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SOLAR WATER PUMPS

Solar Appliance Technology Brief

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Photo Credit: Aggrico

CONTEXT

This technology brief is one in a series of insight briefs developed to synthesize the latest market intelligence and chart the pathway to commercialization for some of the off- and weak-grid appropriate technologies most relevant to catalyzing energy access and achieving the Sustainable Development Goals.

The first iteration of the LEIA Technology Summaries was published in 2017 to help the newly established Efficiency for Access Coalition navigate a nascent market. At the time there was limited data and reliable research available on market trends and performance of appliances suitable for resource-constrained settings. This brief updates and expands on these summaries, bringing together the latest insights on market and technology trends, consumer impacts, and pathways to scale for solar water pumps intended for use by small holder farmers. You can access briefs on all technologies that are a part of this series here.

This brief was developed by CLASP and Energy Saving Trust as part of Low Energy Inclusive Appliances programme, a flagship program of the Efficiency for Access is a global coalition working to promote high performing appliances that enable access to clean energy for the world's poorest people. It is a catalyst for change, accelerating the growth of off-grid appliance markets to boost incomes, reduce carbon emissions, improve quality of life and support sustainable development.

This brief was authored by Jenny Corry Smith and Michael Spiak of CLASP. We thank Adrian Honey (Lorentz), Martina Groenemeijer (Futurepump), Max Garnick (SunCulture), Cai Williams (Impact Pumps), Yasemin Erboy Ruff and Elisa Lai (CLASP), Leo Blyth (Energy Saving Trust) and others for their review and input.

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SDG INTERLINKAGES

SOLAR WATER PUMPS

- **SDG 1:** No Poverty
- **SDG 2:** Zero Hunger
- **SDG 4:** Quality Education
- **SDG 5:** Gender Equality
- **SDG 6:** Clean Water & Sanitation
- **SDG 7:** Affordable & Clean Energy
- **SDG 8:** Decent Work & Economic Growth
- **SDG 9:** Industry, Innovation & Infrastructure
- **SDG 10:** Reduced Inequalities
- **SDG 11:** Sustainable Cities & Communities
- **SDG 12:** Responsible Consumption & Production
- **SDG 13:** Climate Action

Solar water pumps can increase farm yields three-fold, increasing household income and food security. As women and children are often responsible for collecting water, a pump reduces drudgery, freeing time up for children to study and for women to engage in other activities that can increase productivity and quality of life.

Introduction

Approximately 95% of farmland in Sub-Saharan Africa and 60% in South Asia is rainfed, reliant on unpredictable weather patterns. Solar water pumps—a clean, modern irrigation solution—have the potential to increase yields by two to three-fold, depending on crop and climate.[1]

This brief focuses on agricultural applications of small-scale solar-powered pumps able to irrigate one to five acres with access to surface water, such as streams, or access to groundwater from an underground well or borehole.[2] These pumps may also be used to collect water for household or community uses; however, these applications are excluded from this brief.

Pump categorization

Solar water pumps are highly customisable depending on crop-specific water needs, climate, weather patterns and water source. There is also a suite of components (e.g. tubing, sprinklers, drip and sensors) that enable irrigation and can improve overall performance. Pumps can be categorised by a variety of factors, but are primarily defined by their orientation to the water they pump and their capacity.

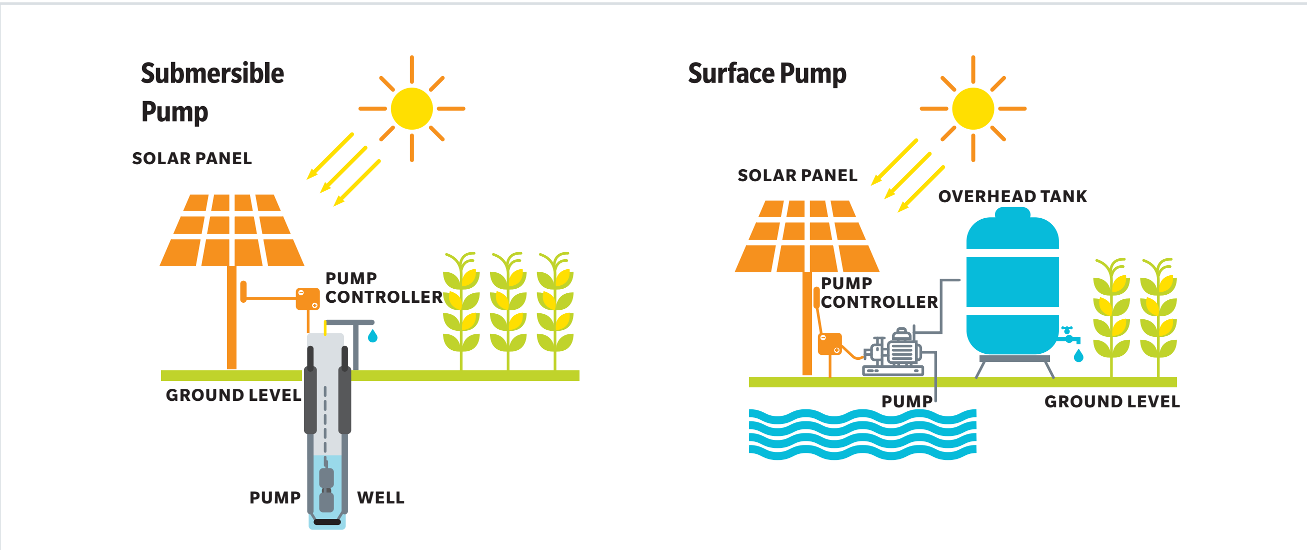
Pump Categories:

