Global Distributors Collective

Finding the sweet spot: identifying affordable quality solar products for the last mile

Funded by:
UKaid
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Contributions from:
VeraSol

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This material has been funded by UK aid from the UK government; however the views expressed do not necessarily reflect the UK government's official policies.

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Contributors

The Global Distributors Collective (GDC) is a collective of last mile distributors around the world, dedicated to supporting distributors to reach millions of unserved customers with life-changing products, and to developing the last mile distribution sector as a whole. The GDC has more than 150 members in 43 countries who have jointly helped over 25 million people benefit from products with high positive impact, such as solar lights, improved cookstoves and water filters. The GDC's ambition is to make last mile distribution the first priority, so that life-changing products can be made affordable and available to all. Visit www.globaldistributorscollective.org to learn more.

The GDC is hosted by international development organisation Practical Action and activities are delivered in consortium with two implementing partners, BoP Innovation Center and Hystra. This report was written by Hystra, on behalf of the GDC.

Hystra is a global consulting firm specialised in designing and implementing sustainable, scalable business strategies with a social and environmental impact. Since its creation in 2009, Hystra has worked in over 40 countries on over 250 projects, serving large corporations, inclusive businesses, social investors, and public and private donors to support business models that change the lives of low-income communities across the globe. Visit www.hystra.com to learn more.

VeraSol, an evolution of Lighting Global Quality Assurance, 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. VeraSol 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, and others. Visit VeraSol.org to learn more.

Sollatek Electronics (Kenya) Ltd has been a regional leader in supplying clean reliable on and off grid energy solutions in East Africa since 1985. They operate as a wholesale and last mile distribution outfit selling their products through a region-wide network of distributors, sales agents and partners. Sollatek Solar Division supplies complete turnkey solar systems and ancillary equipment including solar energy systems, solar modules, charge controllers, batteries, solar home systems and portable lanterns. Over the last ten years, Sollatek has sold over 800,000 solar lanterns and solar home systems in East Africa. Visit www.sollatek.co.ke to learn more.

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Graphic designed by: Re-emerging World

List of acronyms

- **Ah** – Ampere Hour
- **FOB** – Free On Board
- **GDC** – Global Distributors Collective
- **ISM** – Initial Screening Method
- **LMD** – Last Mile Distributor
- **MLS** – Multi-Light System
- **Non-QV** – Non-quality-verified
- **ODM** – Original Design Manufacturer
- **OGS** – Off-Grid Solar
- **PAYGO** – Pay As You Go
- **QTM** – Quality Test Method
- **QV** – Quality-Verified
- **RRP** – Recommended Retail Price
- **SL** – Solar Lantern
- **SLA** – Sealed Lead Acid
- **UoN-LL** – University of Nairobi – Lighting Laboratory
- **Wp** – Watt-peak

Key definitions

- **Grey market:** the market made up of off-grid solar (OGS) products that do not comply with the applicable Kenyan Standard (KS 2542) and the Lighting Global Quality Standards for pico-solar products[1]
- **Lighting Global Quality Standards (also referred to as "the standards"):** standards that set a baseline for off-grid lighting product quality, durability, truth-in-advertising, warranty, and lumen maintenance[2]
- **(Non-) Quality-verified (QV/non-QV):** products that are (not) compliant with the Lighting Global Quality Standards
- **Pico-solar products:** pico-solar products have a solar panel rated 10 Watt-peak (Wp)[3] or lower and enable up to Tier One Electricity Access[4]; this includes
  - **Solar lanterns (SL):** a simple, portable one-light system with one LED light, an embedded 0.5–3.0 Wp solar panel, and an internal rechargeable battery; some models include USB charging for mobile phones
  - **Multi-light systems (MLS):** fixed systems of up to three or four LED lights with a standalone solar panel rated up to 10 Wp and a rechargeable battery; some models include USB charging for mobile phones
- **Price-competitive/affordable:** can be sold on cash to end-users at 25-50 per cent cheaper price-points than leading QV products in the market with similar specifications (e.g. battery size, panel size, number of light points, etc.), and a valid two-year warranty
- **Price-quality sweet spot:** products in the price-quality sweet spot are both price-competitive (see definition above) and meet the Lighting Global Quality Standards

1. The Kenyan Standard KS2542 is aligned with the Lighting Global Quality Standards for pico-solar-solar products.

2. In June 2020 the International Electrotechnical Commission (IEC) published quality standards for pico-solar products and solar home system kits under the designation IEC TS 62257-9-8. The new IEC standards are based on and will replace the Lighting Global Quality Standards. Product testing for this study was carried out according to the methodology described in IEC TS 62257-9-5:2016 and test results were assessed for compliance with the Lighting Global Quality Standards for pico-solar products.

3. As per the definition used in the Lighting Global Quality Standards.

4. Products enabling 'Tier One' access, according to the SEforAll Multi-tier Framework for Energy Access, have a minimum of 3 Wp in power capacity, giving at least four hours of light per day and one hour of light per evening. ESMAP (2015), Beyond Connections, Energy Access Redefined, Technical Report 008/15.

Executive summary

Last mile distributors (LMDs) of beneficial products need access to products that are high quality, meet customer preferences, and can be sold at the last mile at affordable prices. Today, in the off-grid solar (OGS) sector, LMDs have difficulty accessing such products due to two key challenges:

- **Challenge one – Product selection:** LMDs struggle to identify the products that are best suited to their customers' needs, and find themselves stuck between quality-verified (QV) products, known to be high quality but carrying a relative price premium, and non-quality-verified (non-QV) products, sold at more affordable price-points yet lacking in quality assurance.
- **Challenge two – Product importation:** once LMDs have selected products, they often have to import them due to lack of (or limited) in-country stock. The whole importation process requires significant management time, as well as working capital, which in addition to creating significant hassle for LMDs, also translates into high additional costs per product. LMDs have no other choice than to reflect these in end-user prices.

This report provides a methodology and insights that can help respond to the first challenge: finding products at the price-quality "sweet spot". The Global Distributors Collective (GDC) is also piloting a model which aims to address the second challenge (product importation), to test if it is possible to make more affordable, quality products accessible to LMDs and thus to their customers (see page 8 for more details).

We ran a rigorous funnelled process to identify 18 best-selling, price-competitive products out of 100 products found in the Kenyan non-QV market and subject these to quality testing at an approved Lighting Global laboratory, in a bid to identify products that meet, or are close to meeting, Lighting Global Quality Standards. For those close to the standards, we identified the key tweaks required in order to make these products fully conform with the standards. Finally, we developed estimates of the likely cost of making these tweaks and supplying these products with a valid warranty and in-country after-sales service. Three key insights came out of this research:

1. There are 50 shades of grey in the non-QV OGS market: the non-QV OGS market includes products with all levels of performance

All 18 tested products fail to meet Lighting Global Quality Standards, yet their performance varies significantly. Out of the eight "finalists", as seen in figure one, three products are close to meeting the standards.

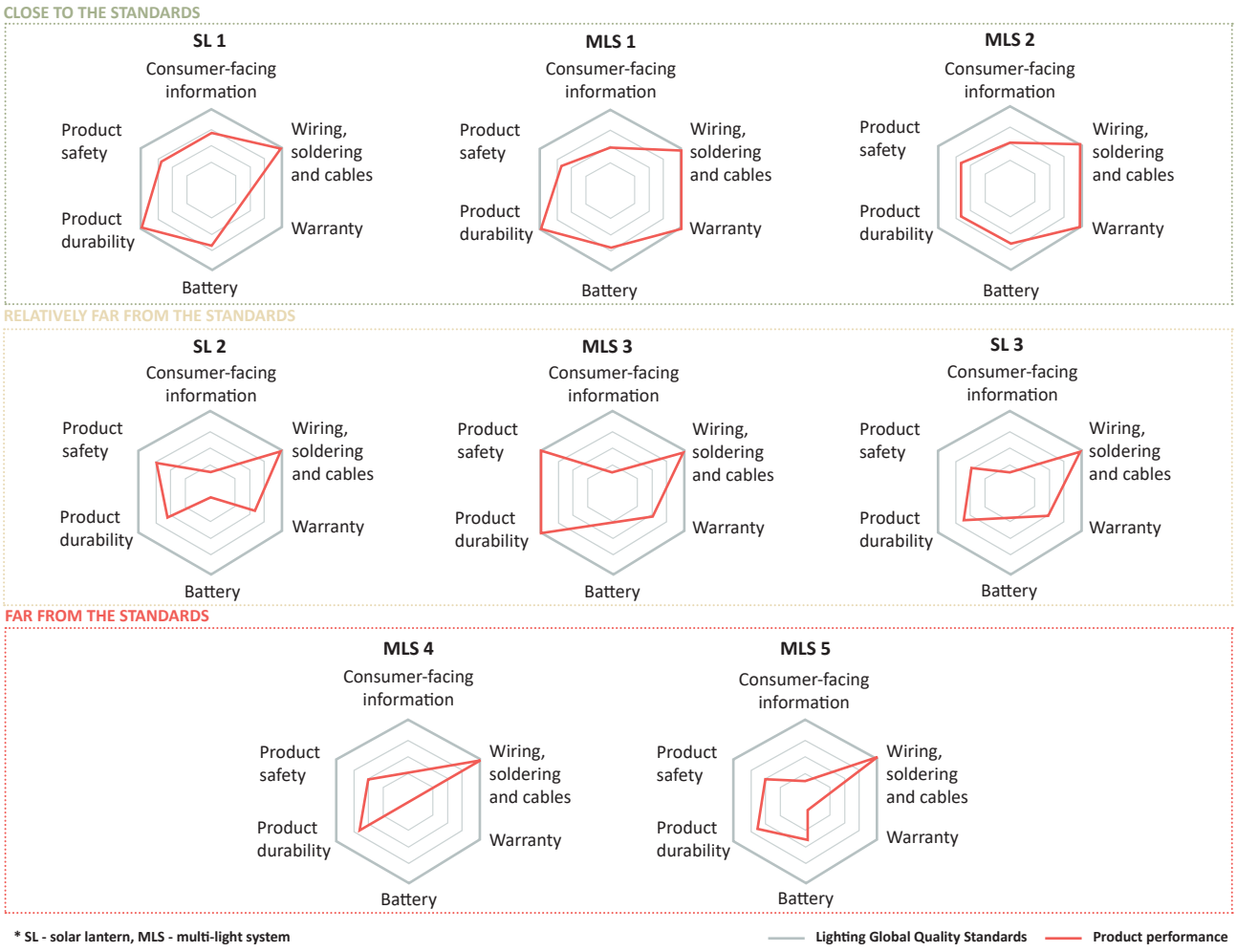


Figure 1 : Comparison of Initial Screening Method (ISM) test results against the Lighting Global Quality Standards[5]

