

QUALITY ASSURANCE FOR OFF-GRID TVS AND FANS: LESSONS LEARNED AND PATHS FORWARD

JANUARY 2020

EFFICIENCY FOR ACCESS COALITION



Since June 2018, Efficiency for Access has developed and been piloting a quality assurance (QA) framework for standalone off-grid TVs and fans. This learning paper presents the current quality criteria for TVs and fans, documents key learnings, and provides recommendations for QA for other off-grid appliances. These learnings and quality criteria aim to organize and align the market and help market actors make more informed decisions.

The paper was developed by CLASP as part of the Low Energy Inclusive Appliances program, a flagship program of the Efficiency for Access Coalition. Efficiency for Access is a global coalition promoting energy efficiency as a potent catalyst in clean energy access efforts. Currently Efficiency for Access Coalition members lead 12 programs and initiatives spanning three continents, 44 countries, and 22 key technologies.

The Efficiency for Access Coalition is jointly coordinated by CLASP, an international appliance energy efficiency and market development specialist non-for-profit organization, and the UK's Energy Saving Trust, which specializes in energy efficiency product verification, data and insight, advice, and research.

The learning paper was peer reviewed by Meg Harper (Schatz Energy Research Center), Dr. George Kyriakarakos (Agricultural University of Athens), and Jeremy Tait (Tait Consulting).

This learning paper has been funded by Good Energies Foundation and UK aid from the UK government. The views expressed do not necessarily reflect the UK government's official policies.



BACKGROUND & INTRODUCTION

High-quality appliances create demand for energy services, help consumers move up the energy ladder, and improve the quality of life in off-grid communities. Still, inconsistencies in performance reporting and a lack of reliable data make it difficult for buyers to identify high-performing products. Coupling this with the fact that appliances are a significant cost for most off-grid consumers, ensuring that products are high-quality and perform as expected is crucial.

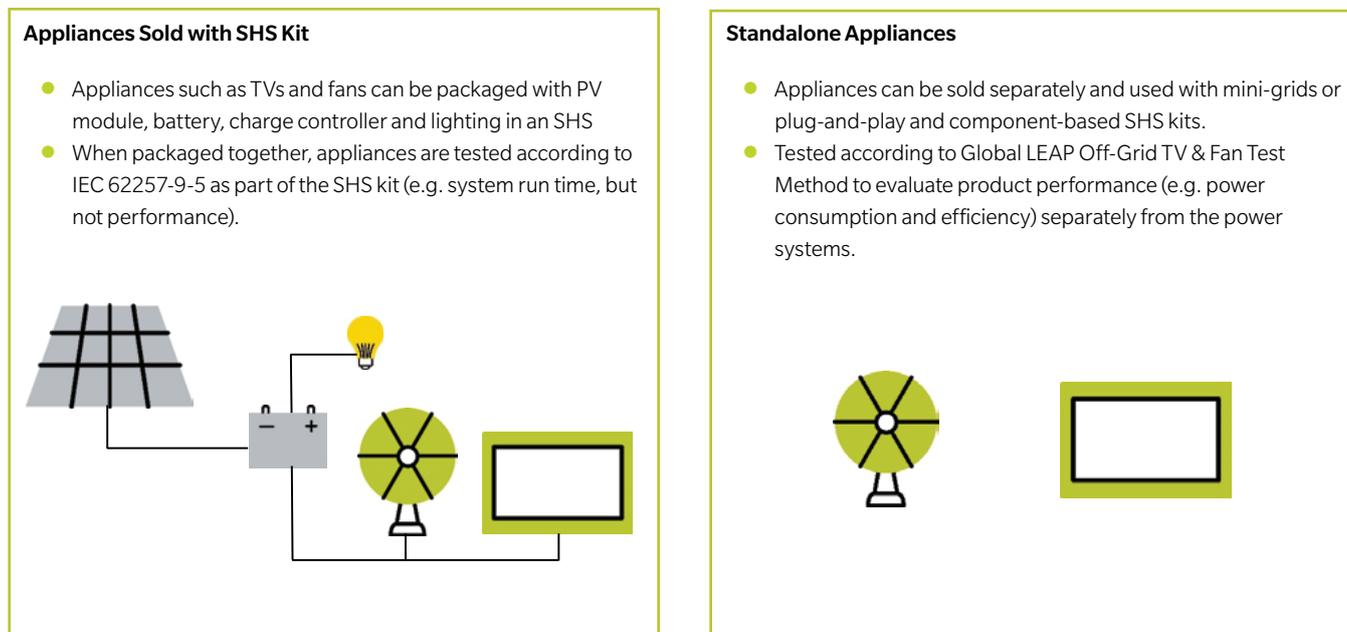
Televisions (TVs) and fans are two of the most commonly available off-grid appliances, each with high consumer demand and large market potential.¹ Despite the prominence of TVs and fans in off-grid markets, stakeholders lack the resources they need to compare and differentiate the quality of these standalone products independent from off-grid solar home system (SHS) kits² (see Figure 1).

