EFFICIENCY FOR ACCESS

TECH TRENDS IN ENERGY ACCESS:

ASSESSING THE SOLAR WATER PUMP MARKET

Part of the Efficiency for Access Appliance Tech Trends Series

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Efficiency for Access Coalition

AUTHORS

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SOLAR WATER PUMP MARKET AT A GLANCE

The far-reaching consequences of climate change on agricultural systems are a growing concern, with significant implications for livelihoods and global food security. As drought risk increases, solar water pumps have emerged as a practical solution to ensure reliable water access for farmers.

Key findings:

- A recent study on productive use appliances highlighted solar water pumps (SWPs) as the most commercially mature agricultural technology in Asia and sub-Saharan Africa.
- When integrated with water storage facilities and sustainable irrigation practices like drip irrigation kits, SWPs can efficiently utilise water resources and satisfy crop water requirements, making them an attractive option for farmers.
- The increasing sales of SWPs in West Africa, and notably Nigeria, indicate a growing momentum to address the energy access gap and provide related services, such as irrigation, in the region.
- Through a 50% end-user incentive, CLASP's SWP Incentive Programme in India is boosting farmer confidence in sustainable irrigation with the potential for global scalability.
- Despite the availability of pay-as-you-go financing plans, SWP users often face difficulties meeting their monthly payments.

In 2021, approximately 2.3 billion people resided in regions grappling with acute water scarcity and stress.[1] A recent Efficiency for Access study focused on climate resilience in low-income communities highlighted drought as a significant concern. Droughts result in severe water scarcity, disrupting agricultural productivity and posing a direct threat to food security. SWPs offer a practical and transformative solution for this challenge, enabling a resilient food-water-energy system.

SOLAR WATER PUMP MARKET AT A GLANCE

So how can the global community expand access to SWPs? This market summary, part of an ongoing series focused on synthesising technical, impact and market research done by Efficiency for Access and partners, offers valuable insights into the evolving solar water pump market and provides recommendations to strengthen the sector. It examines trends among manufacturers and consumers of solar water pumps; identifies opportunities to enhance performance and affordability; assesses barriers to scaling; and offers actionable advice for various stakeholders, including investors.

This report highlights several important features of the current solar water pump market:

- Consumer preferences for pump type vary by size, with smaller pumps favoring engine-powered pumps due to lower upfront costs and higher flow rates.
- Submersible pumps continue to dominate the pump market, comprising 84% of the market share.
- Solar power is a cost-effective energy solution for groundwater irrigation in sub-Saharan Africa in numerous scenarios.
- SWP sales have consistently outpaced those of other large appliances, such as refrigerator units, since 2019.
- Knowledge and availability of proper installation services and reliable, affordable servicing and maintenance services are critical for scaling SWPs in any market.

In conclusion, the increasing prevalence of climate change poses a significant threat to agricultural systems and global food security. Explore the full report to learn more about improving climate-resilience through access to SWPs.

Image credit: Futurepump

MARKET TRENDS AND INSIGHTS

MARKET DYNAMICS AND CONSUMER CHOICES

A recent study on productive use appliances has highlighted solar water pumps (SWPs) as the most commercially mature agricultural technology in Asia and sub-Saharan Africa.[2] This finding is corroborated by the GOGLA off-grid market trends report series, which has shown that SWP sales have consistently outpaced those of other large appliances, such as refrigerator units, since 2019.[3] Despite these numbers, penetration in most countries is still quite low with an average of 1% of smallholder farmers in 12 out of 13 countries in sub-Saharan Africa having access to a SWP.[4]

In 2021, the global solar water pump market was estimated to be worth USD$ 2.79 billion. Projections indicate that it is poised for substantial growth, with an expected market size of USD$ 6.59 billion by 2030. This growth represents a registered Compound Annual Growth Rate (CAGR) of 10.02% from 2022 to 2030.[5]

The most recent report reveals a remarkable 63% surge in SWP sales during the second half of 2022. Notably, a significant portion of these pumps were sold in key markets such as Kenya, Nigeria, and India,[6] underscoring the growing global demand for this technology.

Between July 2019 and December 2022,[ii] Kenya was responsible for approximately 35% of global SWP sales, positioning the country among the most mature markets for SWPs (Figure 1). From 2019, at a regional level in Africa, East Africa has recorded the bulk share of SWP sales.