2. The price-quality sweet spot exists: non-QV products are emerging with the potential to meet Lighting Global Quality Standards at competitive prices

The tweaks needed to make the three best-performing products in this sample compliant with the Lighting Global Quality Standards **would add just one to five per cent to these product's Free on Board (FOB) pricing**[6]. Even with the provision of a two-year warranty and after-sales, these tweaked products could be sold at:

- **25-35 per cent cheaper** than the average leading QV products in the market today with similar specifications, for solar lanterns
- **40-55 per cent cheaper** for multi-light systems with two-to-four light points[7]

Further research is needed to understand why the difference in price may be so significant (reasons may include cheaper design, leaner operations, etc.). These lab results also remain to be confirmed on the ground and at scale, including seeing whether multiple batches achieve sufficient quality consistency. Nevertheless, these estimates point to a potentially significant business and impact opportunity to make sweet spot products more broadly recognised by and available to LMDs and their customers.

5. The red lines on the radar charts show where each product lies in relation to the Lighting Global Quality Standards. The wider the area inside the red line, the closer the product is to the standards. Initial Screening Method (ISM) tests have been grouped into six categories; the breakdown of this categorisation is shown in the appendix, in figure 17. Each product has been given a score for each category based on the number of tests it passed over the total number of tests available for a given category, expressed as a percentage (whereby 100 per cent = meeting Lighting Global Quality Standards).

6. This is a theoretical estimate based on manufacturer interviews that would need to be proven in practice.

7. This is a theoretical estimate based on industry benchmarks drawn from an established manufacturer in the off-grid solar sector; Sollatek (an established wholesaler in the sector) and consultation with experts in the field. It includes some marketing support and LMD credit financing, as well as after-sales and an LMD margin. This estimate does not include the cost of attaining Lighting Global certification and assumes tax exemption is applied. Further research is needed, which the GDC intends to pursue via its pilot described on page 8, to test whether these products could remain in the price-quality sweet spot if supplied to distributors with reliable after-sales support, consistent batch quality and short lead times on the ground.

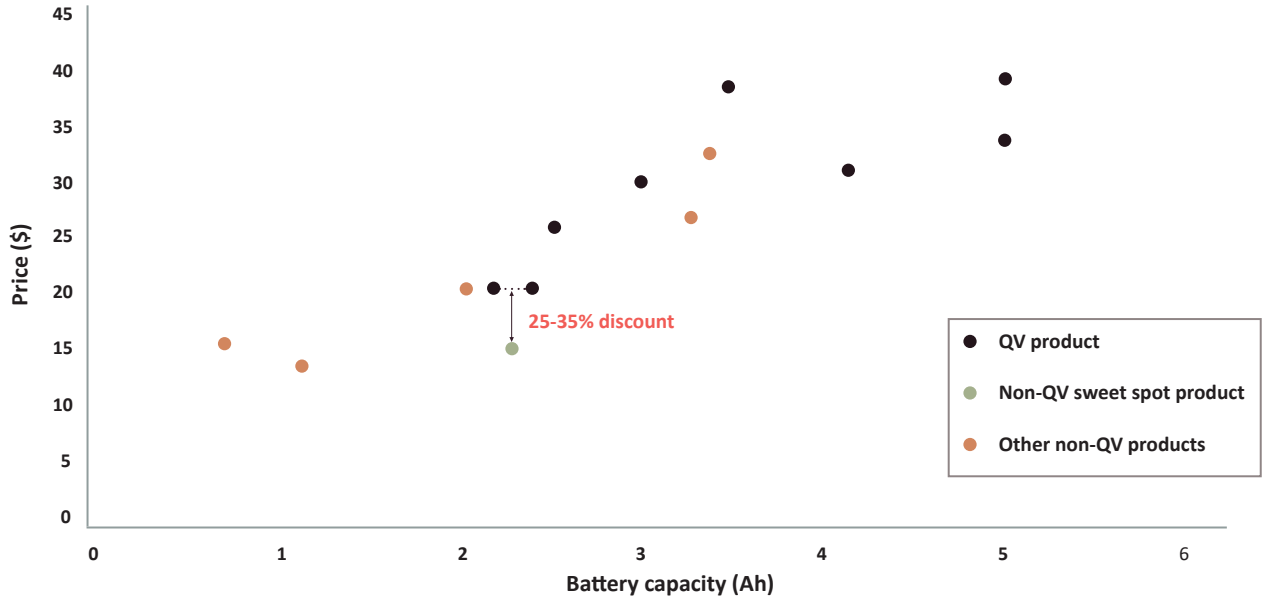


Figure 2 : Comparison of cash-sales recommended retail price (RRP) for comparable QV and the tested non-QV solar lanterns (one light point, with mobile phone charging)[8]

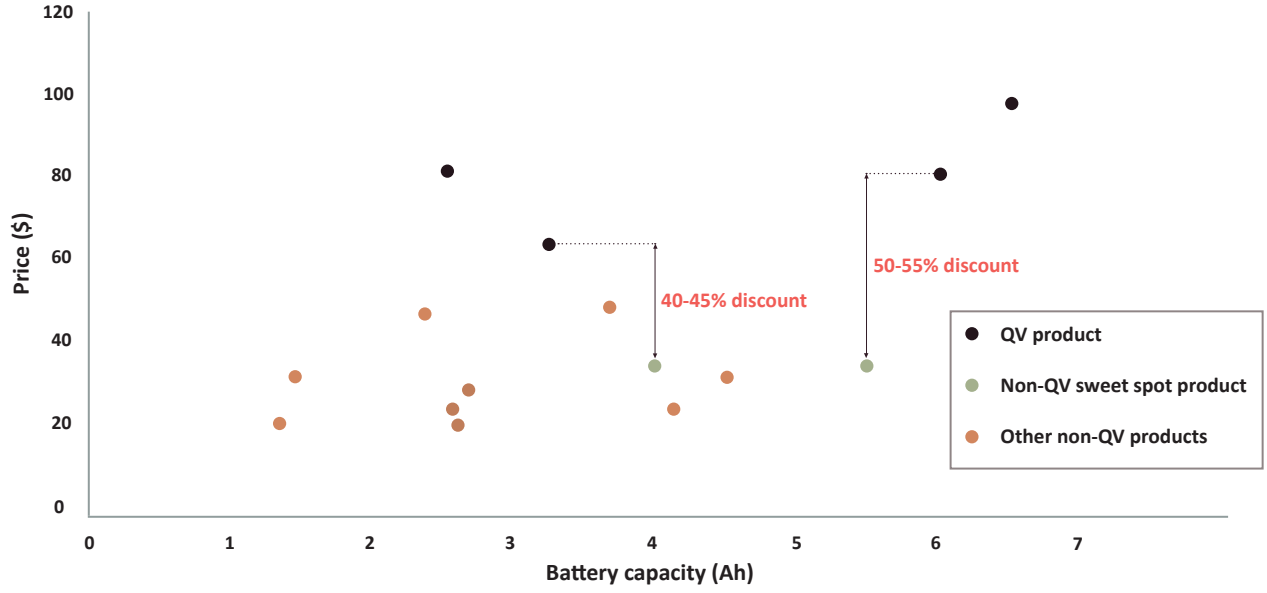


Figure 3 : Comparison of cash-sales recommended retail price (RRP) for comparable QV and the tested non-QV multi-light systems (two-to-four light points, with mobile phone charging)[9]

8. Products are compared based on their measured battery capacity, used as the best available proxy to compare similar products; other metrics of comparison, such as available daily electrical energy (Watt-hour/day), were not available. Non-QV products are selected from the 18 products that were put through ISM pre-tests and ISM full tests; sample size = six (including one sweet spot product; one tested solar lantern was removed from the sample because the battery capacity could not be measured during testing as the sample was non-functional). RRP for non-QV products are estimated based on field survey data; RRP for sweet spot products are estimated based on the data described in footnote 7; battery capacity is based on ISM testing results. QV products have been selected based on a) leading QV brands in Kenya, b) product specifications and c) available data; sample size = eight. RRP were estimated based on wholesalers' data and consultations with manufacturer representatives; battery sizes are based on specification sheets on the Lighting Global website (soon to be integrated with the VeraSol website).

