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DRAFT TANZANIA STANDARD

(Draft for comments only)

Mini-Grid Systems –

Part 8: Electricity metering minimum accuracy and environmental requirements

TANZANIA BUREAU OF STANDARDS

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Table of contents

1. Foreword

This Draft Tanzania Standard is part of an integrated set of specifications and standards issued to govern design and construction of mini-grid power systems in Tanzania. This draft standard aims at supporting improved residential, commercial and public services for rural communities of Tanzania. The mini-grid energy systems, when properly designed, will support affordable and reliable energy supply for remote households, community services, commercial and economic activities including shops, workshops, mic ro-industry, fresh water pumping, secondary schools, health services, public lighting, places of worship or cultural activities, agro-processing activities and other activities.

There are many existing metering standards, including pre-payment standards, but almost all of these are oriented towards large scale utility operations with standard customer interconnects ranging from 50 amps to 200 amps or more, with load profile reporting and measuring capabilities consistent with the needs of such large utilities.

Rural mini-grids may include consumers who have a total power requirement of an amp or less, and who may use only a fraction of a kilowatt-hour per day. In addition, the power systems themselves may have only a limited amount of energy to supply, so this may need to be rationed among existing customers.

Mini-grid equipment suppliers have developed a number of novel m etering systems for use on mini-grids with low load requirements. Such metering systems may incorporate advanced prepayment capabilities such as limits on daily energy delivery as well as on demand and constitute the leading edge of metering technology. However, since these meters are involved in financial transactions, it is very important that the meters measure energy (and potentially also power) accurately under differing environmental and loading conditions, and that they be robust to survive wider variations of voltage and frequency.

It is recommended that some form of metering be required by the regulatory authority for all consumers on all mini-grids. This is because of fairness issues (fewer possible complaints about over or undercharging) and also to enable performance reporting of system losses. If the operator does not know how much energy is purchased, it is not possible to assess system losses.

The intent of this standard is to allow the development of novel or innovative billing strategies while maintaining confidence in the devices used as meters. Accordingly, this standard will not mandate nor control such items as payment strategies , communications protocols or register design. This standard will include.

a) Requirements for an accuracy standard that is appropriate to the reduced power levels that are present in these systems along with a testing/certification requirement.

b) Environmental/surge withstands requirements to ensure that the meters are able to operate in the real world.

c) Minimum requirements for the deterrence/detection and information display via external devices such as text messages, rather than requiring a display register.

2. Scope

This standard specifies the minimum level of functionality requirements for three phase or single phase, total current, static kilowatt-hour (kWh) meters to be installed in distribution networks of mini-grid systems.

The provisions of this standard apply to:

a) Three phase meters intended to measure 3 phase 4 wire, 230/400V, 50Hz service and to single phase meters intended to measure 1 phase 2 wire, 230V, 50 Hz service.

b) Requirements for accuracy, testing, as well as electromagnetic compatibility, and surge withstand capability requirements of devices used as electricity metering for three phase and single phase service.

Note 1 It is not within the scope of this standard to mandate or regulate capabilities for time of use (TOU) metering, smart metering, prepayment metering, communications methods or protocols, power quality data collection or any capability within the realm commonly referred to as "advanced metering".

Note 2 This standard shall be read in conjunction with other relevant –Tanzania standards, applicable standards and specifications to have uniformity, compatibility and standardization in distribution system.

3. Normative references

For the purpose of this Tanzania standard, the following references shall apply:

TZS 629: 2001 (1st Ed) *Class 0.5, 1 and 2 alternating current watt-hour meter – Specification*

IEC 62052-11: *Electricity metering equipment (AC) -General requirements, tests and test conditions – Part 11: Metering equipment*

IEC 62053 -21*: Electricity metering equipment (a.c.) - Static meters for active energy (classes 1 and 2)*

IEC 62053 -23: *Electricity metering equipment (a.c.) - Static meters for reactive energy (classes 2 and 3)*

IEC 62058-11: *Electricity metering equipment (AC) - Acceptance inspection - Part 11: General acceptance inspection methods*

IEC 62058-31: *Electricity metering equipment (AC) - Acceptance inspection - Part 31 Particular requirements for static meters for active energy (classes 0,2 S, 0,5 S, 1 and 2)*

IEC-60664-1: *Insulation coordination within low voltage system including clearances and creepage distance for equipment*

