



Quality Assurance for Pay-as-you-go Energy Systems

Version 1.0

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Pay-as-you-go (PAYG) enabled solar home systems and pico-solar products are rapidly expanding in market share, using new approaches to connectivity and emerging mobile money systems to provide low-cost financing for off-grid energy. The general principle is that end-users make ongoing payments for the system instead of paying cash up front, with confirmation of the payments through a range of approaches that generally use mobile connectivity of some type, either directly built-in to the energy system or via a mobile phone. The payments are due either until it is owned outright or in perpetuity in the case of energy service business models. If payments are not made in time, the system has internal circuitry to prevent its use, enforcing the loan or energy service payments.

The systems include a range of typology and system scales but generally include the following elements beyond a solar energy system without embedded PAYG financing:

- **Payment Step (examples below):**
 - **Scratch cards or payments to agents** for top-up codes
 - **Mobile money payments** using available mobile money systems
- **Confirmation Step (examples below):**
 - **Manual keypad entry** for top-up codes
 - **Internal GSM-enabled circuits** that send and receive data from remote servers
 - **Connection with other devices** that enable confirmation of payment, e.g., smart phones
- **Metering and Enforcement:**
 - **Internal circuitry** that compares information on payments received and the number of units consumed, and disables / enables system operation

Quality Standards for PAYG

The [Quality Standards](#) protect buyers with a baseline set of quality, durability, and truth-in-advertising requirements. PAYG-enabled systems should meet the same requirements as standard systems; the information below is intended to highlight how certain requirements in the Quality Standards apply to PAYG systems.

Interpretation for existing Quality Standards compliance with PAYG:

1. Truth in advertising (energy system performance): End-user experiences with the PAYG-enabled product should match the advertised values. The operation of the PAYG system should match what

is advertised in terms of the steps required for users to unlock and use the system, net of any self-consumption of energy for the PAYG system.

2. Truth in advertising (metering fairness): The PAYG system should be capable of accurately metering service to customers so they reliably get the service that is paid for.
3. Durability and workmanship: All "local" hardware (i.e., located at the household) that is included as part of the PAYG system is subject to standard assessments of workmanship and durability as applicable to the product category. This includes remote-entry keypads, integrated circuits, and any other hardware systems.
4. Battery protection: Appropriate battery protection must remain active regardless of whether the system is in an enabled or disabled state. To avoid damage to a battery during periods of disabled system status, the solar module must be able to charge the battery even if the product is in a disabled state.¹

Testing and Assessment

The following tests and assessments specifically apply to PAYG systems for meeting the Quality Standards:

Drawing on standard testing:

- Energy self-consumption: If the PAYG system adds an additional parasitic load to the device it will be measured and accounted for in normal system-level assessments of service provided. Note, if a parasitic load (such as a GSM-enabled circuit) can be unplugged or turned off when not in use, the parasitic load must still be accounted for in the estimated run time of the system, unless clear instructions to disconnect the device when not in use are presented in the user manual, along with an explanation of why the device should be disconnected when not in use.
- Durability and workmanship: PAYG components must pass the same durability and workmanship tests that are applied to other parts of the energy system. If there are remote elements (e.g., a remote keypad unit) the unit should pass the same requirements for durability as remote, handheld lighting devices, i.e., pass drop and water protection assessments.

Manufacturer declarations:

Additional manufacturer declarations will be required to verify the products meets the standards with respect to PAYG elements. Because it is often difficult to replicate use-phase conditions for the transactions, metering, and enforcement in the lab, market check testing will be employed to verify manufacturer declarations. These checks will be targeted based on anecdote and reports from the field and implementing partners. The following are categories of declaration required for PAYG products:

¹ The requirement for PAYG products to be able to charge the battery in a disabled state may be waived for products using lithium-based batteries in cases where the product is designed to protect the battery from damage when not charged for extended durations (e.g. up to one year). The design shall also ensure the product can still charge once payment is made and the charging system is re-connected. The preventive measures shall address both the discharge during use and self-discharge of the battery and shall prevent the battery from being charged if it has been discharged to an unsafe voltage. [Allowing a lithium cell to discharge below 0% state of charge can cause the anode's copper foil to dissolve and redeposit, forming conductive bridges from the anode to the cathode. If the damaged cell is then recharged, these bridges can cause internal short circuits that can initiate thermal runaway leading to explosion. Recharging a lithium cell after it has discharged below 0% can be unsafe.]

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- Multi-option system configurations
 - If there are both PAYG and non-PAYG versions of a product, any advertisements must be truthfully advertised with respect to energy services provided. If the run time and/or brightness of lights (or other service metrics) are different, these should be reflected in advertising.
- Units of measure for purchasing energy:
 - Declare if the customer purchases time or energy service and on what basis. E.g., customer purchases service by the day
- Metering accuracy, precision, and drift
 - Declare that the characteristics of the metering circuits provide customers with the level of service that is promised.
- Threshold rules for cutoff:
 - What is the internal software rule for determining if a customer is cut off from energy service? e.g., The count for the number of Wh consumed is greater than 105% of the purchased value of Wh.
- Battery protection:
 - The manufacturer must confirm that appropriate battery protection remains active regardless of whether the system is in an enabled or disabled state and that the solar module is able to charge the battery even if the product is in a disabled state.

Communication of QA Verification:

Any PAYG-enabled product that meets the baseline Quality Standards and the additional requirements for PAYG will be eligible to receive a Standardized Specifications Sheet (Spec Sheet). The Spec Sheet will include a free-form box where manufacturers may choose to include relevant PAYG information. Any information presented on the Standardized Specification Sheet will be subject to verification through the VeraSol Market Check Test program.

Add-on PAYG approaches

In some cases a product is sold in both a PAYG-enabled version and a non-PAYG version. The provider of PAYG technology may be the same organization that designs and sells the energy system, or may be a third-party “business to business” provider of PAYG. In either case, in order to verify the quality of both versions, the following process will apply:

Normal testing for the first version: One version will need to be tested using the appropriate full QTM method. Typically this is the non-PAYG version of the product.

Declarations and testing for the second version: There are several options available for verifying the quality of the second (typically PAYG) version of the product:

Option 1: The second version may be tested using the standard framework without any reference to the first version. Typically, however, an expedited and/or more inexpensive approach will be preferred from among the options below. {Normal QTM Verification Fee}

Option 2: A targeted set of testing is required to verify key parameters that may be affected by the PAYG elements of the system. These tests will be based on small sample sizes (4 samples provided by manufacturer with n=2 for each test), and include:

- A visual inspection of the product, including an internal assessment

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- Durability testing on any aspects of the product that may have been impacted by the addition of the PAYG option (e.g. new ports or changes to the existing casing)
- An estimate of the parasitic consumption or additional standby loss due to the addition of the PAYG option.

Manufacturers must also submit an expanded set of declarations that focus on identifying if performance is equivalent to that of the previously tested product. These declarations will be subject to market check tests. {PAYG Verification Fee + Fee to cover additional market check / field tests}

About VeraSol

An evolution of Lighting Global Quality Assurance, the VeraSol program supports high-performing, durable off-grid products that expand access to modern energy services. VeraSol builds upon the strong foundation for quality assurance laid by the World Bank Group and expands its services to encompass off-grid appliances, productive use equipment, and component-based solar home systems. Like Lighting Global Quality Assurance, the VeraSol program is managed by CLASP in collaboration with the Schatz Energy Research Center at Humboldt State University. Foundational support is provided by the World Bank Group's Lighting Global program, UKaid, IKEA Foundation, Good Energies Foundation, and others.

Please visit VeraSol.org for more information.