9. Non-QV product sample size = 11 (including two sweet spot products). QV products sample size = four. Data sources are consistent with those described in footnote 8.

3. **Customers and distributors may be taking a stab in the dark,** as they seem unable to identify sweet spot products

Many of the best-selling products identified via the field survey did not emerge as those meeting – or being closest to meeting – Lighting Global Quality Standards. One reason for this may be that distributors and customers lack awareness of and/or are unable to identify best-performing products (in terms of the quality) in the non-QV market. Customers may have also developed low expectations in terms of product durability due to the frequent product failures in the non-QV market. This means that they buy the same brand again, even if it failed only after a few months, because they expected to have to do so in the first place and do not know of any price-competitive alternatives.

Another possible explanation is that customers are knowingly choosing price over quality, opting for poorer quality products at cheaper prices. There are many reasons why this may be the case: the quality of energy services provided by non-QV products may be lower than comparable QV products, yet meet customer needs nonetheless. Some non-QV products may also have a more rudimentary design (as was the case for one of the products put through quality testing) that allows for easier replacement of components, meaning they could be easier to maintain without having to consult the manufacturer to service a warranty.

Whatever the cause, the result is that distributors focusing on quality-certified offerings partly lose out to more price-competitive offerings, and customers – especially those at the last mile - end up spending more money than needed on poor quality products that they have to buy over and over again.

We therefore need to find ways of making 'the invisible, visible', by exploring new opportunities for the sector to identify and promote sweet spot products, including:

- **Identify existing sweet spot products:** for instance, by increasing access to Initial Screening Method (ISM) testing (the full set of quality tests used for this report) for manufacturers committed to improving their product quality based on test results.
- **Support manufacturers in developing more sweet spot products:** for instance, by raising the awareness of Lighting Global Quality Standards amongst new manufacturers in the sector and helping them reach those standards.
- **Help sweet spot product manufacturers find a route to market via distribution partnerships:** for instance, by matchmaking manufacturers and local wholesalers or larger distributors who can make products more widely accessible to local distributors.
- **Help customers identify sweet spot products:** for instance, via a customer-facing label. Beyond finding the right design for this label to correspond to what customers value, such an initiative would also need to secure resources to maintain the label's integrity over time to counter the risk of fraud.

GDC pilot: helping Sollatek, an established wholesaler, identify and supply sweet spot products to LMDs in East Africa

The GDC is working to capitalise on the findings outlined in this report and turn them into a direct and practical opportunity for LMDs to procure competitive, quality products at lower costs. To do so, it has partnered up with Sollatek, an established wholesaler in the off-grid solar market, operating in East Africa, to import a small catalogue of sweet spot products and supply these in-country with low minimum order quantities, credit payment terms and a two-year warranty to be serviced in-country.

The lessons from this pilot, due to launch later this year (2020), will be publicly disseminated with a view to enabling other wholesalers and distributors to replicate and scale this initiative, both in off-grid solar and other sectors across other geographies.

Context and objectives

Last mile distributors (LMDs) are primarily dedicated to selling 'beneficial products' (including solar lights, water filters, nutrition products and improved cooking solutions) to underserved areas and are therefore key to unlocking these products' potential impact. However, LMDs face many operational challenges, as the recently published report by the Global Distributors Collective (GDC) "Last Mile Distribution: state of the sector report" (October 2019) highlights. One such difficulty is procuring the right products for their target audience, at the right price, in the right place, and within an acceptable timeframe.

The Global Distributors Collective (GDC) conducted research to better understand these procurement challenges and explore possible solutions. We started with a focus on LMDs selling off-grid solar (OGS) products, since this is the most common product category among GDC membership (accounting for 65 per cent of GDC members, with the next most common category being improved cookstoves at 38 per cent).

Procurement challenges faced by LMDs in the OGS sector

LMDs need access to products that are high quality, meet customer preferences, and can be sold at the last mile at affordable prices. Today, in the OGS sector, LMDs have difficulty accessing such products due to two key challenges:

- **Challenge one - Product selection:** LMDs struggle to identify the products that are best suited to their customers' needs, and find themselves stuck between:
  - **Quality-verified (QV) products, known to be good quality,** with (generally) strong brand awareness and after-sales support. These are often supplied by vertically integrated organisations which sometimes have their own distribution networks in-country. They also carry more premium price-points compared to other products available in the market.
  - **Non quality-verified (non-QV) products, which are sold at more affordable price-points** and account for 70 per cent of global pico-solar products sold[10]. Today, very little is known about this segment of the market – often referred to as the 'grey market' – and evidence available to date suggests that quality within this market is often low[11]. Impact-led LMDs are therefore both unwilling to take on the risk of supplying non-QV products that could fail them and their customers, and unable to compete with their competitive price-points, making it difficult for them to develop sustainable business models.

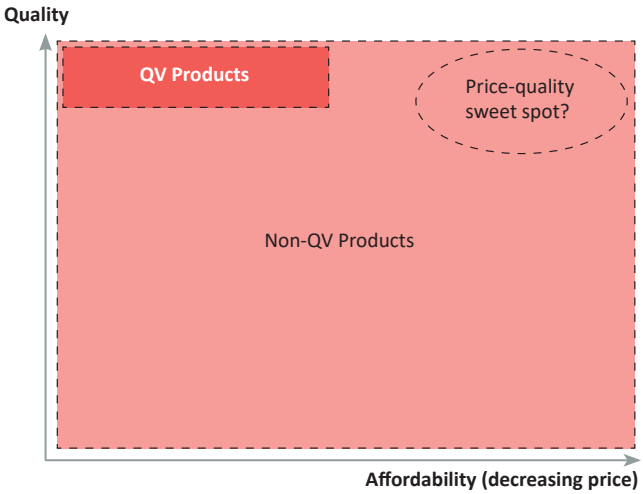


Figure 4 : Illustration of the LMD challenge in identifying quality, affordable products in the OGS cash sales sector[12]

10. Vivid Economics and Open Capital Advisors (March 2020), Off-grid solar market trends report 2020.

11. For instance, in 2017 Lighting Global tested 17 top-selling non-QV solar products in five domestic markets across Africa and South Asia, and all products failed to meet the Lighting Global Quality Standards; 84 per cent of these failed due to one or more deficiencies affecting product durability. Lighting Global (2018), Quality Matters, Technical Notes Issue 27.

12. Not representative of the market split of QV and non-QV products; merely intended as an illustration of the procurement 'Challenge one'.

- **Challenge two – Product importation:** once LMDs have selected products, they often have to import them due to lack of (or limited) in-country stock. The whole importation process requires significant management time, as well as working capital, which in addition to creating significant hassle for LMDs, also translates into high additional costs per product. LMDs have no other choice than to reflect these in end-user prices. More specifically, the challenges LMDs face include:
  - A three to four month lead time between placing an order and receiving it (in Africa)
  - Prohibitively large minimum order quantities (typically one container, representing e.g., 1,500-2,000 solar home systems)
  - High working capital requirements (as manufacturers often request 50 per cent upfront payment and 50 per cent to be paid at port, while LMDs will only recover their money once they have sold their products, sometimes several months after arrival at port)
  - Limited ability to test new products or feed back tweaks to manufacturers, and influence product design to meet customer needs before committing to a whole batch
  - Significant hassle in overseeing the importation process due to complex and ill-applied customs regulation

We started reflecting on what potential solutions could be developed in response to these two key challenges, and thus asked ourselves:

- Could there be products in the market today that are both quality[13] and affordable[14] at the last mile, i.e. products in the price-quality sweet spot? If so, how could these be identified?
- How could they be made more accessible to LMDs in-country?

This report will provide insights to help respond to the first question. The GDC is also piloting a model that aims to answer the second one, to test if it is possible to make more affordable, quality products accessible to LMDs and thus to their customers at the last mile (see page 8 for more details).

We hope that the methodology and preliminary results described in this report will encourage importers and wholesalers in other sectors and geographies to dig further into the potential of affordable beneficial products, and build a differentiating offer that could help LMDs across sectors best serve those who need it most: customers at the last mile.

13. I.e. meeting Lighting Global Quality Standards.

14. I.e. that can be sold on cash to end-users at 25-50 per cent cheaper price-points than leading QV products in the market with similar specifications (e.g. battery size, panel size, number of light points, etc.), and a valid two-year warranty.

Looking for the best approach to address Last Mile Distributors' (LMDs) procurement challenges

The methodology described here is just one way to try to address LMD procurement challenges. LMDs face a range of procurement challenges beyond finding the right product, particularly when they import products themselves, including: lengthy lead times between placing and receiving orders, prohibitively high minimum order quantities, high working capital requirements, and significant time and hassle in overseeing the end-to-end procurement process.

Numerous pioneering pilots have emerged in the off-grid solar sector in recent years to try and address these challenges, including some that leverage aggregation or bulk buying models in order to help LMDs benefit from economies of scale, with mixed results so far. In 2019, the GDC explored the potential of setting up a centralised purchasing platform to pool LMDs' demand. We found that setting up such a model sustainably requires two key conditions to be met:

(1) A willing and able lead organisation: starting such a platform from scratch would require investing significant set-up capital, in order to be able to order large quantities with better conditions than those LMDs have access to themselves. The alternative is to leverage the logistics assets and expertise of an existing player, to keep set-up costs low and avoid the steep learning curve that inevitably comes with the importation of beneficial products in most countries. Discussions with five potential candidates (including Sollatek, with whom we are pursuing the approach described on page 8) proved that few commercial organisations with these assets are interested in venturing into this opportunity, given the challenges, risks and costs involved in coordinating and administering orders across multiple small players.