IEC-60068-2-1*: Environmental Testing-Part 2-1: Tests-Test A: Cold*

IEC-60068-2-2: *Environmental Testing-Part 2-2: Tests-Test B: Dry heat*

IEC-60529: Degree of Protection

IEC 61000: *Electromagnetic compatibility (EMC) Part- 2-2, 4-2, Part-4-3, 4-4, 4-5, 4-6, 4-8, 4-11, 4-12.*

IEC-60664: *Insulation coordination within low voltage system including clearance and creepage distance for equipment*

EN 50470-3: *Electricity metering equipment static meters for active energy, Classes A, B and C*

TANESCO –Specification S01: Supply and Installation of Plant and Equipment

- TANESCO engineering manuals

In the event of conflict between these standards and this specification, this standard shall govern. It is the intent of this standard to regulate only accuracy, surge withstand capability and electromagnetic compatibility, and not to specify constructional details.

4. Service conditions

Electricity metering for mini-grid system shall be designed for outdoor service under the conditions as follows:

a) Altitude above mean sea level (MSL): Up to 3,000 meters
b) Maximum ambient temperature: +40°C
c) Minimum ambient temperature: 0°C
d) High levels of humidity that promote the growth of fungi
e) Sun exposure of 700 watts/m ^{2}
f) Limit range of temperature for storage and transportation: -10°C - +70°C
g) Coastal areas with high levels of salt contamination

For some equipment IEC standards specify an altitude not exceeding 1000 m as a normal service condition. Altitudes higher than 1000 m are considered as abnormal service conditions and may require special considerations in the design, manufacture or application of the materials or equipment. It is the responsibility of the proponent to recognize the particular conditions occurring on any site and call them to the attention of the manufacturer.

5. Electrical system parameters requirement

System parameters for mini-grid low voltage metering of single phase (230V) and three phase (230/400V) are as follows:

a) Normal system low voltage (U): 230/400V (±10%)
b) Maximum high voltage for meter operation voltage (U_m): 253/440V

c) Minimum low voltage for meter operation: 161/280V
d) System frequency range: 50 Hz (± 3Hz)
e) Neutral grounding arrangement: system neutral is multi-grounded

6. Accuracy requirements

The accuracy requirements of metering shall be as follows:

a) Accuracy Class: 1.0 for active energy
b) Accuracy Class: 2.0 for reactive energy, if this capability is provided.

7. Power consumption of meter

a) Power consumption of meter in voltage circuit including power supply-per phase (at reference voltage): ≤ 2.0 watts and ≤ 10VA
b) Power consumption of meter in current circuit at basic current-per circuit: ≤ 4VA
c) The meter shall have a protective circuit to protect itself against any electric trouble and electromagnetic interference from other devices connected to the meter through interface such as communication port and power cable.

8. Design

Electricity metering for mini-grid system shall be designed to comply with the following mandatory capabilities:

a) Maximum temperature rise of external surfaces: +25°C with ambient temperature of +50°C
b) Rated Impulse voltage withstand (BIL):6 kV, for a wave shape of 1.2 / 50 µsec
c) Power frequency withstand voltage for 1 minute: 4kV applied between voltage and current circuits tied together and earth
d) Short time over current: $30xI_{max.}$ with tolerance of 0 to 10% for ½ cycle.
d) Minimum Creepage distance: 10mm minimum
e) Operating voltage range within which meter will maintain specified accuracy class: From - 40% to +15% of reference voltage range (U)
f) Basic or test current for single and three phase meters is not regulated, but is recommended to be 5amps.
g) Ratio of maximum allowable current to basic current (I_{max}/I_b): 4 or greater
h) Temperature rise of terminal: +30°C with ambient temperature of +50°C
i) Compliance with electromagnetic compatibility standard IEC 61000.
j) Meters shall be of Protective Class II per IEC 62052-11, which specifies that “protection against electric shock does not rely on basic insulation only, but includes additional safety precautions such as double insulation or reinforced insulation”.

9. Accuracy requirement tests

a) Every energy meter shall be calibrated for limits of error to influence quantities under reference conditions shall comply: IEC 62053-21 for active energy and IEC 62053-23 reactive energy.

b) The accuracy class of energy meter shall comply: Class 1.0 for active energy and Class 2.0 for reactive energy, if this capability is provided.

c) Limits of error due to influence quantities under reference conditions shall comply: IEC 62053-21 and IEC 62053-23.

d) The energy meter shall be normally functional within 5 seconds after the reference voltage is applied to the meter terminals.

e) When the voltage equal to 115% of the reference voltage is applied for the specified period with no current flowing in the current circuit, the test output of the meter shall not produce more than one pulse.

f) Energy meter calibration shall provide wide dynamic range and high stability over the specified operating temperature range of the meter.