However, sales in West Africa have consistently been increasing, particularly in Nigeria.[7] This trend is also reflected in the sales of solar energy kits in West Africa, indicating growing momentum to close the energy access gap and delivery of related services such as irrigation in the region.

In Asia, India has the most arable land which stands at 17.5 lakh/sq.km.[8] This land is irrigated via over 30 million agriculture pump sets, out of which, 20 million pump sets are connected to the grid and around 10 million pumps are diesel pumps. While the current number of SWPs installed may be negligible compared to grid-connected and diesel-powered pumps, there exists an enormous untapped potential for SWPs that can bring about significant positive impacts on the environment and water resources if harnessed effectively. A market sizing study carried out in 2019 indicated a growing market for SWPs following the launch of the Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM) scheme but the market is expected to reduce as the government subsidy programme comes to an end.[9]

Our market scoping exercises show that submersible pumps are still the dominant pump category in key markets with 84% of the market share, while surface pumps constitute 14% and hybrid (surface and submersible) come in at 3% (Figure 2).

Figure 1. Evolution of SWP Sales Since July 2019: Kenya vs. Rest of the World

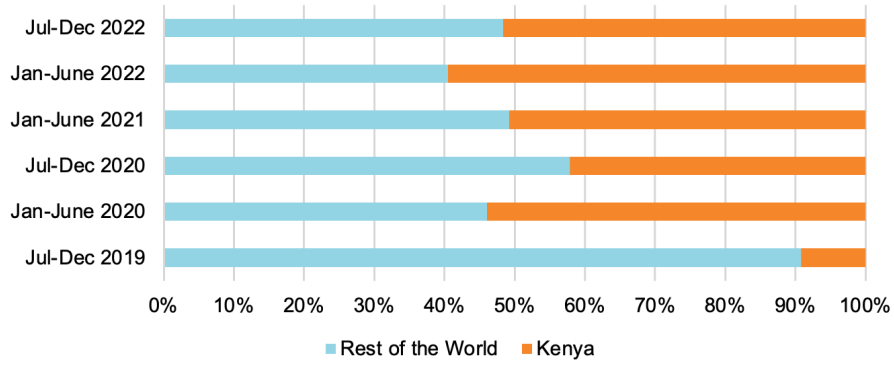
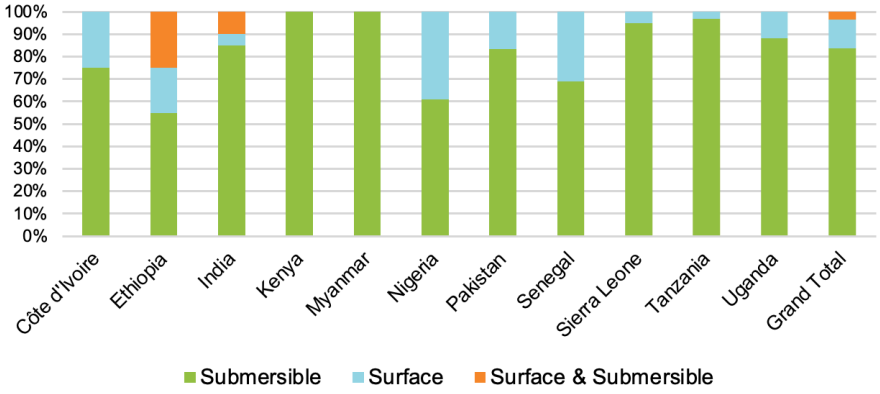


Figure 2. Types of pumps ranked by country



ii Estimates based on sales numbers reported to GOGLA by affiliated companies.

AFFORDABILITY ASSESSMENT

While many SWPs have made significant strides in improving efficiency through the adoption of brushless DC and permanent magnet motors,[10] a critical obstacle still hampers their widespread adoption: affordability. This challenge is compounded by the impact of weakening local currencies against the US Dollar, driven by the global economic slowdown, which directly affects the landing costs of SWPs.[ii] Consequently, a significant portion of potential consumers, particularly farmers, find themselves unable to bear the substantial upfront costs associated with these pumps.