(2) A market that is "just right": the lead organisation needs to operate in a country that has sufficient sales volumes of beneficial products for the centralised purchasing platform to be able to cover its operating costs. However, we found that most mature markets with potentially large volumes often already had in-country stock available for many brands (set up by manufacturers), thus rendering the platform redundant and/or making its use limited to lower volume items, questioning its potential sustainability.

The GDC's preliminary research in 2019 unfortunately did not find any markets that had both of these factors present, and thus pivoted towards the approach that is described on page 8. We are nevertheless keen to continue exploring opportunities to pilot a centralised purchasing platform model, so please do reach out to us at GDC@practicalaction.org.uk or lklarsfeld@hystra.com if you would be interested in this initiative.

Methodology

This research focused on Kenya, as one of the most mature markets for solar products globally, representing 15-20 per cent of the global volume in cash sales and 40-45 per cent of the global volume in PAYGO sales in 2019[15]. The findings in this report are primarily drawn from research and laboratory testing conducted on top-selling products already in the Kenyan 'grey market'. They were identified via a funnelled product identification and quality testing process, conducted in partnership with VeraSol[16]. We designed this methodology with a view to identifying products that have the highest possible chance of being both high quality and price-competitive; our sample thus has a purposeful (positive) bias. We limited our research to pico-solar products (both individual solar lanterns and multi-light systems with two, three or four light points) sold on cash.

Field survey and desk research:

We identified 100 non-QV products in the Kenyan market via a bottom-up approach, including a field-survey and extended desk research. We identified:

1) 32 non-QV pico-solar products via a field survey conducted by Sollatek, an established manufacturer in Kenya, through their country-wide network of sales agents. Agents visited 18 distributors of solar products in five Kenyan regions to record the brand names and key specifications of their top three best-selling non-QV products

2) 68 non-QV pico-solar products via research on Jumia, Kenya's leading e-commerce platform; of these, 26 were branded and 42 were unbranded

Quality/Price filtering:

We shortlisted 18 products (and seven backup products)[17] based on product specifications, price and ease of availability. We removed products that did not:

- Appear high quality on face value, e.g. based on the battery-to-panel reported ratio
- Show potential to fall within the 25-50 per cent price-competitiveness bracket defined in the scope of this research
- Allow for manufacturer identification (e.g. unbranded products)

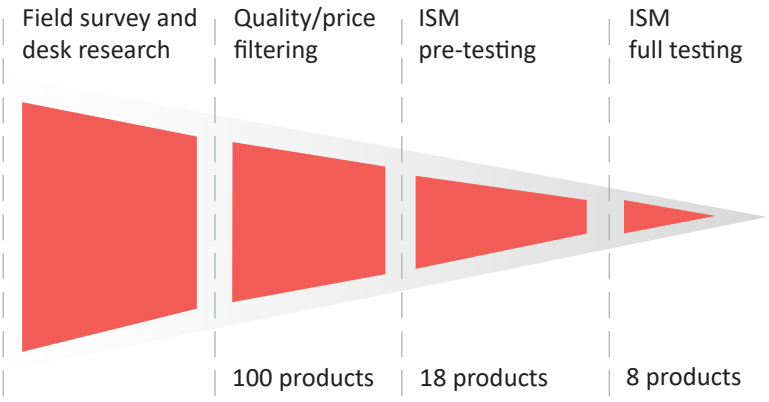


Figure 5: Funnelled product identification and testing process

15. Out of products recorded by GOGLA participating affiliates. GOGLA (2019), Global off-grid solar market report semi-annual sales and impact data H1 and H2 2019.

16. An evolution of Lighting Global Quality Assurance.

17. One of the back-up products eventually replaced a product in the final list of 18, due to an unforeseen shortage of stock of the originally shortlisted product.

Initial Screening Method (ISM) pre-testing

Testing was carried out by the University of Nairobi Lighting Laboratory (UoN-LL), housed at the Institute for Nuclear Science & Technology at the University of Nairobi. UoN-LL is a member of the Lighting Global Lab Network and is approved to conduct tests for Lighting Global. The 18 shortlisted products were subjected to a subset of tests that are part of the Initial Screening Method (ISM), described in the International Electrotechnical Commission (IEC) publication IEC TS 62257-9-5. VeraSol selected these tests based on knowledge of common failure mechanisms of pico-solar products, which include customer-facing information, AC/DC charger safety, physical and water ingress protection, battery capacity and charge/discharge control.[18] VeraSol technical experts evaluated the pre-testing results to identify eight products that had the highest expected ease of meeting the Lighting Global Quality Standards.

ISM full testing

UoN-LL subjected the eight selected products to the remainder of the tests which the ISM comprises. This includes testing of PV modules, full-battery and solar run time, battery storage durability, mechanical durability, luminous flux and lumen depreciation. Completion of full ISM testing provided a more complete picture of the overall quality and performance of the selected products.[19]

Caveat

We performed testing of each product on two to three samples only, which does not allow to validate the consistency of quality across a larger population. To be quality-verified by Lighting Global and meet the Kenyan national standards, products must be fully tested at an ISO 17025 accredited lab according to the Quality Test Method ("QTM"), as described in IEC TS 62257-9-5, with each test being conducted on a sample size of six products. As such, the testing carried out for this study is not acceptable evidence of standards compliance. For these products to be legally imported into Kenya, they must present official QTM test reports showing that they comply with the standards.

Furthermore, it is recommended that distributors purchasing products identified through this method implement additional checks to ensure that product quality is maintained over time, such as running on-site manufacturer due diligence or running periodic testing of randomly selected samples.

18. For more information on the standards, please refer to the Lighting Global website: https://www.lightingglobal.org/wp-content/uploads/2017/09/Pico_MQS_v8_0.pdf. The test methods that were followed are described in IEC TS 62257-9-5:2016.

19. For more information on the ISM test, please refer to the Lighting Global website: https://www.lightingglobal.org/quality-assurance-program/testing-process/initial-screening-method-ism-testing/

Insights

1. There are 50 shades of grey in the non-QV OGS market: the non-QV OGS market includes products with all levels of performance

None of the 18 shortlisted and tested products meet the Lighting Global Quality Standards. Even the eight "finalist" products that were put through full ISM testing did not meet the standards. For the ten products eliminated after quality 'pre-tests', pre-testing results suggested that they would likely be far from compliance across multiple categories. As the products shortlisted for this report were identified following a biased approach, seeking those with the highest chances of meeting Lighting Global Quality Standards, these results suggest that most non-QV products in the market would likely not comply with the Lighting Global Quality Standards.

However, the extent to which the eight "finalist" products deviate from Lighting Global Quality Standards varies significantly, with some close to meeting the standards. Three products, highlighted in the green box below, are close to meeting the Lighting Global Quality Standards and require only simple tweaks to become fully compliant. On the other hand, two tested products, highlighted in the red box below, fail on at least half of the tests conducted and would require significant modifications in order to meet the standards. The remaining three products, in the yellow box below, lie somewhere in between.[20]