- **Surface pumps** draw water from surface sources, such as streams and ponds. The pump itself is designed to be situated outside of the water source (Figure 1). The accessibility of surface pumps can present a trade-off between convenience of installation and maintenance, as well as exposure to the elements and potential theft. Some surface pumps are now designed to be mobile to address these concerns.
- **Submersible pumps** are designed for underwater installation, such as in boreholes and wells (Figure 1). Whilst they are generally less accessible, they do not need to be primed and are not constrained by some of the physical limitations of surface pumps, such as suction lift limits (i.e. the maximum vertical distance the pump can pull water in before pumping it out).

Capacity/Size:

- **Pumping head** is the vertical distance a solar water pump is able to pump water, measured from the surface of the water source. Head is often measured as a unit of pressure in the pumping system. It includes friction losses of water moving through the system, such as the discharge pipe or sprinkler irrigation equipment.
- **Volume of water pumped per day** is the amount of water a solar water pump is able to pump with available solar irradiation per day.

Figure 1. Basic Components of Submersible and Surface Pumps



1. Efficiency for Access, Solar Water Pump Outlook 2019: Global Trends and Market Opportunities (2019): https://efficiencyforaccess.org/publications/solar-water-pump-outlook-2019-global-trends-and-market-opportunities.
2. These pumps have capacities of less than 2 HP and 2250W PV arrays (with most in the 200-600W range), that operate with head depths less than 100m, and move less than 60m3 a day assuming average solar conditions.

- **Power capacity** is sometimes measured in horsepower (HP) or photovoltaic (PV) array watts (W). It is determined by the required head depth and volume of water needed each day and is adjustable for each pump (i.e. more or less PV arrays can be added, as needed).

Other design considerations include the use of water tanks and batteries built into the charge controller to give the user more flexibility the timing of irrigation activities.

State of Play

The market for solar irrigation solutions designed for use on smallholder farms, whilst young, has leveraged the technology innovations of the more mature market for commercial, large-scale solar water pumps (Figure 2). Over the last two decades prices have declined by over 80%.[3] Solar water pumps are both replacing incumbent products (e.g. diesel and grid-connected electric pumps) as well as creating new markets (e.g. farmers who are not currently using pumps to irrigate but would get value from doing so).

The 2017 LEIA Solar Water Pump Technology Summary identified advances in brushless DC motors, PAYGo firmware and GSM-enabled systems as innovations that would improve performance and affordability for smallholder farmers.[4] Today, there are now pumps available in the market that incorporate all of these innovations.