10. Data retention

a) All programmed/configured data shall be retained in a non-volatile memory. The meter shall employ a memory that offers a minimum of 5 years of critical configuration data retention.

b) The meter memory shall also be used to record the minimum following security data that may be displayed/read through the communication port on request.

- Unique serial number of the meter as indicated in the nameplate, which shall not be changed or erased
- Number of times the meter has been configured
- Date and time of last configuration
- Number of times the meter has been de-energized
- Date and time of last de-energization
- Number of resets
- Date and time of last reset
- Date of battery installed
- Date and time of battery failure
- Date and time of last reverse run
- Date and time of last phase loss
- Date and time clock change (time and date)
- Date and time of calendar change (tariff, TOU etc.)

c) Registers data may be written into the memory at least once per day, and whenever power failure occurs.

11. Display functions

a) No display is mandatory but if one is supplied, it shall comply with the requirements of this part. The term “display”, for purposes of this standard refers to a visually readable output unit that is intended to be installed outdoors either integrated with the meter or located nearby, but otherwise exposed to outdoor environmental conditions. Similar visual readout devices that are intended to be installed indoors are not covered by this part.

b) A display is not mandatory, but if there is none then customers shall be able to access meter reading data in some way.

c) If provided, a display shall be high contrast, UV protected and easy-to-read multi-segment liquid crystal display (LCD).

d) The LCD shall be able to withstand environmental conditions as specified in this standard. The LCD shall not have any change in color, contrast, brightness and in any other feature during entire meter life period. The temperature limit of LCD is the same as that of the meter. The quality of LCD shall not degrade due to solar radiation.

e) The display shall have access to all the metering parameters and shall be tailored to display only the required information by masking-out undesired information.

f) The display shall have an anomaly indicator flash to indicate, when there is failure in the electronic components, overflow in calculation and/or any other error which results in meter malfunction and/or any tampering with meter or a missing phase or neutral.

g) The display shall have a reverse direction indicator flash to indicate when the active energy in any of phase is flowing in the reverse direction. Alternately, a four-quadrant indicator is also acceptable provided it shall blink when measured active energy in one or more of the phases is in the reverse direction.

h) A battery low indicator flashes or blinks when the battery requires replacement. Meter shall indicate, when remaining battery life is less than or equal to 25%.

i) All data shall automatically, under control of the meter internal clock, be noted with a time stamp.

12. Real-time lock (RTC) and calendar

a) The meter clock used for controlling measurements shall be a quartz controlled real time clock/calendar which shall generate signals measurement of kWh and kW, as well as for the switching of various tariffs, automatic reset and integration period for demand and load curves. The RTC may be used to facilitate time and date based energy rate switching, interval measurement and time stamping of events, logs and alarms.

b) Software clocks commonly used for computer timing are not acceptable for meter measurement control.

c) The clock shall use the notation 00:00 to 23:59. The calendar shall be correct for meter service life and automatically cater for leap year.

d) When the time of the Real-Time Clock (RTC) is changed, both the time before change and after changed shall be stored.

13. Battery

a) A suitable battery or super capacitor shall support the real-time clock and event/alarm logging in the event of power failure. The battery should assure long life continuous operation and one year continuous operation without AC power. The shelf-life time of the battery shall be more than 5 years.

b) In case of battery low/failure, the battery low/failure indicator in the display shall be flashed or blinked.

14. Anti-tampering/Ant-fraud features

The meter shall have anti-tampering and anti-fraud functions that have indication and registration locally in the meter. The exact nature of the anti-tampering/anti-fraud features is subject to agreement between the purchaser and the supplier, but the following elements are recommended to be included in the capability:

a) In case of tampering or opening meter security box, meter shall display anomaly indication on LCD.

b) Meter shall record energy consumption in the absence of neutral wire as long as phase wire is connected to the phase terminal or to the neutral of the meter. In this case the energy recording shall start when a minimum of 10% of basic current flows through the phase wire. In such case the energy recording shall be based on the current flowing through the meter with assumed voltage and power factor.

c) The meter shall be capable of recording energy accurately in case of change of phase with neutral or missing one or more phase and /or neutral.

d) The meter shall record number of magnetic attack events, record date, time and duration of last 10 magnetic attacks.