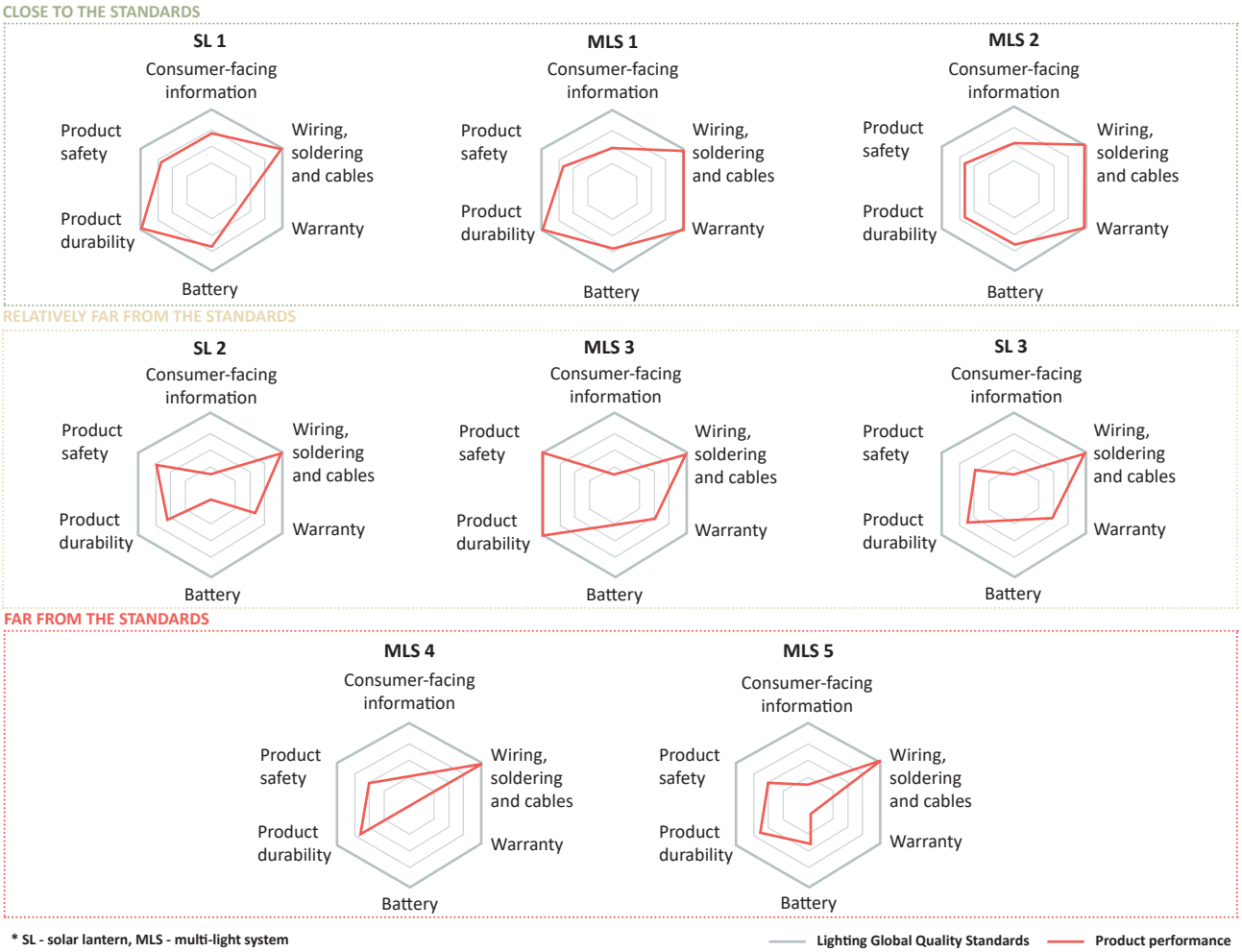


Figure 6 : Comparison of Initial Screening Method (ISM) test results against the Lighting Global Quality Standards[21]

20. Products that have deficiencies associated with customer-facing information and battery specifications that are only slightly out of compliance are considered to be close to the standards. Products that have a combination of failures, especially those that have both battery capacity and charge control issues, are deemed to be far from meeting the standards .

21. The red lines on the radar charts show where each product lies in relation to the Lighting Global Quality Standards. The wider the area inside the red line, the closer the product is to the standards. Initial Screening Method (ISM) tests have been grouped into six categories; the breakdown of this categorisation is shown in the appendix, in figure 17. Each product has been given a score for each category based on the number of tests it passed over the total number of tests available for a given category, expressed as a percentage (whereby 100 per cent = meeting Lighting Global Quality Standards). The "warranty" category was given additional nuance and scored 100 per cent for a pass on the test; 50 per cent for a one-year warranty or where parts are excluded from the warranty; and 0 per cent if no information was provided.

The tests that products most commonly fail, and that mark the biggest difference between products that are 'close' and 'far' from the Lighting Global Quality Standards, relate to product battery, customer-facing information and warranty: indeed, not a single tested product meets the standards for the battery and customer-facing categories, while only two products (both produced by the same manufacturer) provide acceptable customer-facing warranty information. All 18 products are fully compliant with Lighting Global standards for the quality of the 'wiring, soldering and cables', and they also pass at least 2/3 of tests relating to product durability.[22]

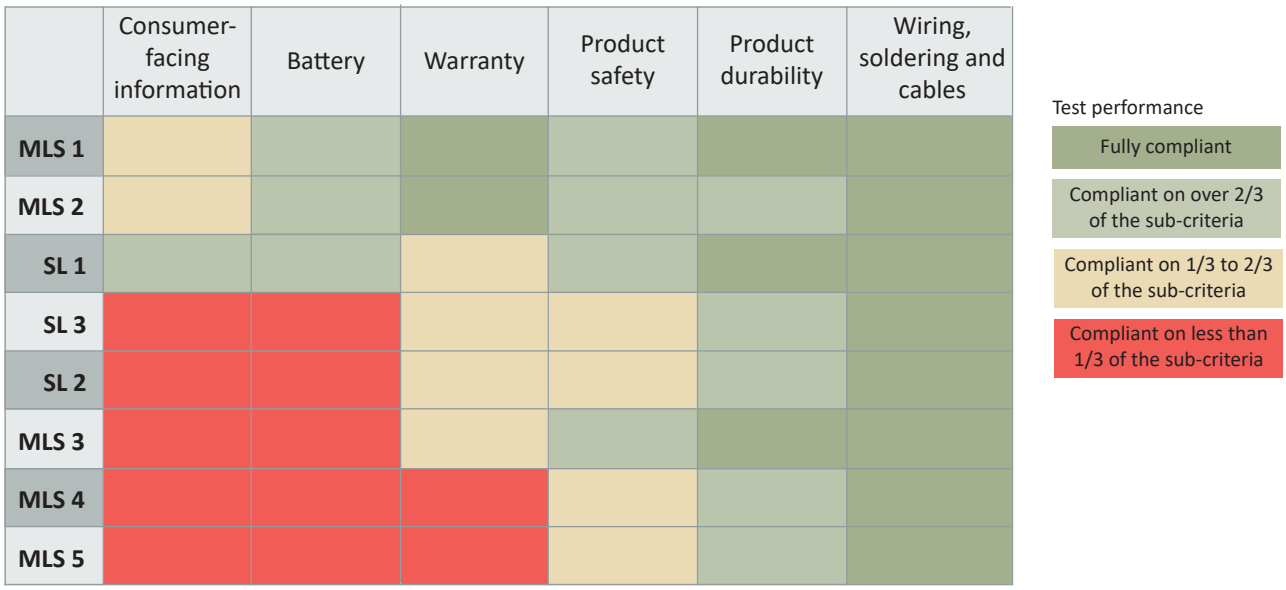


Figure 7 : Overview of compliance with the standards by category for products put through full ISM testing

Battery

A key factor in products' overall performance is battery chemistry: all three products that are 'close to the Lighting Global Quality Standards' have lithium ion (li-ion) batteries, as opposed to the other five that have sealed lead acid (SLA) batteries. One of the key tests conducted on batteries is 'battery storage durability', a measure of the permanent loss of capacity due to storage at a discharged state. All three products that have li-ion batteries passed, whereas 80 per cent of the other tested products did not. The three li-ion products are also the only ones that passed the truth-in-advertising test on battery capacity, which suggests that a failure to accurately report on battery capacity may often be linked to battery performance issues.

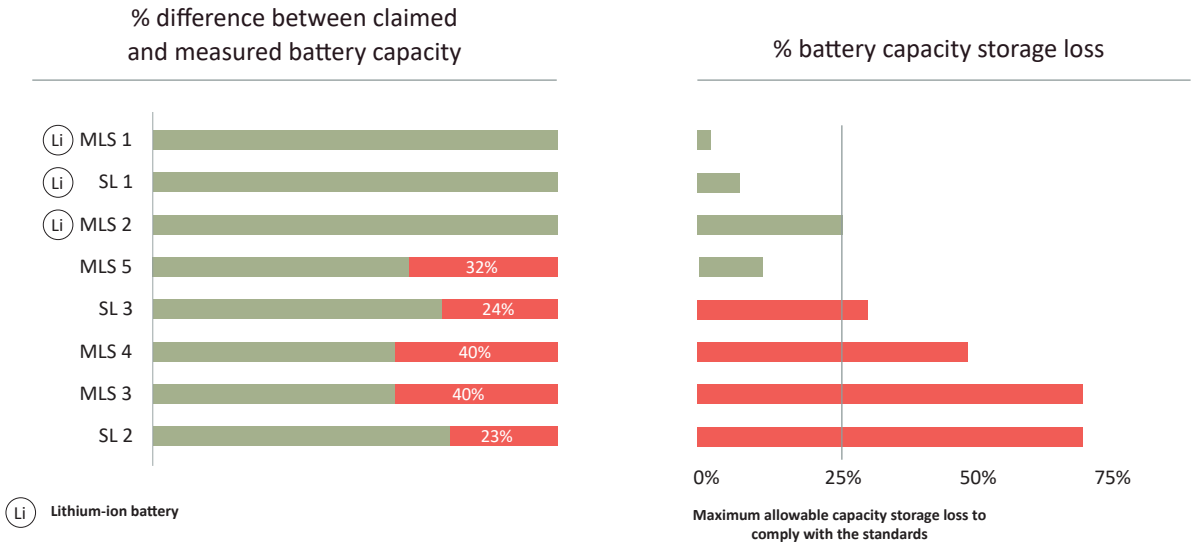


Figure 8 : Results from the truth-in-advertising test on battery capacity and the battery capacity storage test

22. For a more detailed breakdown of each category, please refer to figure 17, in the appendix.

Battery type, however, does not seem to affect how products fare in the other two tests in this category – battery deep discharge protection and battery overcharge protection (measures of the minimum and maximum battery voltage during discharge and charge, respectively). In fact, none of the eight products passed both the overcharge and deep discharge protection tests.[23]

Figure 9 : Deviation from Lighting Global Quality Standards for battery protection

While correcting for a failure on battery protection (for either discharge or overcharge) can be relatively simple (e.g. by making small software or hardware corrections), correcting for a failure of the battery storage test will likely entail sourcing a new battery, and possibly replacing an SLA battery with a li-ion battery, which typically costs twice as much as a comparable SLA battery.[24] In addition, this would require a significant re-design of the product, further driving up costs for manufacturers.