Moreover, SWPs face stiff competition from alternative options, such as more affordable engine pumps (either petrol or diesel-powered) and grid-connected AC pumps. An entry-level SWP is priced at approximately USD$ 382, while an entry-level engine pump costs about USD$ 200. In India, for instance, electric pumps have gained popularity due to their cost-effectiveness, with the most budget-friendly option being around USD$ 250 for a 5 horsepower (HP) pump. In stark contrast, off-grid solar pumps demand an investment of approximately USD$ 3,700, while on-grid solar pumps[iii] of a similar size cost around USD$ 3,160.

Speaking to a major pump manufacturer and distributor in Kenya, sales for the larger engine pumps (above 20 HP) are reported to have been decreasing over the last few years as more consumers opt for solar powered pumping systems.[iv] For smaller pumps (less than 4 HP), however, most consumers prefer the engine pumps over SWPs, owing to their lower upfront cost and higher flow rate. While the upfront cost of engine pumps may be lower than SWPs in the same category, the overall lifecycle cost of a SWP is generally lower than an engine pump, especially when fuel prices have been rising in most low-income countries.

A recent study highlights that solar power provides a more cost-effective energy solution than incumbent diesel pumps for groundwater irrigation in sub-Saharan Africa under many circumstances.[11] Further, SWPs paired with water storage facilities and sustainable irrigation practices such as drip irrigation kits make up for the lower yield, encourage sustainable use of water resources and more importantly satisfy crop water needs more efficiently.

THE OPPORTUNITY FOR FINANCE

Smallholder farmers (SHFs) face a particularly complex affordability challenge with solar water pumps (SWPs) compared to other productive-use appliances - arising from the varying factors that affect the profitability of using a SWP, including farm productivity, access to profitable markets for their produce, and the presence of competing household needs. Even with pay-as-you go payment plans, SWP users still struggle to keep up with their monthly repayments. Our recent research to understand the impacts of SWPs on their users revealed that nearly half of the interviewed SWP users had to make unacceptable sacrifices to make product repayments.[12] This underscores the need for an enabling end-to-end support system (agronomy support, reduced food loss through cold storage, drying and value addition, and access to good markets for farm produce) to enhance adoption of SWPs and other productive use equipment.

ii Most pumps are imported from China, India and the US and weakening local currencies against the USD have seen landing costs skyrocket.
iii On-grid pumps are generally AC motors connected to grid electricity.
iv Most of these large pumping systems are mainly donor-funded community water supply systems which have seen a major shift away from diesel-powered pumps to low opex/operating cost solar pumps.

Image credit: Shell Foundation

INSTALLATION, SERVICING AND AFTERSALES SUPPORT

Knowledge and availability of proper installation services and access to reliable and affordable servicing and maintenance services are crucial in scaling SWPs in any market. Our recent field testing of SWPs revealed that the performance of a SWP is dependent on site-specific factors such as the vertical and horizontal lengths where the water is pumped, the type and diameter of the pipes used, and source of water. The findings further show that proper training of installers and strict adherence to installation and operational guides during installation mitigate against variability in SWP performance over time.[13]

Manufacturers have a responsibility to provide adequate information and guidelines on installation and routine maintenance of SWPs, while installers have a duty to follow these guidelines to ensure optimum pump performance and ensure customer satisfaction. The 2019 Global LEAP SWP Test Method requires that pump manufacturers provide user and operational manuals and evaluates pumps on the presence of solar photovoltaic (PV) operation guidelines, installation requirements and guidelines, product operation and maintenance guidelines.[14] Pumps tested and evaluated under this method can be accessed through the VeraSol product database.

In most off-grid markets there are critical gaps in a healthy installation, servicing, and maintenance ecosystem. While the incumbent engine pumps are easily repairable, SWPs require specialised technical training which is currently not readily available. Our recent report identified a gap in aftersales services support where nearly half of SWP users who experienced problems with their pumps reported that the issue had not been resolved.[15] To address this, distributors, manufacturers, and technical trainers must leverage existing local technicians through training and upskilling to increase the pool of certified technical installers and repair technicians. Some manufacturers such as Lorentz have been providing specialised training[16] to engineers, technicians, and aftersales support staff through its partner distributors and training centers such as the Strathmore Energy Research Center.