While there is no formal framework in place to evaluate the quality of off-grid appliances on a continuous basis, the [Equip Data tool](#)³ from Efficiency for Access (EforA) acts as an important first step in closing the information gap on appliance performance. By testing appliances and sharing

performance data, Equip Data allows market actors to access reliable data and make product comparisons. Building on the work of Equip Data, EforA developed and piloted a quality assurance (QA) framework for standalone off-grid TVs and fans. Through this framework, EforA developed a set of quality criteria⁴, tested products, evaluated them using the established quality criteria, and shared findings and data with stakeholders to promote quality products.

This document presents the draft quality criteria for TVs and fans, outlines key findings from testing and evaluation, provides recommendations for expanded QA efforts for other off-grid appliances, and solicits feedback from the sector to help improve the evaluation criteria. Lessons learned from testing and evaluation under the pilot QA framework provide insights into the effectiveness of the QA framework as well as potential future QA interventions for other off-grid appliances. These learnings and the quality criteria may be used to organize and align the market on uniform test methods and performance reporting, and allow market actors like policymakers, program partners, manufacturers, and distributors to make faster, more informed decisions about off-grid products.

Figure 1: Appliances Sold with SHS Kit vs. Standalone Appliances



1. Efficiency for Access, The State of the Off-Grid Appliance Market, 2019. <https://storage.googleapis.com/e4a-website-assets/Clasp-SOGAM-Report-ExecSummary-final.pdf>

2. Read more about Quality Standards for SHS kits here: <https://www.lightingglobal.org/resource/solar-home-system-kit-quality-standards/>

3. Equip Data is a product testing and data sharing program that develops and maintains off-grid test methods, works with a network of labs to test products to these test methods, and shares the data on an online database. <https://efficiencyforaccess.org/equip-data>

4. See Annex A and B for the detailed quality criteria.

METHODOLOGY

To develop a QA framework for TVs and fans, Efficiency for Access worked through a three-step approach outlined in Figure 2.

Figure 2: Process for Piloting QA for TVs and Fans



Draft Quality Criteria for TVs and Fans

The Lighting Global Quality Assurance program and its evolving quality standards for pico-solar and SHS kits have been instrumental in building a rigorous technical foundation that inspires confidence in solar lighting products and protects buyers and consumers from negative user experience. The current Lighting Global Quality Standards⁵ are built on the principles of:

- **Performance reporting:** Ensures the most essential performance information is reported to help buyers compare products and make more informed decisions;
- **Truth-in-advertising:** Ensures consumer-facing information is accurately described and that end-users

get the energy services that they expect from the product;

- **Durability, safety & quality:** Ensures products meet minimum safety requirements and have appropriate protection to prevent early failure; and
- **Consumer protection:** Ensures end-users have instructions on how to use products and are protected by adequate warranty coverage.