Customer-facing information

Most products, especially those far from meeting the standards, fail to meet requirements for customer-facing information. This includes truth-in-advertising, which requires that any customer-facing information be truthful and accurate[25], and performance reporting, which requires products to present key performance metrics, such as daily solar run time and light output, on the packaging. Products that are far, or relatively far, from complying with the Lighting Global Quality Standards meet only one out of six requirements for customer-facing information, as opposed to those that are close to meeting the standards, which meet at least half of the requirements in this category.

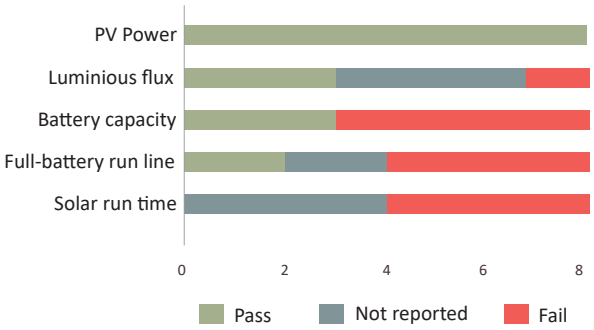


Figure 10 : Number of products passing the truth-in-advertising tests (sub-category of the consumer-facing information category)

23. For the deep discharge protection test, products must show a minimum of 1.82 V/cell for sealed lead acid (SLA) batteries and 2.95 V/cell for lithium-ion (li-ion) batteries. For the overcharge test, products must show between 2.35 V/cell and 2.45 V/cell for SLA batteries and below 4.25 V/cell for li-ion batteries.

24. Based on pricing of a US distributor of China-made batteries; this may differ from the Chinese market but is meant as an indicative order of magnitude.

25. Numeric aspects, such as battery capacity, PV module power, light output and run time, must be at least 85 per cent of the advertised ratings.

While it is possible that some manufacturers knowingly oversell the performance of their products, interviews with manufacturers suggest such failures could also be linked to:

- A lack of awareness or understanding of the Lighting Global Quality Standards, as suggested by the fact that 100 per cent of products fail the performance reporting test
- Limited measurement capacity: manufacturers may not know how to follow the IEC testing methods, for instance, or be lacking appropriate, good quality and calibrated equipment to estimate the product's performance accurately
- Misalignment on the relevance of existing standards to customers: as one manufacturer put it, "*customers do not know what 'lumens' or 'luminous flux' means, it is too technical, so I would never think to put it on the packaging*"

Warranty

Finally, most tested products fail to offer a customer-facing warranty, even if they are close to meeting the Lighting Global Quality Standards overall. To meet Lighting Global Quality Standards, pico-solar products must offer a customer-facing warranty covering the whole product for at least one year. Only two products – both produced by the same manufacturer – meet this requirement. One reason for this may be that manufacturers, often based in China, do not have the resources or skills to operationalise such a warranty for distributors in Africa or East Asia. The GDC pilot described on page 8 is looking to address this challenge.

2. The price-quality sweet spot exists: non-QV products are emerging with the potential to meet Lighting Global Quality Standards at competitive prices

Non-QV products are available at a wide range of price points. While some are priced similarly to comparable QV alternatives, others can be up to four times cheaper, especially for large systems[26] (see Figure 13 below).[27] However, as shown in our quality testing, most of these products face multiple issues that could reduce their performance and durability compared to QV products. They are also typically not offered with a valid warranty. This means customers are unlikely to get the same benefits from cheaper non-QV options as from a "comparable" QV alternative.

Could non-QV products be tweaked to meet the Lighting Global Quality Standards, offered to distributors and end-users with a valid warranty and after-sales service, and remain as price-competitive? We put this idea to the test, focusing on the products from our sample that we identified as 'close to meeting the standards'.

According to interviews with established OGS product manufacturers, **the tweaks needed for these products to meet the standards would add an estimated $0.20-0.60 to their Free on Board (FOB) price (around one to five per cent in FOB).**[28] If we take Multi-Light System (MLS) 2 (with an FOB pricing of around $18) as an example, the cost of additional tweaks needed to meet the Lighting Global Quality Standards amount to around $ 0.20-0.51 per product, as illustrated in Figure 11:

26. GOGLA and Hystra (2019), Pricing Quality: cost drivers and value add in the off-grid solar sector.

27. In figures 12 and 13, products are compared based on their measured battery capacity, used as the best available proxy to compare similar products; other metrics of comparison, such as available daily electrical energy (Watt-hour/day), were not available. It should be noted that li-ion batteries can be discharged more deeply than SLA batteries, which can result in more "useable" storage capacity in a li-ion battery than a SLA battery with the same rated capacity. The typically higher performance of li-ion batteries is unlikely to be perceived by a customer at the point of purchase, as they will likely see two products with similar battery specifications as comparable.

28. This is a theoretical estimate based on manufacturer interviews that would need to be proven in practice.

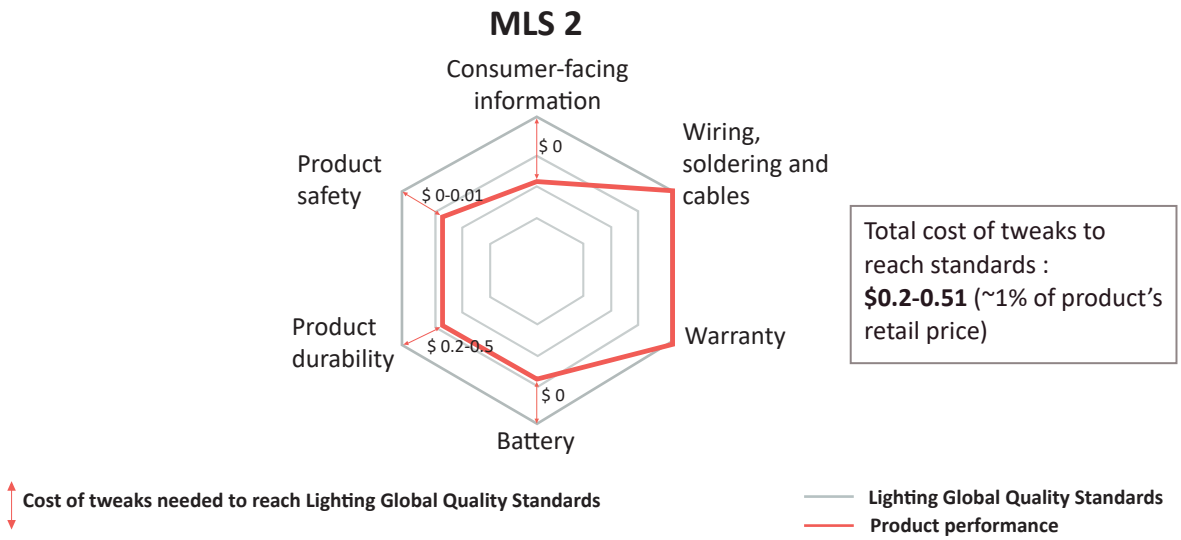


Figure 11 : Radar chart showing estimated cost of required tweaks for MLS 2 to meet Lighting Global Quality Standards[29]

- Customer-facing information: MLS 2 failed to report performance information on the product packaging, including battery and solar run time. Tweaks to the existing packaging to add this information would make the product compliant with Lighting Global Quality Standards for this category, without adding cost to the product
- Battery: MLS 2 failed the battery deep discharge protection test, falling eight per cent short of the required V/cell level prescribed by the Lighting Global Quality Standards. According to the interviewed manufacturers, this could be resolved by an amendment to the product software, again without additional cost to the product
- Product durability: MLS 2 failed the drop test part of the product durability category, whereby it is dropped from a 1m height multiple times to assess its robustness to damage. To rectify this failure, the manufacturer could add additional protection cushioning, adding $0.20-0.50 to the product cost
- Product safety: MLS 2 failed the test on water ingress protection, which determines the degree of protection provided by enclosures of electrical equipment against water. This is because the product has components that are advertised as portable, meaning the water ingress requirements are relatively high. Adding a warning label to the product would ensure it is compliant with Lighting Global Quality Standards, which would be done either directly on the packaging (at no additional cost) or with a sticker (at around $0.01 per product).

29. This is a theoretical estimate based on manufacturer interviews that would need to be proven in practice.

We estimate that **the tweaked versions of these products could be sold in Kenya with a two-year warranty, with an end-user recommended retail price (RRP) that would place them in the price-quality sweet spot, namely:**

- **25-35 per cent cheaper** than the average leading QV products in the market today with similar specifications, for solar lanterns
- **40-55 per cent cheaper** for multi-light systems with two-to-four light points[30]

Further research is needed to understand why the difference in price may be so significant (which may include cheaper design, leaner operations, over-sizing, etc.). These results also remain to be proven 'on the ground', including seeing whether a consistency of quality can be achieved across multiple batches. Nevertheless, these estimates point to a potentially significant business and impact opportunity to make sweet spot products more broadly recognized by and available to LMDs and their customers.