ACCESS TO ALTERNATIVE WATER SOURCES

Access to a reliable and sustainable source of water is a prerequisite to improving food security and ensuring maximum profitability from using a SWP. While not all farmers have access to surface or groundwater sources such as wells and boreholes, rainwater harvesting, either from surface runoff or from rooftops, can completely shift the tide in irrigation, and potentially double the current market size estimates. Speaking to farmers in Kenya, access to water was identified as a major stumbling block to the adoption of solar irrigation in Kitui, Siaya, Uasin Gishu and Garissa Counties. Additionally, data from our recent SWP field testing show that there is a direct correlation between water sufficiency, water storage practices and consumer satisfaction, where SWP users who did not practice water storage expressed frustrations with their pump not meeting their irrigation needs.

From our field testing of SWPs, we recommend that SWP manufacturers and distributors bundle SWPs with water storage facilities or recommend buyers to purchase harvesting and storage structures to ensure maximum productivity from the pump and as a means to encourage sustainable use of water resources.

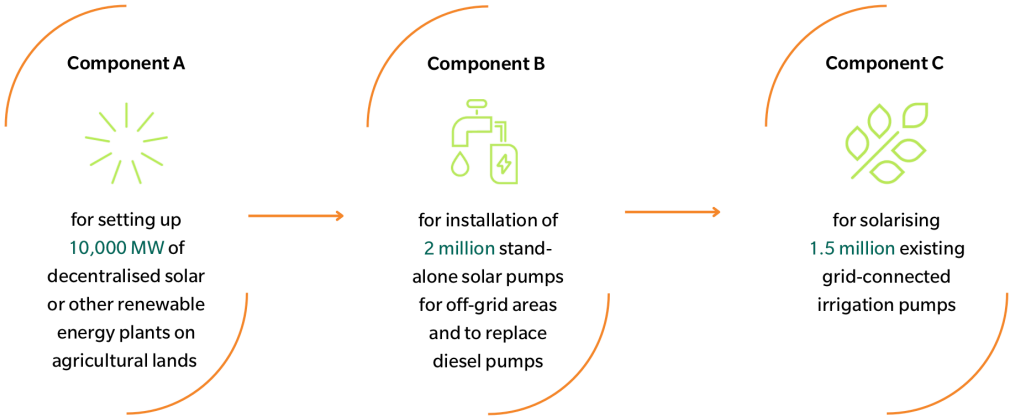
Figure 4. Drip irrigation from rooftop water harvesting

CASE STUDY 1

TRANSFORMING AGRICULTURE:
SOLAR WATER PUMPS AND SUSTAINABLE IRRIGATION
INDIA

In India, the demand for electricity to power irrigation has consistently increased over the past five years, primarily due to subsidized and often unmetered electricity supply. This situation has resulted in significant challenges, such as farmers over-consuming energy by running their pumps for extended periods during irrigation, leading to a troubling depletion of groundwater levels across the country. To address this critical issue, the Indian government began actively promoting solar irrigation pumps since 2019.

In 2014 and 2015, the Central Government set an ambitious target of deploying 1 million solar pumps by 2020-21 as part of a comprehensive scheme. This scheme encompasses three major components, as illustrated in the figure below. In the Budget for 2020-21, an expansion of the scheme was announced and later approved by the government. Notably, this expansion included the introduction of feeder-level solarization as a new variant under Component-C, significantly increasing the targeted solar capacity addition to 30.8 GW. According to the Expenditure Budget document for 2023-24, Rs 1996 crore is allocated for PM KUSUM program.[17]



Achievement as of 30 June 2023

Component A	Component B	Component C
Total sanctioned solar capacity (MW) **4716**	Total sanctioned standalone pumps installed **947991**	Total sanctioned individual pump solar (IPS) **121930**
Total installed solar capacity (MW) **113.06**	Total installed standalone pumps **244373**	Total installed individual pump solar (IPS) **1519**
		Total sanctioned feeder level solar (FLS) **2205279**
		Total installed feeder level solar (FLS) **0**

The successful implementation of the Solar Water Pumps (SWPs) program will not only contribute to sustainable agriculture and rural development but also align with global efforts to combat climate change and ensure access to clean and safe water for all.