To develop the quality criteria for TVs and fans, Efficiency for Access worked in consultation with several stakeholders, including IFC Lighting Global country teams who already have experience with QA for pico-solar products and SHS kits. These consultations characterized the off-grid appliance market as nascent and one of rapid change. Feedback unearthed the need to encourage the development of high-quality products that better serve and protect consumers through a focus on performance reporting, truth-in-advertising, durability, safety & quality, and consumer protection. The initial framework is voluntary and flexible enough to collect data points and adjust the quality criteria over time.

Based on these considerations, Efficiency for Access drafted its quality criteria for TVs and fans, outlined in Table 1 below, to reference the principles of the Lighting Global Quality Standards. The detailed quality criteria and explanation of each parameter is included in Annex A and B of this document.

Table 1: Summary of Draft Quality Criteria for Off-Grid TVs and Fans

Aspect	Requirements	TV Evaluation Parameters	Fan Evaluation Parameters
Performance Reporting	Performance metrics and units are presented on packaging and other consumer-facing materials	<ul style="list-style-type: none"> • On-Mode Power Consumption (W) 	<ul style="list-style-type: none"> • Air Delivery (m³/min) • Power Consumption (W)
Truth in Advertising	Value presented on consumer-facing materials deviate no more than 15% from the tested values	<ul style="list-style-type: none"> • On-Mode Power Consumption (W) • Maximum On-Mode Power Consumption (W) • Standby-Mode Power Consumption (W) • Luminance in Home and Retail Setting (Cd/m²) • Viewing Angle (degrees) 	<ul style="list-style-type: none"> • Air Delivery (m³/min) • Power Consumption (W) • Service Value (m³/min/W) • Fan Speed (RPM)
Durability	Product is functioning and no dangerous failures after testing	<ul style="list-style-type: none"> • Function in voltage fluctuation conditions • Function in harsh environment exposure conditions 	<ul style="list-style-type: none"> • Function in voltage fluctuation conditions • Function in harsh environment exposure conditions
Quality & Safety	Product passes all applicable quality and safety tests	<ul style="list-style-type: none"> • Physical Ingress Protection (IP2X⁶) • Workmanship Inspection 	<ul style="list-style-type: none"> • Physical Ingress Protection (IP2X⁶) • Drop Test • Fan Blade Guard Safety Inspection • Workmanship Inspection
Consumer Protection	User manual must present instructions for use and basic electrical safety; warranty is accurately specified and consumer-facing with minimum coverage of one year	<ul style="list-style-type: none"> • User manual • Warranty (one year) 	<ul style="list-style-type: none"> • User manual • Warranty (one year)

5. Learn more about the Lighting Global Quality Standards: <https://www.lightingglobal.org/quality-assurance-program/our-standards/>

6. IP refers to ingress protection. The first digit indicates the degree of protection against access to hazardous parts and solid foreign objects, and 2 is rated for protection against a solid object of 1.25 mm (e.g. a finger). The second digit indicates the degree of protection against water, which is not tested

Product Selection, Testing & Evaluation

From June 2018 to December 2019, Efficiency for Access sampled and tested total of 19 products—eight TVs sourced directly from manufacturers and 11 fans sourced from retail markets or from manufacturers. The pilot used a pre-existing testing process from Equip Data that included a random sampling procedure, network of test lab partners,⁷ and publication of test results via an online database.

The process for selecting, testing, and evaluating products against the quality criteria involved five key steps highlighted in Figure 3.

Figure 3: Process for Selecting, Testing and Evaluating TVs & Fans



*Equip Data is an online database that contains consistent and comparable product performance data for off-grid TVs, fans, refrigerators, and solar water pumps.

Engaging market actors to use results

During the initial pilot, several stakeholders utilized the evaluation results, including IFC Lighting Global country teams and manufacturers.

- IFC Lighting Asia-India, used the evaluation process to screen off-grid appliances as a part of their eligibility requirements to participate in the IFC Lighting Asia-India program's in-country consumer awareness campaigns.
- Efficiency for Access also worked with IFC Lighting Asia-Pakistan to test and evaluate locally available fans. The evaluation results showed that there was an opportunity to improve the design of fans sold in the market and so the Pakistan team worked with local manufacturers to help them source highly efficient brushless DC motors.⁸
- One manufacturer who participated in the pilot found the evaluation useful to inform product and packaging design. The manufacturer has been working to improve ingress protection and durability based on the evaluation recommendations and will retest the product in January 2020.