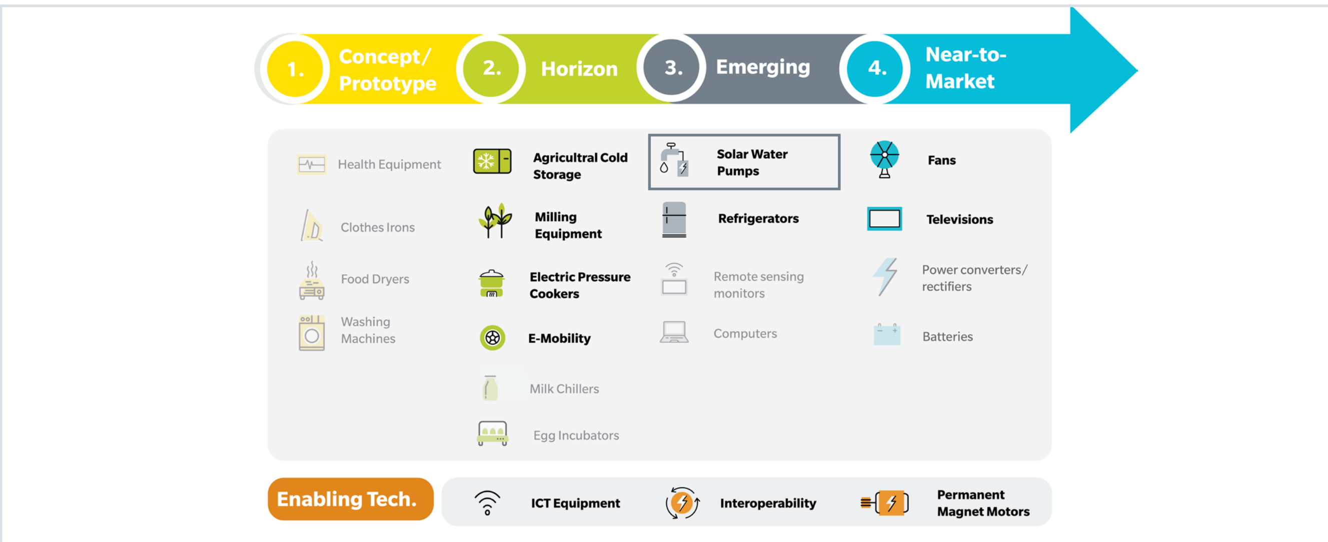
34 solar pumps were lab tested through the 2019 Global LEAP Solar Water Pump competition and associated results based financing program.[5] On a partly cloudy day, the daily wire-to-water efficiency[6] across all tested pumps—nearly all of which a used brushless DC motor—varied from 11-60%, with an average efficiency of 32%. The average efficiency of tested surface and submersible pumps on a typical solar day is similar—with surface pumps averaging 29% and submersible pumps at 33%.[7] Across all pump types, the PV array accounts for 30-50% of the overall price of the solar water pump system (Figure 3).[8]

Market Insights

The solar water pump market is highly variable across regions, particularly when comparing India with Sub-Saharan Africa. The Indian government has launched several subsidy programs for solar water pumps, but the total number of installations is low compared to the number of electric and diesel pumps. It is estimated that of the 30 million irrigation systems installed, 70% are electric, 29% are diesel and 1% are solar.[9] The PM KUSUM scheme provides a 60% subsidy for solar water pumps from the Indian government with a goal to install 2.75 million pumps by 2022.[10] Pumps sold in India are generally larger than those sold in Sub-Saharan Africa.[11]

The solar water pump market in Sub-Saharan Africa for smallholder farmers is nascent with low penetration, little immediate demand and a large impact potential. Of the 4% of farmers in Sub-Saharan Africa that irrigate their land, most use buckets, followed by diesel or electric water pumps. Cumulative solar water pump sales are estimated to be less than 50,000 and annual sales are approximately 10,000.[12] However, these estimates only represent sales from a small group of companies

Figure 2. Relative Market Maturity of Solar Appliances



3. Efficiency for Access, Solar Water Pump Technology Roadmap. (2019), pg. 13, https://efficiencyforaccess.org/publications/solar-water-pump-technology-roadmap.
4. Efficiency for Access, Low Energy Inclusive Technology Summaries. (2017), https://efficiencyforaccess.org/publications/low-energy-inclusive-appliance-technology-summaries.
5. VeraSol, VeraSol Product Database: Solar Water Pumps (2020): Accessed March 2021. https://data.verasol.org/products/swp.
6. Wire to water efficiency is a measure of hydraulic power generated by a solar water pump divided by its input power.
7. Efficiency for Access, 2021 Appliance Data Trends: Insights on Energy Efficiency, Performance and Pricing for Off-Grid and Weak-Grid Appropriate Appliances (2021): https://efficiencyforaccess.org/publications/2021-appliance-data-trends.
8. Id.
9. Lelin Thouthang and Rohin Kumar, Can India's 30m Gird/Diesel Irrigation Pumps Go Solar?, energypost.eu, July 1, 2019, https://energypost.eu/can-indias-30m-grid-diesel-irrigation-pumps-go-solar/ https://energypost.eu/can-indias-30m-grid-diesel-irrigation-pumps-go-solar/.
10. Institute for Energy Economics and Financial Analysis, India: Vast Potential in Solar-Powered Irrigation. (2018).
11. Efficiency for Access, Off- and Weak-Grid Solar Appliance Market: India. (2020), https://efficiencyforaccess.org/publications/off-and-weak-grid-solar-appliance-market-india.
12. GOGLA, Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data H1 2020. (2020), https://www.gogla.org/global-off-grid-solar-market-report.

that report sales to GOGLA.