CASE STUDY 2

EMPOWERING AGRICULTURE THROUGH INNOVATIVE FINANCIAL SOLUTIONS

KENYA

In Kenya, Equity Bank plays a vital role in supporting smallholder farmers by offering tailored financial products designed to address the challenges of accessing financing for mechanization, water harvesting, and storage. The bank's Maji Loan, for instance, provides unsecured financing for the purchase of essential equipment, including tanks, water connections, boreholes, shallow wells, water pumps, and more, enabling users to access water resources. Additionally, Equity Bank offers the Kilimo Biashara loan, which assists small-scale farmers in purchasing farm inputs like certified seeds, fertilizers, chemicals, machinery, hiring labor, and covering harvesting costs. To further ease the burden of loan repayments, the bank collaborates with cooperatives to customize financial products, both unsecured and asset financing, to align with cropping cycles and harvesting times.

In partnership with 4R Digital, Davis and Shirtliff have launched Daylipa, a platform aimed at providing flexible credit solutions for customers seeking to acquire irrigation and other productive use equipment. Through a mobile app, users can save towards equipment ownership, which can later be redeemed at any of their retail outlets. Daylipa's vision includes offering irrigation equipment on credit, allowing users to pay as they use by pre-loading tokens onto their PAYGO module.

In parallel, CLASP and Nithio, with support from the Global Energy Alliance for People and the Planet, have introduced the Productive Use Appliance Financing Facility. This initiative aims to make productive use appliances, including Solar Water Pumps (SWPs), more accessible and affordable to consumers and businesses in countries such as DRC, Ethiopia, Kenya, Nigeria, Uganda, and Sierra Leone. The facility's objectives include assisting companies in accessing working capital, expanding to new geographic areas, and reducing the upfront costs associated with these productive use appliances.

CASE STUDY 3

CLASP'S INNOVATIVE SOLAR WATER PUMP INCENTIVE PROGRAMME

INDIA

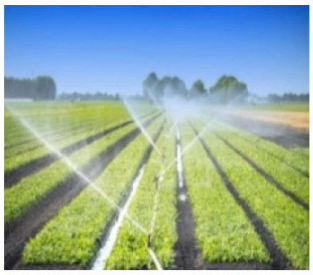
In an effort to boost farmers' confidence in the potential productivity gains and income growth associated with Solar Water Pump (SWP) irrigation, CLASP, with support from IKEA Foundation, has launched a pioneering program. This initiative not only seeks to demonstrate the benefits of sustainable SWP usage but also aims to alleviate the financial burden faced by many farmers.

Currently in its pilot phase, the program is being implemented across three distinct geographical regions in India, involving the participation of 100 small and marginal farmers. The primary objective of this pilot program is to assess the effectiveness of an end-user incentive scheme and its impact on farmers' adoption of SWPs.

Under the current program criteria, farmers who meet specific conditions are eligible to receive incentives to assist them in repaying their SWP loans. Upon meeting the prescribed criteria, farmers become eligible to receive an incentive equivalent to 50% of the total pump cost, with the remaining 50% being the responsibility of the farmers themselves.

This innovative subsidy model holds the potential to extend beyond SWPs and encompass other productive end-use appliances. The initiative's success in India may serve as a promising blueprint for future expansion to benefit farmers and communities globally.

Impact Areas Identified for the Incentive Program:



WATER USE EFFICIENCY	AGRICULTURAL PRODUCTIVITY	AGRICULTURAL COST REDUCTION	SOCIO-ECONOMIC DEVELOPMENT
Monitoring change in pattern, timing and amount of water used for irrigation and increase in water efficiency	Monitoring changes in the agricultural productivity and development of the ecosystem	Reduction in irrigation cost owing to the shift to solar electricity from diesel and electric pumps	Monitoring socio-economic development and holistic growth of the farmer

FUTURE OUTLOOK

SWPs hold significant promise - with high potential for impact on farmers, particularly in off-grid and weak-grid areas, where electricity access is unreliable and costly.

However, achieving widespread adoption and market maturity requires a comprehensive and multi-pronged approach that involves various stakeholders collaborating towards a common goal. Some of the options for making SWPs a more viable solution has been listed below.

SCALING ADOPTION OF SOLAR WATER PUMPS REQUIRES FLEXIBLE BLENDED FINANCE

There is a need for both demand side and supply side subsidies to address affordability and access to financing for SWP companies and consumers alike. Grants, results-based financing (RBF), concessional loans, technical assistance and matchmaking support are needed for SWP companies to lower costs of their equipment, expand to new markets or pilot new business models.