The above examples highlight the ways that quality evaluation can be used by two select stakeholder groups (i.e. program partners and manufacturers) to increase the share of high-quality products. As stated in the recommendations section of this document, there is an opportunity to engage a more diverse group of market actors to use and benefit from the testing and evaluation process.

The following section maps the results for TVs and fans tested and evaluated using specific quality criteria for each product category. While the sample size was small, the testing and evaluation process provides informative findings that help move quality assurance for off-grid appliances forward.

The results from this evaluation show that while most products meet minimum durability, quality, and safety requirements, performance reporting is largely unaligned. Most of the products do not advertise key performance values or include inaccurate values. Additionally, many products fail to include the required minimum one-year warranty and documentation, an essential component to consumer protection.

8. Read the full story: <https://medium.com/efficiency-for-access/off-grid-fan-quality-testing-in-pakistan-fce8364721e0>

TV QUALITY EVALUATION & KEY TAKEAWAYS

Performance Reporting

Three out of eight TVs evaluated failed to provide any indication of the product’s expected power consumption during operation on the product nameplate or packaging (see example nameplate in Figure 4). The lack of power consumption ratings can be a critical barrier for potential buyers to accurately estimate the energy usage and size SHS capacity appropriately to power the appliance.

Truth-in-Advertising

All but one TV met the truth-in-advertising requirements, either through not reporting these metrics or through reporting values that deviated less than 15% from the values determined through testing. It’s important to note that in the pilot criteria, companies could exceed the 15% deviation for truth-in-advertising if the actual performance is better than advertised.

Figure 4: Example of a TV Nameplate⁹



The evaluation results showed that allowing companies to over-report performance could present issues. To illustrate this, Table 3 on the following page provides two indicative TV examples that show both case of over-reporting and under-reporting.

Table 2: Summary of TV Quality Criteria & Evaluation Results

Aspect	Requirements	Evaluation Summary (n=8)		
		Pass	Fail	Not Reported
Performance Reporting	On Mode Power Consumption	5	3	--
Truth in Advertising	On Mode Power Consumption	5	0	3
	Maximum On Mode Power Consumption	3	1	4
	Standby Mode Power Consumption	2	0	6
	Luminance in Home Setting (Cd/m ²)	0	0	8
	Luminance in Retail Setting (Cd/m ²)	0	0	8
	Viewing Angle	0	0	8
Durability	Power Consumption (W) in Voltage Fluctuation Conditions	8	0	--
	Power Consumption (W) in Harsh Environment Exposure Conditions	8	0	--
Quality & Safety	Physical Ingress Protection	8	0	--
	Workmanship Inspection	8	0	--
Consumer Protection	User Manual	6	2	--
	Warranty Documentation	2	6	--

9. Brand name, model number, and serial number removed for privacy purposes.

Table 3: Examples of TV On Mode Power Truth-in-Advertising Evaluation

Example	Advertised On Mode Power Consumption	Tested On Mode Power Consumption	Deviation from advertised values	Evaluation results based on current criteria
1 – Under-reporting	13 W	17 W	+30%	Fail (given the tested performance is worse than advertised)
2 – Over-reporting	24 W	13.5 W	-77%	Pass (given the tested performance is better than advertised)

Example 1 demonstrate a typical case for a product that does not meet the truth-in-advertising requirement because the tested performance is worse than advertised. In example 2, the TV’s actual tested on mode power is better than the advertised value, which is considered a pass based on the current truth-in-advertising requirement. In this case, a buyer using the rated energy consumption to size the capacity would likely result in an oversized SHS. This indicates that the performance reporting criteria can potentially be tightened. Even when the tested power consumption is lower than rated value, the rated power consumption value should be reported within a certain range of the tested values.