15. Sample testing

a) Testing (acceptance and rejection) shall be as per IEC-62053-26.

b) Testing (acceptance and rejection) shall comply: IEC-62053-21 and IEC62053-23. Factory acceptance tests (FAT) will be carried out on random samples before acceptance of meters.

16. Routine testing

Every energy meter that is delivered shall be routine tested for satisfactory performance and to comply with accuracy class in accordance with IEC 62053-21.

17. Type testing

The offered meters shall be type tested and shall have passed the tests specified in Annex A. Tests may be performed at Tanzania Bureau of Standards or an accredited independent testing laboratory within the five years prior to supply.

18. Name plate information and connection diagram

Every energy meter shall be provided with a suitably sized nameplate containing information specified below. Information on this nameplate shall be in English.

a) The Manufacturer's name or trademark, place and country of origin
b) The number of phases and the number of wires for which the meter is designed
c) Manufacturer unique serial number
d) Year of manufacture
e) The reference voltage in the form of the nominal voltage of the system to which the meter is to be connected
f) The basic current (I_b) and the rated maximum current (I_{max}) Amps
g) The reference frequency
h) The metrology constant: in the form Imp/kWh and Imp/kVA$_r$h
i) The accuracy class index of the meter
j) Appropriate symbols identifying insulation class, measuring elements and other relevant characteristics
k) The meter connection diagram shall be indelibly marked on every meter

Annex A

(informative)

Applicable IEC Reference Standards for Energy Meters Testing

Tests of Insulation Properties	
Impulse voltage tests	7.3.2 of IEC 62052-11
AC voltage tests	7.3.3 of IEC 62052-11
Tests of accuracy requirements	
Test of meter constant	8.4 of IEC 62053-21
Test of starting condition	8.3.3 of IEC 62053-21
Test of no-load condition	8.3.2 of IEC 62053-21
Test of error due to influence quantities	8.2 of IEC 62053-21
Test of error due to variation of the current	8.1 of IEC 62053-21
Accuracy tests at reference conditions	8.1 of EN50470-3
Repeatability	8.2 of EN50470-3
Variation of the error due to variation of the voltage	8.2 of IEC 62053-22
Variation of the error due to variation of the frequency	8.2 of IEC 62053-22
Variation of the error due to variation of the temperature	8.2 of IEC 62053-22
Maximum permissible error	8.4 of EN50470-3
Tests of electrical requirements	
Test of power consumption	7.1 of 62053-21
Test of influence of supply voltage	7.1 of 62052-11
Test of influence of short-time over-currents	7.2 of 62053-21
Test of influence of self-heating	7.3 of 62053-21
Test of influence of heating	7.2 of 62052-11
Test of immunity to earth fault	7.4 of 62052-11
Tests for electromagnetic compatibility (EMC)	
Radio interference suppression	7.5.8 of IEC 62052-11
Fast transient burst test	7.5.4 of IEC 62052-11
Damped oscillatory waves immunity test	7.5.7 of IEC 62052-1
Test of immunity to electromagnetic RF fields	7.5.3 of IEC 62052-11

Test of immunity to conducted disturbances, induced by radio-frequency fields	7.5.5 of IEC 62052-1
Test of immunity to electrostatic discharges	7.5.2 of IEC 62052-11
Surge immunity test	7.5.6 of IEC 62052-11
Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test	IEC 61000-4-2
Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio frequency, electromagnetic field immunity test	IEC 61000-4-3
Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	IEC 61000-4-4
Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test	IEC 61000-4-5
Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields	IEC 61000-4-6
Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test	IEC 61000-4-8
Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity test	IEC 61000-4-11
Tests of the effect of the climatic environments	
Solar radiation test	6.3.4 of IEC 62052-11
Dry heat test	6.3.1 of IEC 62052-11
Cold test	6.3.2 of IEC 62052-11
Damp heat, cyclic test	6.3.3 of IEC 62052-11
Mechanical tests	
Vibration test	5.2.2.3 of IEC 62052-11
Shock test	5.2.2.2 of IEC 62052-11
Spring hammer test	5.2.2.1 of IEC 62052-11
Tests of protection against penetration of dust and water	5.9 of IEC 62052-11
Test of resistance to heat and fire	5.8 of IEC 62052-11