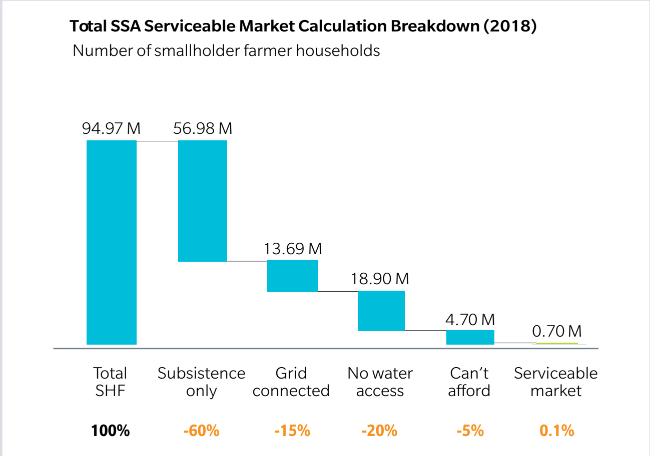
Historically, few incentives and subsidy schemes have targeted smallholder farmers, but this is beginning to change. In December of 2020, leading industry stakeholders BBOXX, EDF and Sunculture announced a partnership with the Government of Togo to subsidise solar water pumps. The government is providing a 50% subsidy to halve the cost of irrigation systems for 5,000 farmers.[13] This is alongside exemptions on import duties and VAT, making the pumps more affordable. The 2020 Global LEAP Results Based Financing Program supported the sale of 6,115 solar water pumps in East and West Africa.[14]

There are approximately 95 million smallholder farmers in Sub-Saharan Africa; however, only 0.1% are currently serviceable for solar water pumps.[15] The serviceable market for solar water pumps represents 700,000 African households and is worth USD 500 million (Figure 3).[16] The market has the potential to triple and reach 2.8 million households by 2030—a value of approximately USD 1.6 billion.[17] In India the serviceable market is much larger—approximately USD 15.1 billion.[18] The market, however, is expected to decrease to USD 9.4 billion in 2030 as subsidies are phased out.[19] These market size estimates are conservative and may increase as incomes grow, pump prices decrease or farmers gain access to water.

The landscape of market actors in the solar water pump sector includes large multi-national companies as well as start-ups based in Africa and South Asia. Business models vary from vertical integration to manufacturing, distribution and servicing specialists.[20] It is unclear how many companies are selling solar water pumps to smallholder farmers. Thirty companies participated in the 2019 Global LEAP Awards Solar Water Pump Competition, but this sample does not represent the entire market. In the small market of Sierra Leone, 52 unique models sold by 23 brands were identified in Freetown and Makeni.[21] Affordability is a top barrier to market growth. The upfront cost of a solar water pump is still relatively high compared to a diesel pump—the average entry-level diesel pump starts at USD 200 compared to USD 600 for a solar equivalent. However, when accounting for fuel costs, the payback period for solar water pumps is less than 18 months.[22] The return on investment is fastest for farmers using their solar water pump to grow high-value horticultural crops.[23]

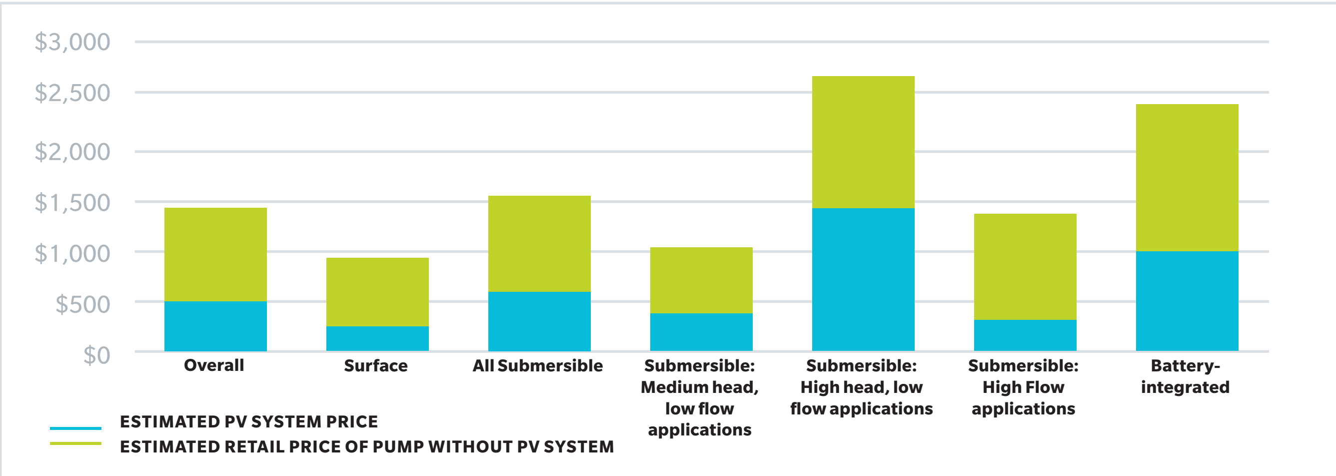
Solar water pumps are often customised to end-user needs and environmental conditions. As a result, their price varies widely depending on type, use case, capacity and design features. 2019 Global LEAP Awards pricing data indicates that submersible pumps are on average more expensive, likely

Figure 3. Serviceable Market for Solar Water Pumps in Sub-Saharan Africa



Source: International Finance Corporation. The Market Opportunity for Productive Use. (2019).