During the evaluation, any unspecified advertised value about power consumption was assumed to be the maximum on mode power consumption. For example, by simply stating “Power consumption: 10 W”, one could assume that 10 W is the maximum power consumption, but in reality the TV actually consumes more than 10 W when the display brightness and audio are set to max. To better align reporting, either both metrics, average and maximum, should be reported, or manufacturers should clearly specify whether the value is the average or maximum power consumption. This will help make products more comparable and ensure that power consumption values are interpreted correctly.

Durability

All TV models were able to perform appropriately during voltage fluctuation conditions and after harsh environmental exposure. This signals that the tested products are properly designed to use in off-grid contexts. While the current durability requirements are likely sufficient, some programs may be interested in conducting additional durability testing based on specific use cases and environmental conditions, e.g. in extremely humid environments.

Quality & Safety

All TVs models met the minimum quality and safety requirements for ingress protection and workmanship inspection. As with durability, stricter requirements for ingress protection and workmanship do not seem necessary

at this point, though some programs may be interested in tightening the quality criteria. For example, if the product will be used in dusty environments, program might want to increase the required level to IP3X for IP4X¹⁰.

Consumer Protection

While most products included a user manual, only two of eight TVs included a warranty with appropriate information on how consumers may service their product in the event of defect or malfunction. Warranty coverage is critical and should be a high-priority recommendation for companies.

FAN QUALITY EVALUATION & KEY TAKEAWAYS

Performance Reporting

Seven out of 11 fans evaluated did not report fan performance metrics (air delivery and power consumption) on either the product nameplate or packaging. While voltage was commonly available on the product nameplate, key performance metrics of fans, such as power consumption and air delivery, were not advertised (see example nameplate of one of the evaluated products in Figure 5). The evaluation suggests that there is a lack of consistent data reporting which makes it difficult for buyers to make informed purchasing decisions.

Figure 5: Example of a Fan Nameplate¹¹



10. IP refers to ingress protection. The first digit indicates the degree of protection against access to hazardous parts and solid foreign objects, and the second digit indicates the degree of protection against water. IP3X is rated for protection against a solid object of 2.5 mm (e.g. a tool) and water protection not tested. IP4X is rated for protection against a solid object of 1 mm (e.g. most wires) and water protection not tested.

11. Brand name and R.T.M. number removed for privacy purposes.

Table 4: Summary of Fan Quality Criteria & Evaluation Results

Aspect	Requirements	Evaluation Summary (n=11)		
		Pass	Fail	Not Reported
Performance Reporting	Air Delivery	4	7	--
	Power Consumption	4	7	--
Truth in Advertising	Air Delivery	2	2	7
	Power Consumption	4	0	7
	Service Value (m ³ /min/W)	0	0	11
	Fan Speed (RPM)	2	0	9
Durability	Performance in Voltage Fluctuation Conditions	11	0	--
	Performance in Harsh Environment Exposure Conditions	11	0	--
Quality & Safety	Physical Ingress Protection	5	6	--
	Drop Test	4	2	5*
	Fan Blade Guard Safety Inspection	11	0	--
Consumer Protection	User Manual	3	8	--
	Warranty Documentation	2	9	--

*Drop tests are not performed on ceiling fans.

Truth-in-Advertising

All of the 11 fans met the truth-in-advertising requirements, but the majority of products met this requirement by not reporting any performance metrics (see Table 4). As with performance reporting, this suggests that there is insufficient information included on the nameplate or packaging to help inform purchasing decisions.

Durability

Like TVs, all fans tested were able to continue performing during voltage fluctuation conditions and after harsh environmental exposure. During the evaluation, the team also identified that the method for the drop test, which involves dropping a fan from a height of one meter, may be too stringent for pedestal fans. Unlike table fans, standing pedestal fans are less likely to be used and dropped from a highly elevated surface and thus the current test method for drop test was not appropriate. Efficiency for Access has since revised the Global LEAP Test Method for Off-Grid Fans¹² to reduce the height of drop test for pedestal fans.