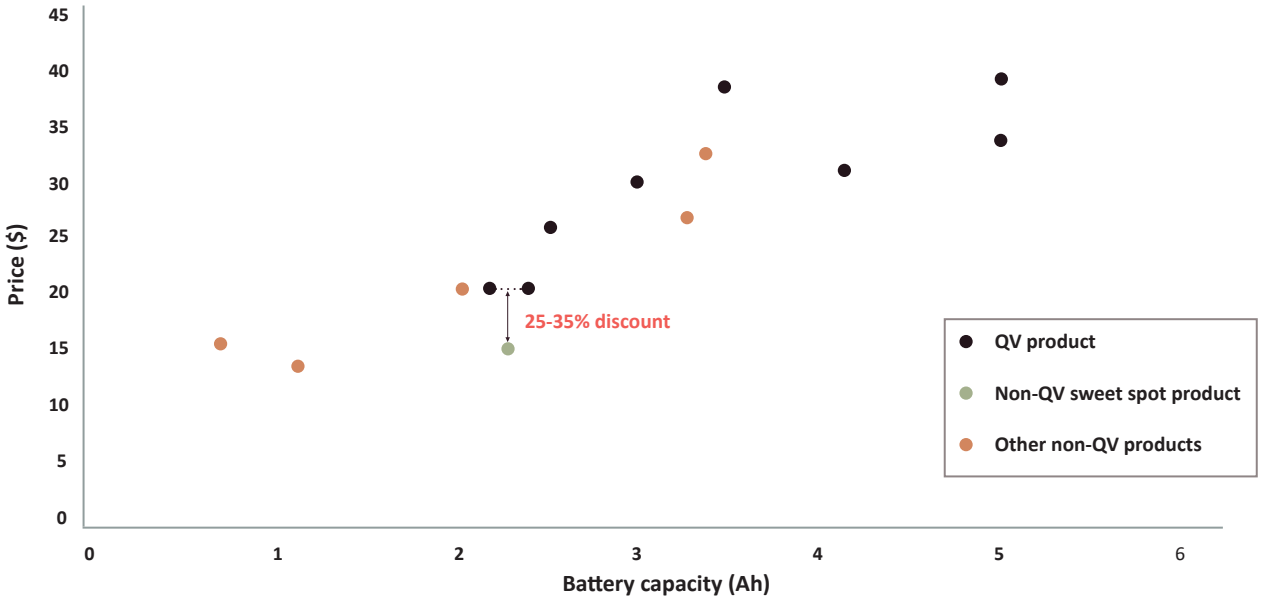


Figure 12 : Comparison of cash-sales recommended retail price (RRP) for comparable QV and the tested non-QV solar lanterns (one light point, with mobile phone charging)[31]

30. This is a theoretical estimate based on industry benchmarks drawn from an established manufacturer in the off-grid solar sector; Sollatek (an established wholesaler) instead and consultation with experts in the field. It includes some marketing support and LMD credit financing, as well as after-sales and an LMD margin. This estimate does not include the cost of attaining Lighting Global certification and assumes tax exemption is applied. Further research is needed, which the GDC intends to pursue via its pilot, to test whether these products could remain in the price-quality sweet spot if supplied to distributors with reliable after-sales support, consistent batch quality and short lead times on the ground (for more on the pilot, see page 8).

31. Non-QV products are selected from the 18 products that were put through ISM pre-tests and ISM full tests; sample size = six (including one sweet spot product; one tested solar lantern was removed from the sample because the battery capacity could not be measured during testing as the sample was non-functional). RRP for non-QV products are estimated based on field survey data; RRP for sweet spot products are estimated based on the data described in footnote 30; battery capacity is based on ISM testing results. QV products have been selected based on a) leading QV brands in Kenya, b) product specifications and c) available data; sample size = eight. RRP were estimated based on wholesalers' data and consultations with manufacturer representatives; battery sizes are based on specification sheets on the Lighting Global website (soon to be integrated with the VeraSol website).

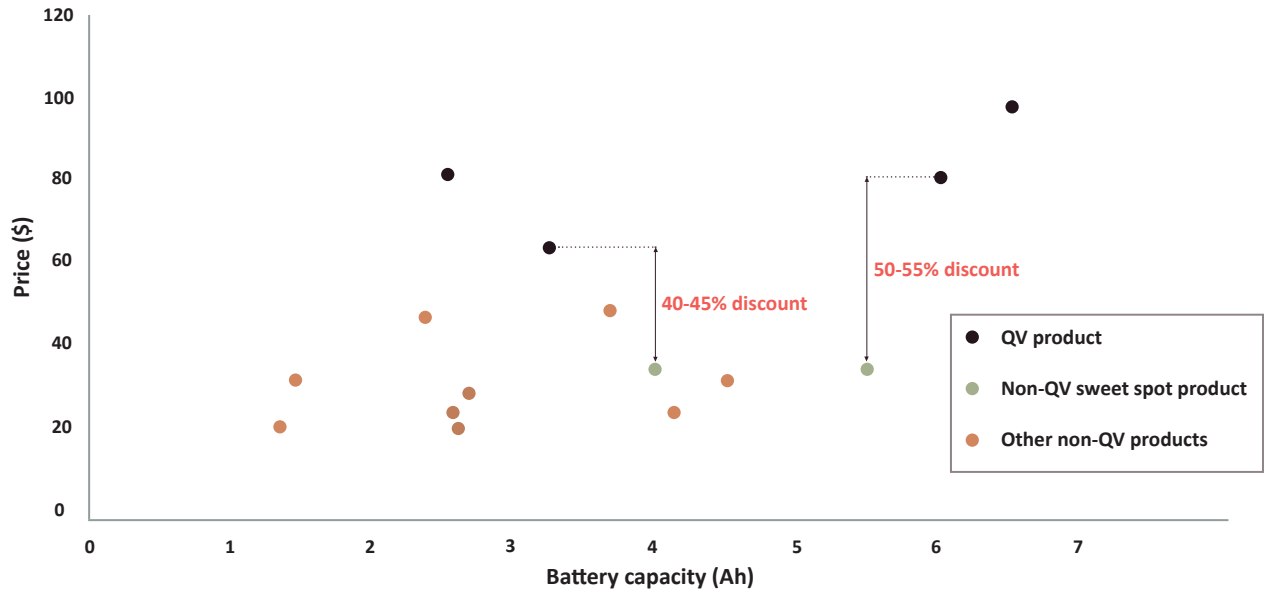


Figure 13 : Comparison of cash-sales recommended retail price (RRP) for comparable QV and the tested non-QV multi-light systems (two-to-four light points, with mobile phone charging)[32]

In addition, beyond products that are already available in Kenya, some emerging Original Design Manufacturers (ODM)[33] are now producing QV products that, at FOB level, are up to 40-60 per cent cheaper than leading products in the market with similar specifications[34]. These manufacturers' products, however, are struggling to find a route to markets like Kenya, as actors on the ground (including both wholesalers and distributors) are not aware of their existence and/or are unlikely to take the risk of importing products that are not well-known already, especially as these manufacturers do not typically have the resources to offer support with marketing materials.

3. Customers and distributors may be taking a stab in the dark, as they seem unable to identify sweet spot products

Best-selling products did not emerge as those meeting – or being closest to meeting – Lighting Global Quality Standards. Rather, products deemed best-sellers by surveyed distributors in Kenya were among those that proved far from meeting the standards, including many that were removed after the initial round of pre-testing.

One reason for this may be that distributors and customers lack awareness of and/or are unable to identify best-performing products (in terms of quality) in the non-QV market. Customers may have also developed low expectations in terms of product durability, due to the frequent product failures in the non-QV market. This means that they buy the same brand again, even if it failed only after a few months, because they expected to have to do so in the first place and do not know of any price-competitive alternatives.

Another possible explanation is that customers are knowingly choosing price over quality, opting for poorer quality products at cheaper prices. There are many reasons why this may be the case: the quality of energy services provided by non-QV products may be lower than comparable QV products yet meet customer needs nonetheless. Some non-QV products may also have a more rudimentary design (as was the case for one of the products put through quality testing) that allows for easier replacement of components, meaning they could be easier to maintain without having to consult the manufacturer to service a warranty[35].

32. Non-QV product sample size = 11 (including two sweet spot products). QV products sample size = four. Data sources are consistent with those described in footnote 31.

33. Companies that both design and manufacture their own products.

34. Based on FOB data from five Chinese ODM, selected for their low FOB pricing of QV products, and data on 12 QV products in the Kenyan market (see footnote 31 for more information on how these were identified and sourced). Products are compared based on their measured battery capacity, used as the best available proxy to compare similar products. All QV products offer a valid warranty.

35. Given many customers report that the after-sales support offered by most companies does not adequately resolve the issues they face with their off-grid solar products (as shown in the recent impact report by 60 Decibels (2020), Why off-grid energy matters, it is understandable that some may opt for an option that does not depend on this after-sales support in the first place.

Whatever the cause, the result is that distributors focusing on quality-certified offerings lose out to more price-competitive offerings, and customers – especially those at the last mile - end up spending more money than needed on poor quality products that they have to buy over and over again.