Figure 4. Average Solar Water Pump and System Price by Pump Type



Source: Efficiency for Access, Appliance Data Trends 2021.

13. BBOXX, EDF and Sunculture, Bboxx teams up with EDF to expand access to sustainable solar-powered farming. 2020. https://www.bboxx.com/press-releases/bboxx-teams-up-with-edf-to-expand-access-to-sustainable-solar-powered-farming/.
14. "Solar Water Pumping Solar Water Pumping." Global LEAP Awards. Accessed April 29, 2021. https://globalleapawards.org/solar-water-pumps.
15. The serviceable market breakdown is shown in Figure 2. It represents all SHF that can afford a solar pump and would be able to use it.
16. International Finance Corporation. The Market Opportunity for Productive Use Leveraging Productive Use Solar Energy (PULSE) in Sub-Saharan Africa. (Washington, DC: 2019), https://www.lightingglobal.org/resource/pulse-market-opportunity/.
17. Efficiency for Access, Solar Water Pump Outlook 2019, pg. 6.
18. Id.
19. Id.
20. Id.
21. Efficiency for Access, Off- and Weak-Grid Solar Appliance Market: Sierra Leone. (2020), https://efficiencyforaccess.org/publications/off-and-weak-grid-solar-appliance-market-sierra-leone.
22. International Finance Corporation. The Market Opportunity for Productive Use. (2019).
23. Efficiency for Access, Solar Water Pump Outlook 2019, pg. 22.

due to larger capacity and design features that allow them to be submerged (Figure 4). Smallholder farmers are highly price sensitive and manufacturers face a trade-off between supplying a more durable pump at a high cost or developing a more affordable pump that may require more maintenance and operational expenditures over time.

Consumer Impacts

Water pumping can increase yields as much as three-fold, providing households with a more predictable source of disposable income (Figure 5).[24] Solar water pumps also build resilience to droughts and can help farmers to more easily adapt to changes in weather patterns as the climate changes.

A 2020 survey of energy access practitioners ranked solar/electric water pumps first in perceived development impact for both household and businesses/productive use applications.[25] A comparison to previous iterations of the same survey reveals an increase in perceived impact: in 2014, pumps ranked only fourth in perceived development impact.[26]

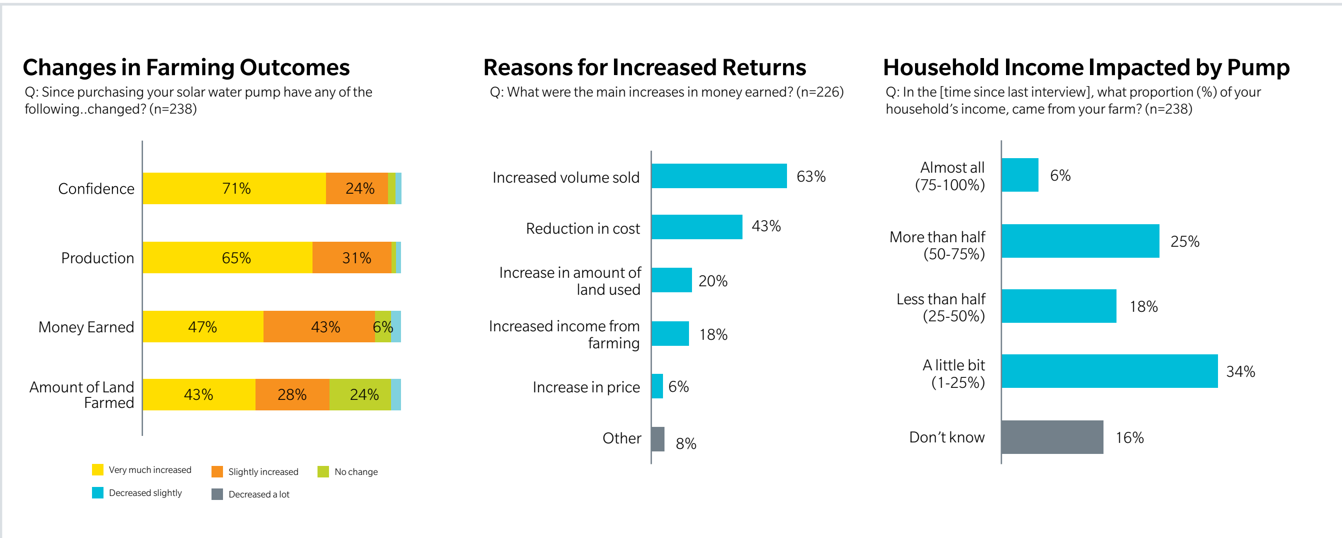
81% percent of solar water pump customers in East Africa reported that their pump improved their quality of life. Farmers report more confidence in their farming outcomes, improved productivity and income generation, and an increase in the amount of land farmed.[27] 88% percent of these customers reported that their pump was a ‘very good’ or ‘good’ value for money.[28] Further, solar water pump customers reported a higher perceived value for money than solar television and refrigerator customers.