In its initial application window, The Productive Use Appliance Financing Facility by CLASP and Nithio received more than 1,500 SWPs, with an average subsidy request of 36% the Free on Board (FOB) price per unit. While the average subsidy request was lower than other productive use appliances like refrigerators, mills, electric pressure cookers (EPCs) and fans,[v] there is still a clear need for more financing to SWP companies to reach maturity in these target markets. Additionally, the provision of end user subsidies and tailor-made financial solutions for SHFs such as loan repayments matched to cropping cycles can significantly increase affordability of SWPs.

OPPORTUNITY FOR UPSKILLING LOCAL SWP TECHNICIANS

While most SWP companies bear the burden of training and upskilling their workforce and partner distributors to ensure an effective installation and aftersales support ecosystem, more technicians are needed as more products enter the market where non-vertically integrated companies dominate the market. Leveraging existing technicians by training and certifying them to support the installation and repair ecosystem can ensure that end users have access to affordable and reliable repair and maintenance services.

NEED FOR INCREASED COLLABORATION BETWEEN WATER, ENERGY AND FOOD SECTORS

To sustainably scale solar irrigation and address food security, concerted efforts and better coordination across relevant sectors are needed to implement interventions including harmonising policies across sectors that can support the scale up of SWPs such as tax incentives for innovators and quality standards harmonisation across countries or regional blocs.

BOOST PRODUCT QUALITY THROUGH VOLUNTARY AND MANDATORY SWP QUALITY STANDARDS

Standards are essential in ensuring quality and performance of the products sold in the market and to create product confidence and awareness among end-users and sector players. In nascent product markets, voluntary standards can encourage the early adoption of quality products while mandatory standards in more mature markets can reduce market spoilage and accelerate growth by increasing consumer and investor confidence.

ENCOURAGE WATER HARVESTING AND SUSTAINABLE IRRIGATION METHODS

Water harvesting has the potential to increase the market for solar irrigation while reducing groundwater overuse. Coupled with sustainable irrigation methods such as drip irrigation kits, highly efficient SWPs can boost crop yields while using less water. With most farmers still relying on inefficient irrigation methods such as sprinkler and overhead irrigation, training and demonstration can accelerate the adoption of these sustainable irrigation methods and increase the uptake of SWPs.

v Market summaries on all of these appliances will be available in the coming months, visit 2023 Tech Trends in Energy Access to learn more.

FURTHER READING

TECHNOLOGY-SPECIFIC RESOURCES:

Evaluating Appliance Performance in the Field: Results from Solar Water Pumps Testing — An insightful report presenting the findings of a technical performance monitoring study conducted between 2021 and 2022 on a range of SWPs to understand how user behavior affects the technical performance of these pumps.

Designing and Implementing Field Testing for Solar Water Pumps - A practical guide on monitoring SWP performance and efficiency in the field to inform decisions about product design, financing, business models and more.

Solar Water Pump Durability Research Memo — Highlighting recommendations for how to enhance SWP durability and identifies opportunities for improving existing test methods and quality assurance efforts.

MARKET-SPECIFIC RESOURCES:

Efficiency for Access Country Profiles — Deep dives on off- and weak- grid sector and appliance performance data, including solar water pumps, for key markets, including India, Sierra Leone, Nigeria, Uganda, Ethiopia, and Pakistan.

Solar Water Pump Outlook 2019: Global Trends and Market Opportunities - A report providing an analysis of the current and future market trends for SWPs in sub-Saharan Africa and South Asia.

Solar-Powered Irrigation Systems: Challenges & Opportunities in Kenya — A workshop readout identifying barriers to scaling solar powered irrigation among smallholder farmers (SHFs) in Kenya including recommendations to addressing each barrier and the necessary actors required.

GENERAL

Building Resilience in Low Income Communities — The Role of Off-Grid Appliances: A Case Study of Siaya County, Kenya — A report examining community resilience in the context of climate change, focusing on the role of off-grid solar products and equipment in supporting low-income communities in Kenya.

Appliances for All: Assessing the Inclusivity of the Solar Lighting and Appliances Sector — A comprehensive report examining how well solar lighting and appliances, including SWPs, are reaching key populations, and assesses inclusion across solar company employment practices and product offerings.

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