Quality & Safety

Although all the tested pedestal fans came with a properly fitted fan blade guard, all six of these failed the physical ingress protection requirement. The physical ingress protection requires fan guards to meet IP2X, which means it must prevent a 12.5mm solid object from penetrating the fan guard to reach the fan blade while in operation. The IP2X is selected as the minimum requirement because the test probe size is similar to the width of a child’s finger. The fact that all tested pedestal fans failed the ingress protection tests indicates significant room for improvement, considering a child could fairly easily touch the rotating fan blade and cause serious injuries.

Consumer Protection

Most of the fans failed to provide other consumer-facing information, such as a user manual or minimum one-year service warranty with appropriate information (e.g. how to access the warranty). This underscores the lack of buyer and consumer protection in the off-grid fan market.

12. Global LEAP Off-Grid Fan Test Method: <https://storage.googleapis.com/leap-assets/Global-LEAP-Off-Grid-Fan-Test-Method-Version-1.2-Jan-2020.pdf>

RECOMMENDATIONS & NEXT STEPS

RECOMMENDATIONS

The initial approach of QA for TVs and fans, albeit small in scale, provides useful insights on the effectiveness of the quality evaluation criteria and future work.

Adjusting the current quality criteria

Based on testing and evaluation results, Efficiency for Access recommends adjusting certain aspects of the quality criteria for TVs and fans outlined in Annex A and Annex B. As discussed, the current criteria allow companies to exceed the 15% deviation for TVs for truth-in-advertising if the actual performance is better than advertised. Since this can create problems for buyers when sizing systems, EforA will adjust the criteria to require all reported values to fall within a certain percentage of the tested value regardless of whether the company is over- or under-reporting performance. To better align performance reporting and make products more comparable, the quality criteria for TVs and fans will also be updated to require that companies report both average and maximum power consumption or specify whether the value is the average or maximum.

As the markets for off-grid TVs and fans reach maturity, environmental sustainability of these and other solar appliances becomes increasingly important. Quality criteria that targets issues such as repairability and e-waste can encourage product manufacturers to improve product design that enables easy repair and recyclability at the end of product life. Efforts as such help extend product lifespans, thus reducing costs for end-users and minimize environmental impacts of solar products. EforA will consider these issues in the next iteration of quality criteria for TVs and fans.

Organizing the off-grid appliance market towards standardization

The review of product performance highlights key parameters where most products failed to meet the quality evaluation criteria for: performance reporting, consumer-facing information, and safety and durability. More organization in the market is needed to align criteria for performance reporting and safety and durability. These efforts can help protect consumers and give market actors the tools to easily identify quality products. By working directly with manufacturers and other stakeholders to test and evaluate products, Efficiency for Access is working to improve these requirements over time and encourage the gradual adoption of the quality criteria and Global LEAP test methods as common practice among companies.

Identifying users of QA for off-grid appliances

A diverse and actively engaged group of market actors that use and value quality criteria is needed to move the off-grid appliance market toward standardization. This pilot found the QA framework was valuable to TV and fan manufacturers and helped them identify design improvements. The framework help the IFC Lighting Global country teams to instill confidence in the products they support. There is a potential to reach a wider group of manufacturers and program partners, but also to engage other market actors like distributors, investors and policymakers to use QA in their decision-making process. Once there is a clear landscape of the demand for QA, Efficiency for Access can work directly with companies, organizations, and governments to support and foster the adoption of standardized testing and evaluation processes.

NEXT STEPS

To better understand the interest, need and current practices for QA for off-grid appliances, Efficiency for Access is holding a series of consultations with various stakeholders including manufacturers, program partners, investors, policymakers, and distributors. The goal of these consultations is to:

- Evaluate the need for QA for off-grid appliances;
- Understand what metrics stakeholders are already using to identify quality products;
- Identify appliances to develop quality criteria for TVs, fans, and beyond.