Current Success and Remaining Challenges

The small-scale solar water pump market has grown significantly in the last three years. Reported sales are still low compared to diesel and electric pumps. However, momentum is building, demonstrating advances in market maturity.

- **Increased private investment and public funding:** There has been a notable increase in funding to support the growth of the solar water pump market since the last LEIA technology summary on solar water pumps was published.[29,30] However, few companies have received private investment and early stage companies still struggle to raise capital. Governments, including India and Togo, are subsidising solar water pumps sales and 12 of the 16 members of the Efficiency for Access Donor Coalition fund programmes or companies with a solar water pump focus.[31]
- **Healthy ecosystem of large multi-national companies and innovative startups:** Several large pump manufacturers are adapting their technology to meet the needs of smallholder farmers. Well established market leaders like Shakti Pumps, Lorentz and Grundfos are among the companies that participated in the 2019 Global LEAP

Figure 5. Changes Reported in Farming Outcomes Three to Nine Months After Solar Water Pump Purchase



Source: 60 Decibels and Efficiency for Access, report forthcoming

24. Id.
25. Efficiency for Access, Off-Grid Appliance Market Survey. (2020), https://efficiencyforaccess.org/publications/off-grid-appliance-market-survey-2020.
26. Id.
27. Efficiency for Access & 60 Decibels, Use and Benefits of Solar Water Pumps: Kenya, Tanzania & Uganda Consumer Research. (2018), https://efficiencyforaccess.org/publications/use-and-benefits-of-solar-water-pumps.
28. Id.
29. Johnathan Schieber, SunCulture Wants to Turn Africa Into the World's Next Bread Basket, One Solar Water Pump at a Time, TechCrunch, December 4, 2020, https://techcrunch.com/2020/12/04/sunculture-wants-to-turn-africa-into-the-worlds-next-bread-basket-one-solar-water-pump-at-a-time/?guccounter=2.
30. Crowdcube, Futurepump. Accessed March 2021. https://www.crowdcube.com/companies/futurepump/pitches/bgKvzb.
31. Efficiency for Access, Efficiency for Access Coalition Initiatives (2020). Accessed March 2021. https://storage.googleapis.com/e4a-website-assets/EforA-partner-map-Oct-20_210122_203121.png.
31. Global LEAP Awards, Global LEAP Awards 2019 Buyer's Guide for Solar Water Pumps. (2019), https://efficiencyforaccess.org/publications/2019-global-leap-awards-buyers-guide-for-solar-water-pumps.

CONSUMER PROFILE

Thika, Kenya

DROPPING DIESEL

Michael Njuguna is a 26 year old farmer who lives near Thika, Kenya. His family owns one acre of land and grows chilies, cucumbers, tomatoes, spinach, zucchini and onions. Prior to purchasing a 150 Watt SunCulture solar pump he irrigated his land with a 4.5 Hp diesel pump. Each day he was spending approximately USD 2.00 (200 KSH) on fuel and USD 1.00 (100 KSH) to transport fuel to power the pump. The down payment for the solar pump was USD 89 and the monthly payment was USD 39 for 13 months. He breaks even after owning the pump for just seven months compared to using the diesel pump everyday, showing a clear economic advantage of the solar pump.

In addition to the cost savings, Michael also now enjoys having lighting and the ability to charge his phone at the farm. Switching to the drip irrigation system that came with the solar pump has also reduced the amount of water used to irrigate and the number of weeds.

Awards Solar Water Pump Competition.[32] Over the last five years, several start-ups have launched offerings tailored to smallholder farmers.

- **Technology innovations:** More solar water pumps are using brushless DC motors. These motors are 10-40% more efficient than brushed AC motors and easier to repair and optimise through programmable controls.[33] The use of sensors and internet of things (IoT) can predict weather and schedule pump run times—reducing labour inputs, optimising pump performance, improving farm production and enhancing water management.
- **Business model and financing innovations:**
  - Offering end-user financing improves affordability. But even if financing is available, the down payment is an insurmountable hurdle for some farmers. Aptech Africa's "pay-n-pump" model allows farmers to purchase water from a pump on a per litre basis.
  - Pump add-ons such as water storage, drip irrigation systems and batteries can improve total system efficiency and give the end-user more flexibility in when they can access water. Bundling pumps with appliances can increase the value proposition for farmers who can also use their solar system at home and during the rainy season to power a television, lights and potentially even electric pressure cookers. Appliance and power system interoperability would give users more flexibility in what appliances can be used with the pump's power system.
  - An irrigation system's potential is not fully realised without considering how to adjust other inputs (e.g. crop selection, soil and fertiliser) to maximise productivity potential. Several companies offer access to agronomists and other support to set farmers up for success.