4. **Making the invisible visible:** there are new opportunities for the sector to identify and help promote sweet spot products

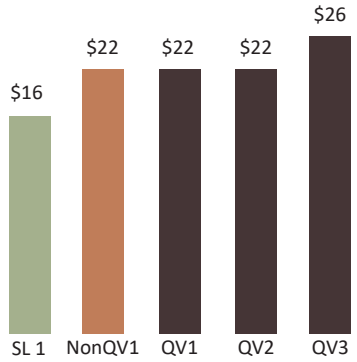
In order to enable these competitive products to reach last mile markets, and help distributors both identify and procure them, the sector must find ways to:

- **Identify existing sweet spot products:** for instance, by increasing access to Initial Screening Method (ISM) testing for manufacturers committed to improving their product quality based on test results. These tests cost about $2,000, require just three-to-four samples and offer valuable feedback to manufacturers on the changes needed in order to meet the Lighting Global Quality Standards. The cost could be co-funded by wholesalers, who would benefit from being able to develop more price-competitive product offerings, and manufacturers, who could prove the quality of their products and enter new markets. Donors could also play a role in reducing these costs, by offering grants to manufacturers, possibly on the provision that they will make the necessary tweaks identified in the ISM testing to meet Lighting Global Quality Standards.
- **Support manufacturers in developing more sweet spot products:** for instance, by raising the awareness of Lighting Global Quality Standards amongst new manufacturers in the sector and helping them reach them. The IFC has been conducting such work in China over the past few years, by engaging with ODM manufacturers and helping them become compliant with the Lighting Global Quality Standards. There could also be an opportunity for manufacturers to increase these products' compliance with the standards, particularly those on warranty provision, by working in closer collaboration with players further down the value chain, such as wholesalers. With appropriate commercial conditions from manufacturers (e.g., a pre-agreed percentage of free products in each container to be used for replacements), these local players can then become the operational link with last mile distributors and customers by servicing the warranty and providing after-sales services more broadly.
- **Help sweet spot product manufacturers find a route to market via distribution partnerships:** for instance, by matchmaking manufacturers and local wholesalers or larger distributors who can make products more widely accessible to local distributors. The procurement initiative that the GDC is currently piloting, described on page 8, is an example of such an initiative, which aims to both help distributors identify sweet spot products and reduce the cost for distributors to access them.
- **Help customers identify sweet spot products:** for instance, via a customer-facing label. Such an initiative would need to be set up by the right player, able to invest the resources needed to maintain the label's integrity due to the high risk of such a label being corrupted locally. VeraSol is currently conducting research to better understand what manufacturers with QV products would benefit from in terms of their branding, with a report on the matter due to be published in 2020. Both VeraSol and the GDC are keen to work with partners interested in developing such an initiative.

Questions for further research

- Given how close some products are to Lighting Global Quality Standards, why don't the manufacturers invest in making the necessary tweaks and getting Lighting Global certification?
- What would be the increase in price of a non-QV product far from meeting the Lighting Global Quality Standards, if it underwent the necessary changes to meet the standards (e.g. a product with significant battery issues)?
- How is customers' willingness to pay affected by product quality? What are the main indicators of 'quality' that they look out for, and that they would be ready to pay for? Which customer-facing information is most important from a customer perspective? What would they need in order to trust this information?
- Why is there such a significant price difference between the average leading non-QV product and the sweet spot products that have been identified?

Appendix



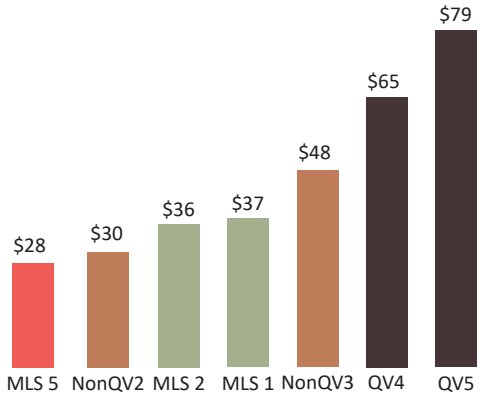
Product specifications	SL 1	NonQV 1	QV 1	QV 2	QV 3
Battery capacity (Ah)	2.31	2	2.2	2.4	2.6
Battery type	Li-ion	SLA	Li-ion	Li-ion	Li-ion
Number of light points	1	"1 LED" & "32 LEDs" options	1	1	1
Panel size (Wp)	2	3	2.3	2	2.4
Mobile phone charging	YES	YES	YES	YES	YES

- QV product
- Sweet spot product
- Removed after pre-tests

Non-QV products that underwent full ISM testing

Non-QV products that underwent ISM pre-tests only

Figure 14: Comparison of cash-sales RRP for solar lanterns with 2-2.6 Ah batteries and 2-3 Wp PV-modules with one light point and mobile phone charging[36]



Product specifications	MLS 5	Non QV 2	MLS 2	MLS 1	Non QV 3	QV 4	QV 5
Battery capacity (Ah)	4.06	4.54	4	5.4	3.61	3.3	6
Battery type	SLA	SLA	Li-ion	Li-ion	SLA	Li-ion	Li-ion
Number of light points	3+ torch	3+ side lamp	3	3	4+ torch	3	3
Panel size (Wp)	3	3	5	5	10	6.5	6.3
Mobile phone charging	YES	YES	YES	YES	YES	YES	YES

- QV product
- Sweet spot product
- Low ease of compliance

Non-QV products that underwent full ISM testing

- Removed after pre-tests

Non-QV products that underwent ISM pre-tests only

Figure 15: Comparison of cash-sales RRP for multi-light systems with 3.3-6 Ah batteries and 3-10 Wp PV-modules with three-to-four light points and mobile phone charging[37]

36. Please refer to footnote 31 for more information on how this data was sourced.

37. Ibid.

Product	Battery type	Measured battery capacity (Ah)	Panel size (Wp)	Number of light points	Mobile phone charging
SL 1	Li-ion	2.31	2	1	Yes
SL 2	SLA	3.46	3	1	Yes
SL 3	SLA	3.43	3	1	Yes
MLS 1	Li-ion	5.4	5	3	Yes
MLS 2	Li-ion	4	5	3	Yes
MLS 3	SLA	2.39	6	2	Yes
MLS 4	SLA	2.68	3	4*	Yes
MLS 5	SLA	4.06	3	4*	Yes

*one of these light points is an independent torch

Figure 16 : Specifications for the eight products put through full ISM testing

1. **Customer-facing information** (six sub-criteria)**:** performance reporting and five truth-in-advertising tests, including battery capacity, PV power, full-batter run-time, solar run-time and luminous flux

2. **Wiring, soldering and cables** (no sub-criteria)

3. **Warranty** (no sub-criteria)

4. **Battery** (three sub-criteria): battery storage durability, battery deep discharge protection and battery overcharge protection

5. **Product durability** (three sub-criteria): lumen maintenance, drop test durability and switch, connector and strain relief durability

6. **Product safety** (three-to-four sub-criteria): physical ingress protection, water ingress protection, water ingress protection (PV module) and AC-DC charger safety (only for products to which this applies)

Figure 17 : Breakdown of tests included in each of the six tested categories

Product	Meets Lighting Global Quality Standards	Consumer-facing information						Wiring, Soldering and Cables	Warranty	Battery			Product durability			Product safety			
		Performance Reporting	Truth-in-advertising							Battery Storage Durabitiy	Battery Deep Discharge Protection	Battery Over-charge Protection	Lumen Mainte-nance	Drop Test Durability	Switch, Connector & Strain Relief Durability	Physical Ingress Prote-ction	Water Ingress Protection (portable products only)	Water Ingress Protection (PV module)	AC-DC Charger Safety
			Battery capacity	PV Power	Full-battery Run Time	Solar Run Time	Luminious Flux												
SL 1	NO	FAIL	PASS	PASS	PASS	NR	PASS	PASS	FAIL	PASS	FAIL	PASS	PASS	PASS	PASS	PASS	FAIL	PASS	N/A
SL 2	NO	FAIL	FAIL	PASS	FAIL	FAIL	FAIL	PASS	FAIL	FAIL	FAIL	FAIL	PASS	FAIL	PASS	PASS	FAIL	PASS	PASS
SL 3	NO	FAIL	FAIL	PASS	FAIL	FAIL	NR	PASS	FAIL	FAIL	FAIL	PASS	PASS	FAIL	PASS	PASS	FAIL	PASS	FAIL
MLS 1	NO	FAIL	PASS	PASS	FAIL	FAIL	PASS	PASS	PASS	PASS	PASS	FAIL	PASS	PASS	PASS	PASS	FAIL	PASS	N/A
MLS 2	NO	FAIL	PASS	PASS	NR	NR	PASS	PASS	PASS	PASS	FAIL	PASS	PASS	FAIL	PASS	PASS	FAIL	PASS	N/A
MLS 3	NO	FAIL	FAIL	PASS	FAIL	FAIL	NR	PASS[1]	FAIL	FAIL	FAIL	PASS	PASS	N/A	PASS	PASS	PASS	PASS	N/A
MLS 4	NO	FAIL	FAIL	PASS	PASS	NR	NR	PASS	FAIL	FAIL	FAIL	FAIL	PASS	FAIL	PASS	PASS	FAIL	PASS	FAIL
MLS 5	NO	FAIL	FAIL	PASS	NR	NR	NR	PASS	FAIL	PASS	FAIL	FAIL	PASS	PASS	FAIL	PASS	FAIL	PASS	FAIL

*NR- Not recorded, *NA- Not applicable

Figure 18 : Full ISM testing results

Sources

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Finding the sweet spot: identifying affordable quality solar products for the last mile

As the off-grid solar (OGS) market has matured, and product choice has expanded, distributors and customers report finding it increasingly difficult to identify and procure high-quality, affordable products at the last mile.

This report brings together the GDC's findings from 6 months of research on the quality of best-selling non-quality-verified (non-QV) products in Kenya. Through a funnelled field survey and quality testing led by VeraSol, our research identified non-QV products that are close to meeting the Lighting Global Quality Standards while remaining highly price-competitive with leading products in the market today.

The GDC is an initiative by:

Practical ACTION

BoP INNOVATION CENTER

HYSTRA hybrid strategies consulting

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