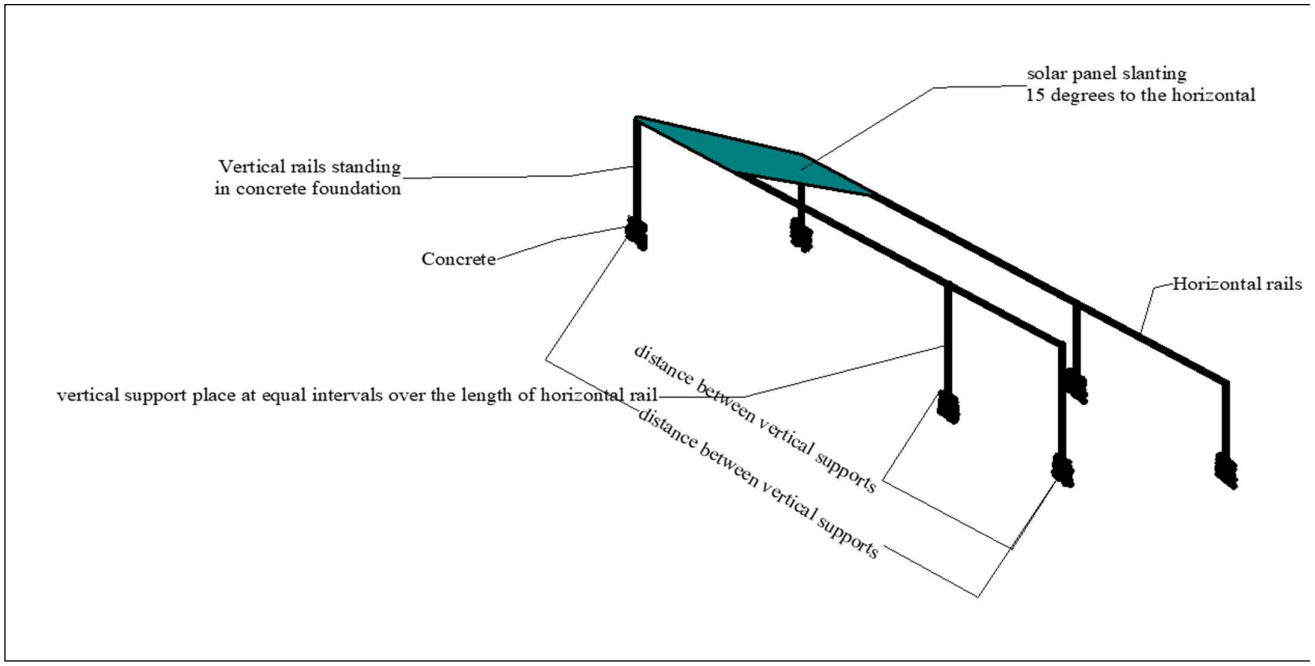

Figure 1 Example support structure for solar panels