Despite these successes, solar water pumps have yet to realize their market and impact potential. Supply and demand side barriers that constrain market growth include: relatively high overall cost of the appliances combined with uncertain return on investment, low levels of consumer awareness and access to finance, and a broader ecosystem to help farmers maximize productivity.

- **Affordability:** Only 0.5% of smallholder farmers in Sub-Saharan Africa will be able to afford a pump (cost: USD 600-2,000) by 2030.[34] Only 25% of pumps sold in East Africa reach people that live below USD 3.10 a day.[35] In India, 60% of pumps observed in the retail market cost more than USD 1,000.[36]
- **Access to Financing:** Consumer financing is critical to bridge the affordability gap, but just 18% of adults in Sub-

33. Global LEAP Awards, Global LEAP Awards 2019 Buyer's Guide for Solar Water Pumps. (2019), https://efficiencyforaccess.org/publications/2019-global-leap-awards-buyers-guide-for-solar-water-pumps.
34. Efficiency for Access, Solar Water Pump Outlook 2019.
35. Efficiency for Access & 60 Decibels, Use and Benefits of Solar Water Pumps.
36. Efficiency for Access, Off-Grid Appliance Market Survey.

Saharan Africa who borrowed money in 2018 reported using a formal lender.[37] 25% percent of solar water pump sales reported to GOGLA between July 2018 and June 2020 were sold using pay as you financing,[38] but this mechanism faces unique challenges. Solar water pumps are more expensive than most SHS systems, more technically complex, are not used continually (e.g. during the rainy season) and are more challenging to market and distribute.[39]

- **Quality & Durability:** The quality and workmanship of solar water pumps in the retail market vary significantly. To unlock the full potential of solar water pumps, challenges related to pump quality and service must be addressed.
    - 51% of customers who have owned their pump for at least one year experienced challenges and the majority also reported that their pump was not in the same working condition as when it was new.[40] The top challenges reported were malfunctioning batteries and issues with the functionality of pump and parts such as valves and controllers.
    - Solar water pump performance can decline overtime, as systems are often pumping water with high levels of sand, clay or salt. Pumps need to withstand variances in water quality, as well as transport in rugged terrain, and should be easy to repair and maintain.
    - Comprehensive evaluation of quality and durability through laboratory testing can be expensive and time consuming. Limitations include available test lab capacity—particularly in Sub-Saharan Africa—and challenges in replicating real world conditions in a lab setting. More research and resources are needed to improve test methods to assess pump durability in "dirty water" conditions and develop quality standards.[41]
- **Installation and Servicing Ecosystem:** Selling and installing solar water pumps requires expertise, particularly for submersible pumps. To optimise submersible pump performance, the site selection process must consider water quality, weather, distance to crops and the water source. These factors can make it prohibitively costly to convert sales and provide maintenance, especially at the last mile. They also create a challenge for manufacturers to identify appropriate distribution partners. Less than 25% of farmers increase the amount of land they irrigate after purchasing a pump, showing that more training and assistance is needed to maximise the pump's potential.[42]
- **Consumer Awareness:** Efficiency for Access interviewed 400 commercial oriented farmers in Tanzania. Most of these farmers irrigated, but there was very low awareness of solar pumping technology and zero uptake. Most farmers who are familiar with the technology still have concerns about affordability and performance.[43] Once a farmer agrees to buy a pump, training is often needed to help them optimise yields and maintain the pump.

Photo Credit: Simusolar

38. GOGLA, Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data H1 2020.
39. IFC, The Market Opportunity for PULSE.
40. Findings from a longitudinal survey being conducted in partnership with 60 Decibels. Results of this three-year study will be published in 2022.
41. Efficiency for Access, Solar Water Pump Durability Research Memo. (2020), https://efficiencyforaccess.org/publications/solar-water-pump-durability-research-memo.
42. Efficiency for Access, Use and Benefits of Solar Water Pumps.
43. Efficiency for Access, Tanzania Market Snapshot: Horticulture Value Chains and Potential for Solar Water Pump Technology. (2019), https://efficiencyforaccess.org/publications/tanzania-market-snapshot-horticulture-value-chains-and-potential-for-solar-water-pump-technology.

Solar water pumps are commercially available, but have not yet reached large-scale deployment

The interventions recommended are appropriate for this level of maturity, and may change depending on regional and national markets. For example, in 2019 more than half of all solar water pump sales reported in Sub-Saharan Africa were sold in Kenya[44] and several donor funded trials have focused on this region. Lessons learnt and the subsequent recommendations from these experiences may differ from those in more nascent markets in West and Central Africa.