The learning from the stakeholder consultations will enable:

- Development of a QA process for other products and refinement of the current set of quality criteria;
- More informed engagement with market actors such as distributors to include product testing and quality as a consideration in their procurement practices;
- Partnership with companies to align their internal test methods with the Global LEAP Awards off-grid test methods, and to inform product design improvements and harmonize consumer-facing information based on Efficiency for Access' recommendations; and
- Opportunities to engage with standards-setting organizations, such as the IEC technical committees, to solidify off-grid appliance test methods.

If you are interested in working with our Efficiency for Access on QA for off-grid appliances or have any feedback, please contact us at info@efficiencyforaccess.org.

FAN QA EVALUATION CRITERIA

Products are tested according to [Global LEAP Off-Grid Fan Test Method](#) and evaluated based on the criteria below.

Aspect	QA Evaluation Criteria
Air Delivery (m³/min)	Performance metric is included on product packaging and other consumer-facing materials with metric and units used included; Value accurately presented on consuming-facing materials ¹⁴
Power Consumption (W)¹⁵	Performance metric is included on product packaging and other consumer-facing materials with metric and units used included; Value accurately presented on consuming-facing materials
Service Value (m³/min/W)	Value accurately presented on consuming-facing materials
Fan Speed (RPM)	Value accurately presented on any consumer facing materials
Power Consumption (W) in Voltage Fluctuation Conditions	Product is functioning and no dangerous failures
Power Consumption (W) in Harsh Environment Exposure Conditions	Product is functioning and no dangerous failures
Physical Ingress Protection	Meets IP2X
Drop Test (not applicable to ceiling fans)	Product is functioning and no dangerous failures
Fan Blade Guard Safety Inspection (not applicable to ceiling fans)	Must meet requirements specified in the Clause 20.101 of IEC 60335-2-80
Workmanship Inspection	Product is fitted with two or more well-balanced blades made from metal or other suitable material so as to be reasonably free from vibration. Fan bearings are in good quality and appropriately lubricated for use.
User Manual	User manual must present instructions for use and basic electrical safety
Warranty Documentation	Accurately specified and consumer-facing; Minimum coverage of one year

14. The reported numeric aspects should deviate no more than 15% from the values determined through testing (although it is acceptable if actual performance is better than advertised).contact with the shipping agent.

15. The regulator, if present, shall be set at the highest speed position.

TV QA EVALUATION CRITERIA

Products are tested according to [Global LEAP Off-Grid TV Test Method](#) and evaluated based on the criteria below.

Aspect	QA Evaluation Criteria
On-Mode Power Consumption (W)	Performance metric is included on product packaging and other consumer-facing materials with metric and units used included; Value accurately presented on consuming-facing materials ¹⁶
Maximum On-Mode Power Consumption (W)	The tested maximum on-mode power consumption value should not exceed the rated, consumer-facing on-mode energy consumption value.
Standby-Mode Power Consumption (W)	Value accurately presented on consuming-facing materials
Luminance in Home Setting¹⁷ (Cd/cm²)	Value accurately presented on any consumer facing materials
Luminance in Retail Setting¹⁸ (Cd/cm²)	Value accurately presented on any consumer facing materials
On Mode Power Consumption (W) in Voltage Fluctuation Conditions	Product is functioning and no dangerous failures
On Mode Power Consumption (W) in Harsh Environment Exposure Conditions	Product is functioning and no dangerous failures
Physical Ingress Protection	Meets IP2X
Viewing Angle (Horizontal and Vertical)	Value accurately presented on any consumer-facing materials
Workmanship Inspection	The quality and workmanship of TV components including but not limited to enclosure, screen, wiring, fittings, and connections must be rated "Good" or "Fair" according to Global LEAP Off-Grid TV Test Method
User Manual	User manual must present instructions for use and basic electrical safety
Warranty Documentation	Accurately specified and consumer-facing; Minimum coverage of one year

16. The reported numeric aspects should deviate no more than 15% from the values determined through testing (although it is acceptable if actual performance is better than advertised).

17. If unspecified, the rated luminance value will be evaluated as the luminance in retail setting.

18. If unspecified, the rated luminance value will be evaluated as the luminance in retail setting.



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