The most significant challenge to achieving market scale is affordability

Over the long term, economies of scale and rising incomes will help, but there are growing calls to provide smart subsidies and concessional financing to bridge the gap. One study projects a 2.7 fold increase in Kenyan solar water pump uptake if a 50% subsidy were offered, costing KES 9.6 billion over five years whilst increasing smallholder farmer by KES 622 billion.[45] Reductions or exemptions in taxes and duties and bulk procurement schemes[46] are other mechanisms that can reduce costs and encourage companies to expand to new markets.

Even with subsidies, consumer financing is still needed to help farmers spread payments on their solar water pump out over time

A risk guarantee agreement between the government and banks and microfinance institutions could incentivise more banks to provide solar water pump financing. A risk sharing scheme in Kenya is projected to cost KES 480 million over five years resulting in a KES 388 billion increase in farmer income.[47]

New business and partnership models are needed

Business models currently adopted or being piloted to address affordability and reduce financing risks include PAYGo, rentals, bundling pumps with household appliances, off-taker setups and using mobile pumps to sell water by the litre. Partnerships with off-takers can de-risk lending if a contract with a buyer is in place or an out-grower scheme connects smallholder farmers with a larger commercial farm. Beyond de-risking credit and market access, these partnerships can also offer agronomical advice to improve productivity. If these business models can scale, they will help expand access to consumer financing and bring investment capital into the market.

44. GOGLA, Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data H1 2020.

45. MercyCorps Agrifin, Policy Brief: Achieving Food Security in Kenya Through Small-Scale Irrigation. (2020), pg. 14, https://www.mercycorpsagrifin.org/project/policy-brief-achieving-food-security-in-kenya-through-smart-solar-irrigation/.

46. The International Solar Alliance is facilitating a global tendering process for design, testing, manufacturing, supply and maintenance of solar water pumps in ISA countries.

47. MercyCorps Agrifin, Achieving Food Security in Kenya Through Small-Scale Irrigation, pg. 16.

Increase support for R&D and innovation to reduce costs and tailor pumps to the needs of smallholder farmers

This includes developing sensors and IoT to monitor pump performance, improving pumping performance of dirty or saline water, increasing efficiency (e.g. switching reluctance motors) and improving repairability. Extensions to warranty periods and reductions in warranty exclusions may be needed to increase consumer confidence and enable pumps to be financed at scale as repairability improves. India's solar water pump subsidy and financing schemes, for example, require a five year warranty on all pumps. Innovations in how to dispense, distribute and deliver water are also needed. Misting and sensing technologies for semi-sealed greenhouses for niche crops like mushrooms are currently being piloted. Costs can also be reduced through streamlined manufacturing using single en-capsulation and injection molding, but the units sold annually need to be in the millions for this to be viable.[48]

Customer acquisition remains a pain point for many companies

They struggle with low consumer awareness and it is resource intensive to identify farmers who will see the most productivity gains from solar irrigation. Government or donor funded consumer awareness campaigns could target smallholder farmers, providing credible and independent demonstrations and education to sensitise farmers to the technology. Such campaigns can also help farmers select quality pumps that are appropriate for their needs and have a strong return on investment and teach them how to use the pump together with other inputs to maximise productivity.

Stakeholders can leverage big data analytics to identify high potential markets

Data collection and analysis through artificial intelligence and machine learning may help accelerate market growth. Efficiency for Access is developing a farmer productivity model that leverages satellite imagery, weather, soil and other data (e.g. the availability of agricultural extension services and crop varieties) to predict the productive potential of individual farmers in Kenya. With such data, solar water pump companies can carry out focused marketing campaigns and donors and investors can target funding to geographies that present the greatest opportunities.

Partnerships are critical for offloading companies' financing tasks

Partnerships with distributors who specialise in selling to farmers or agricultural extension services can also reduce customer acquisition costs and provide support for customer training and product servicing. Additional support may include evaluating the credit worthiness of customers and collecting payments. Sector support programmes like VeraSol provide performance benchmarks and can be used by distributors to identify pumps to add to their product line.[49] Other market interventions such as results-based financing initiatives can also be structured to facilitate new partnerships. The 2020 Global LEAP results-based financing scheme brokered partnerships between six global suppliers of high-quality solar water pumps and 17 distributors with operations in Sub-Saharan Africa to sell 6,115 solar water pumps.

48. Pmanifold Business Solutions Pvt. Ltv., Scaling up Solar Water Pumps in Asia and Africa, webinar, June 25 2020: https://www.youtube.com/watch?v=vqSIFYzlm-I.
49. To learn more about VeraSol, visit https://verasol.org/.

Photo Credit: Shell Foundation

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